SOUTHERN ELECTRICIAN

PUBLISHED MONTHLY

Vol. 45. JANUARY, 1913 No. 1

PUBLICATION OFFICE
DALTON, GA.

EDITORIAL and ADVERTISING DEPARTMENTS
GRANT BUILDING ATLANTA, GA.

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SUBSCRIPTION RATES

Domestic ---------- $1.00 For Two Years
Canada ---------- $1.00 Per Year
Foreign ---------- $1.50 Per Year

Complaints of failure to receive SOUTHERN ELECTRICIAN regularly or of any errors of any nature, should be promptly made to the Atlanta office.

Advertising copy or change orders for standing advertisements must reach the Atlanta office by the 5th of the month preceding the month of publication.

Entered at Dalton, Ga., Postoffice as Second-class Matter.

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The World's Largest Power Development.

In May of this year a number of noted engineers, members of the diplomatic corps, officials of the war department and other invited guests will assemble to see President Woodrow Wilson press the button that will set in motion the mighty turbines in the world's greatest power station at Keokuk, Iowa, and thus cause a dream of more than thirty years to become a fact. The achievement of harnessing the Mississippi river, for years believed impossible, is the greatest engineering feat of ages. Its magnitude, involving peculiar technical difficulties, has long dismayed eminent engineers who shook their heads and doubted its feasibility. Capitalists have gasped at the suggestion that they supply funds to erect a $25,000,000 dam and power station which, in the opinion of experienced builders, must end in failure. The article describing this project found elsewhere in this issue, is a story of a man and an idea—a man who had faith in himself and in his idea.

Hugh L. Cooper, unquestionably one of the world's foremost hydraulic engineers, builder of the remarkable plant at Niagara where the tailrace opens as a tunnel under the curtain of the falls, is the man who dared to place fetters on the mightiest river in North America. He has further dared to start this work in the face of discouragement that would have staggered an engineer of lesser caliber and determination. He, however, is the type of man who, when convinced of the correctness of his position, thrives on discouragement and opposition. After months of patient, careful investigation of the site for the projected dam, during which borings were made to a depth of more than sixty feet through an unbroken, seamless bed of blue limestone extending from the Iowa to the Illinois shore, Mr. Cooper prepared his plans. With their completion he began his arduous campaign of interesting capital. Thirty-eight times he was refused a dollar by the mighty financiers, many of whom had lost fortunes in water power projects developed under decidedly more favorable circumstances and which had cost enormous sums above original estimates. However, the pleased stockholders of the Niagara Falls company, for whom this engineer had erected a successful power station, were interested without much trouble and little by little stock was subscribed. Mr. Cooper spent every cent of his private fortune before he succeeded in financing the enterprise, the bonds and stocks of the Mississippi River Power Company being finally sold in New England, France, Germany, England, Belgium, Canada and in Keokuk. An idea of the enormity of the undertaking may be gained from the statement that the interest has been $1,000 a day for the last two years, work beginning on the actual construction in the winter of 1910.

Hugh L. Cooper is a native of Wisconsin and a self-made man who began life as a poor boy on a farm. He declines to discuss himself or his successes, being of a modest disposition and all mention of him in print is irritating.

The vast power going to waste in the Des Moines rapids was called to the government's attention by Robert E. Lee, who in 1837 while stationed near Keokuk made measurements of the flow. A chart, and a thorough report on the proposition was also made but the time was not ripe for grappling with such a problem and seventy-five years passed before it was pushed to conclusion. The Keokuk and Hamilton Water Power Company was formed in the 90s, bankers and business men of the two towns holding the stock. For years the project lagged until Mr. Cooper came on the scene, after which time things began to happen for in 1905 ex-President Theodore Roosevelt appended his signature to the act empowering the construction of the big dam. Four years were then taken up in interesting capital. Finally the long-expected message from Mr. Cooper came stating that the dam would be built. The pent-up feeling of the two towns broke forth and for hours, bells rang, sirens screamed and people of every station in life cheered and congratulated each other on the dawn of a new era. The two city councils appropriated public money and the legislatures of Iowa and Illinois helped to further the project. Congress ordered a thorough investigation, and finally the war department approved of the plans and work began in the winter of 1910. More than 2,000 men have since been steadily employed. Fifteen miles of standard railroad are operated within the works proper, and more than 10,000,000 feet of lumber were used in the form work of dam and power house and about 650,000 cubic yards of concrete will have been used before the development is completed. The large coffer dam covers an area of thirty-four acres, within which is located the power house, government lock with gates larger than those at Panama and the dry dock. None of the dam construction is done by contract and all men are employed by, and are under direct supervision of the chief engineer, Hugh L. Cooper.

When the spillways are closed next May the Mississippi above the dam will become a placid lake, from a mile to two and a half miles wide and sixty-five miles long. The dangerous rapids, which once were a menace to navigators and which caused many wrecks before the government built the Keokuk-Montrose canal, will be submerged beneath forty feet of water. A great sea wall from 45 to 72 feet high and miles long has been erected on the Iowa shore to prevent damage to property. On either side of the lake a boulevard has been laid out and fine residences are being built on the bluffs since the twelve miles between Nauvoo and Keokuk embrace some of the most beautiful river scenery in the United States.

The Keokuk power station is near the geographical center of the country, within a few hundred miles of St. Louis, Kansas City, Minneapolis, St. Paul, Louisville, Omaha, Memphis, Cincinnati, Toledo, Detroit, Sioux City, Wichita and Little Rock, and in every case within a thirty-six hours freight radius. From a manufacturing standpoint the location could not be more ideal. St. Louis already has contracted for 60,000 horsepower of electrical energy for ninety-nine years. It has been said that horsepower and population are related as five to one—thus if only 100,000 horsepower of energy be consumed in manufacturing goods at the base of supply, a city of at least 500,000 people will spring up in time.

Progress of the Hydro-Electric Industry.

The year 1912 is signalized by notable achievements in the progress of waterpower development throughout the country, and indeed throughout the world. The completion of some large projects, the inauguration of others and the vigorous prosecution of construction work on those already begun, have characterized the year as one of singular prosperity in the hydro-electric business. Great as are these indications of a healthy condition of the industry, they do not, however, constitute the most important contribution of the year 1912 to the history of waterpower development.

Before it could come into its own, waterpower had perforce to await the invention and development of electrical apparatus. Waterpower has been the industrial "sleeping beauty," and electricity has played the role of the versatile "Prince Charming," whose kiss she awaited from time immemorial before she might take her place in the world of great activity. But once awakened, what a marvelous creature is she proving herself to be. At Keokuk, Iowa, a powerhouse is fast nearing completion, where under a single roof nearly half a million horsepower is to be generated and transformed, and thence transmitted to distant places, there to be utilized, year in and year out. At the Centennial Exposition in Philadelphia in 1876, there was exhibited a great Corliss engine; it marked the acme of accomplishment thirty-six years ago in the triumphs of steam engineering. This great engine developed 1,400 horsepower. It occupied a floor space approximately 40 x 40 feet. Fancy a power house, designed to deliver half a million horsepower and equipped with a battery of such engines! Imagine the engines standing side by side in a single row with the battery of boilers similarly placed behind it. If the chief engineer were called from unit No. 1 to unit No. 357, he would have a three and one-half mile walk—he could scarcely get there short of an hour's time! Such a plant, operating at good present-day economy, would in one hundred years consume 620,000,000 tons of coal.

Within two decades we have passed through several eras. First, waterpower was of little economic or industrial importance. Then came the revolutionizing developments in electrical generating apparatus and presently there came higher voltages, and coincidentally came the perfecting of water-wheels and governors; and then waterpower was prepared to extend a strong right hand of fellowship to all the world of industry. For generations and centuries waterpower had been a thing of local interest and of local utility only. No one dreamed of utilizing it, save on a small scale. How absurd would have been the term "waterpower monopoly," for it would have been as well to talk about monopolizing the buttercups and daisies! But now there has indeed been a change. Immense capital was soon needed to swing a hydro-electric project. The local promoter must needs go to the money centers for assistance, and straightway waterpower securities took their place among first-class industrials. And still the public did not know that waterpower had become a public utility.

Presently there came to the new hydro-electric companies springing up all over the land the clear realization of the need for steam auxiliary plants. They increased their capitalization and absorbed the steam plants of public service corporations. Still more impressive became the need of coupling-up the waterpower plants within a given territory. By this process, the utility of a transmission system became immensely enhanced, and economies otherwise impossible became easy of accomplishment. The next era was one of combination and centralization of control, and next came the consolidation of combinations covering different and widely separated territories. The process was as natural as it was simple to effect. In all this there was no violation of law, or at least frequently there was none, and we should give the projectors of the combinations the benefit of any doubt as to their intention to control their markets or do other questionable acts which so frequently characterize trusts.

We have now led up to the year 1912. In our opening paragraph reference was made to the most important contribution of the year 1912 to the history of the hydro-electric industry. This most important contribution was the publication of the report by the United States Commissioner of Corporations on "Water Power Development in the United States." This report removes the question of the monopolistic trend of waterpower control from the realm of uncertainty and speculation, and spreads the facts out before us in broad daylight. Turning to the report, we learn as follows: "In California, six nominally distinct corporations, with their subsidiaries, control over 86 per cent of all the power developed in the state from water and a large amount (200,000 horsepower) of auxiliary steam power. As a matter of fact, however, these six companies are nearly all so inter-related that the power business of the state is already highly monopolistic. In Washington, one corporation owns 44 per cent and another 26 per cent—the two combined own 70 per cent of the developed waterpower. The first named owns power also in Idaho. In Montana, one corporation owns 50 per cent and a second all but 3 per cent of the remainder. In Colorado, one concern owns 67 per cent and another 14 per cent. In South Carolina, the Southern Power Company owns 75 per cent of the developed power; in North Carolina, the Carolina Power & Light Company owns 45 per cent, and the North Carolina Power & Electric Company 39 per cent, while the North Carolina Electrical Power Company holds all but 7 per cent of the rest. In Georgia, 95 per cent is held by three interests, 58 per cent by one of them. In Michigan, it is the same story, so why repeat?

Disturbing as these figures are, they do not constitute the proof of the reality of any colossal power trust. The commissioner finds this proof by grouping the ownerships, or the communities-of-interest not geographically, but by groups. And when this is done it appears that the one great overshadowing aggregation is the General Electric group. This group includes the General Electric Company, and its three subsidiary corporations, the United Electrical Securities Co., the Electrical Securities Corporation, and the Electric Bond and Share Company. This group owns or controls 939,115 developed and 641,000 undeveloped horsepower in the United States, and 62,500 developed and 62,500 undeveloped horsepower in Canada. It controls public utilities in eighteen states. This company, with nine others, control or have under their influence, more than 80 per cent of all the commercial power developed and under construction in the United States. The five largest groups of holders of developed waterpower in the United States control more than 50 per cent of all the commercial power developed and under construction in the country, besides having more than 1,200,000 horsepower undeveloped.

The influence of this report cannot fail to greatly hasten the coming of the next era of the waterpower industry, for beyond a doubt the next era is that of state or governmental regulation and control. The people are coming to realize that private ownership of any considerable proportion of the country's waterpower resources will result in an intolerable condition; for the energy of falling water is our only indestructible source of power upon which, when coal is gone, we can certainly depend. We are coming to the belief that the waterpower of our streams is the natural heritage of all the people, and that it must under no circumstances be permitted to pass under monopolistic control. Whether or not this doctrine is generally believed, it is rapidly finding expression in the passage of laws. Switzerland, France, Italy, Canada, New York, Pennsylvania, Oregon, Idaho, California; all these have enacted laws whereby the state assumes control and regulation of their respective waterpower resources. All of them have ceased giving waterpower franchises in perpetuity; they all provide for the rescinding of charters for non-use, and require that actual construction shall begin and shall be completed within a reasonable time. All of them prohibit combinations of waterpower companies for the limiting of output or the maintaining of prices; all of them impose reasonable charges based upon the power output; all of them provide that inasmuch as waterpower is in essence a public utility, the state may take by condemnation any existing power plant when it shall become clear that the public good requires it; and, finally, all of them reserve to themselves the right to fix the price at which private companies developing waterpower shall sell such power. There can be little question that the coming year will add other states to this list, for it would seem that people have at last become thoroughly aroused to the existing situation.

Beyond state regulation and control of waterpower, there remains but one step; and sooner or later this step will also be taken. Already the Province of Ontario and the state of New York have committed themselves to the doctrine of state ownership of waterpower, and state development, transmission and distribution of the power. We must recognize the potency of arguments in favor of this doctrine, the logic of it as the final step. The economic laws of power development necessitate centralization of control. The ultimate development of all the power of falling water will demand the building of storage reservoirs on a scale such that nothing short of the sovereign power of the state itself can compass their building. The comprehensive system of power development and power distribution which the social fabric will very soon require can be designed and executed by no lesser power. The credit of the state can be made a basis for borrowing money at lower interest rates than private companies can command and the state can well afford to give its citizens the profits which private capital cannot or will not forego. That is, specifically, the state can sell power at a price only sufficiently above cost to meet the interest and in a fifty-year period amortize the investment.

From the standpoint of the welfare of the Southern states, it is our belief that the prompt passage of laws for state regulation and control of waterpower will greatly innure to their lasting benefit, and we further believe that the one which first frankly adopts the policy of state development will receive an industrial impetus far beyond any which may result from the development of its remaining waterpowers for private profit.

J. A. SWITZER.

Convention of Mississippi Electric Association.

The fifth annual convention of Mississippi Electric Association will be held April 21-22-23 at Natchez, Miss. Arrangements have been perfected for the association delegates to meet at Vicksburg on the morning of April 21, when passage will be taken on Steamer Concordia for Natchez, leaving Vicksburg at noon. Natchez will be reached early next morning. During the trip on the river the first day's session of the convention will be held. Entertainment of an enjoyable character has been provided for that night.

The steamer trip on the "Father of Waters" will be an interesting and unique experience to every one, and should prove a drawing card that will make the fifth convention the largest and most successful in the Association's history. Details of meetings and entertainment at Natchez will be announced later.

A GENERAL VIEW OF LOCK, POWER HOUSE AND DAM OF THE MISSISSIPPI RIVER POWER COMPANY'S DEVELOPMENT.

The World's Largest Hydro-Electric Development at Keokuk, Iowa.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN).

BY J. H. ALEXANDER.

A Description of the Mammoth Engineering Achievement in the Heart of the Middle West.

IN THE very heart of the nation, the Mississippi River Power Company is building the world's largest single waterpower development, to furnish electric current in large quantity to a region hitherto looked upon as being devoted chiefly to agriculture. It is located in the Mississippi river where the states of Illinois, Iowa and Missouri meet and will develop on the shafts of its water wheels over 300,000 horsepower, generating 231,500 kilowatts by the operation of thirty units in its power house. The work consists of a dam across the Mississippi between Hamilton, Ill., and Keokuk, Iowa, joining on the Iowa side with the power house, between which and the Iowa shore a very large lock and large dry dock are constructed, both becoming the property of the United States upon the completion and entirely at the cost of the power company.

THE KEOKUK DAM.

The dam is 4,649 feet long, including 119 similar spans and an abutment at each end. It is 53 feet high, 42 feet wide at the base and 29 feet wide on top, and is set several feet into the hard blue limestone bottom of the Mississippi. Each of the 119 spans is 30 feet wide between the 6-feet piers and is arched at the top, the arches supporting a causeway which is the summit of the structure. In each span is a spillway 32 feet high, vertical up-stream and an ogee curve down-stream. Each spillway is topped by a steel gate 11 feet high, operated from the causeway above. The dam is of the gravity type, of massive concrete, and was built in steel forms filled with a very large cantilever traveling crane to which the buckets of concrete were delivered by trains running on standard gauge railway tracks on top of the dam structure itself, the mixing plant being at the Illinois end of the dam.

Note:—The birdseye view of water-power works in the Mississippi shows the dam stretching across from the Illinois bluff nine-tenths of a mile to the upper end of the power house which reaches about a third of a mile down the river to the lock. The wall with arches in the middle of the picture is the west lock wall. The dry dock will be between that and the Iowa shore, where the little wooded park is now. The seawall is seen at the left of the picture reaching across to become the upper wall of the dry dock. The forebay is between the power house and the sea wall.

THE POWER HOUSE AND THE TURBINES.

The power house is set about 25 feet down into the river bottom with a tailrace excavated to the same depth along its eastern side and extending much farther down stream. The structure of the power house is of massive concrete, 1,718 feet long, 132 feet, 10 inches wide and 70 feet high, to the generator floor. The superstructure has reinforced concrete walls and trussed roof and is 107 feet, 6 inches, from floor to pinnacle of the roof. The power house is set almost parallel with the river, with the forebay

FIG 1. JUNCTION OF DAM AND POWER HOUSE.

Note:—The junction of the dam and the power house is here shown and the construction of the dam in steel forms with a cantilever traveling crane partly dismantled. The two spans on the left are being filled completely to make the west abutment of the dam. In each of the arched spans will be built a spillway topped by a steel gate.

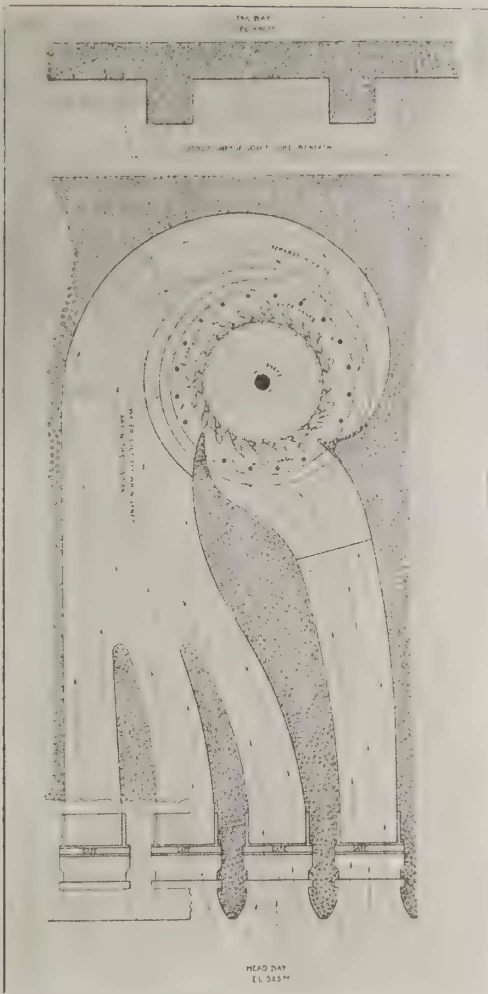


FIG. 3. DIAGRAM SHOWING FOUR INTAKES CONVERGING INTO SCROLL CHAMBER AROUND WHEEL.

between it and the Iowa shore and contains thirty similar units of 9,000 kva. capacity and four auxiliary units. Half of it is nearing completion, and the other half will be completed later, while the first half is being operated.

Each power unit consists of a turbine direct-connected to a generator on a vertical shaft. The turbines are of special design of Francis type the diameter at the twenty

FIG. 2. WHEEL CHAMBER SHOWING BOLTS AND BAFFLE PLATES.

Note:—The turbine is placed in the illuminated circle. The ring projecting from the ceiling supports the cone, at the top of which is the thrust bearing supporting the shaft containing the turbine runner on its bottom and the revolving part of the generator on its top, a total weight of 550,000 pounds on this one bearing. This picture shows the center of the scroll case 39 feet in diameter which has four intakes and is 22 feet high.

buckets being 16 feet 2 inches. They will operate at 57.7 revolutions per minute and show an efficiency of 86 per cent. They are rated at 32 feet head the actual head varying from 29 to 43 feet, with the stages of water in the river. The weight of the revolving parts of the unit, on the shaft, is 550,000 pounds, and this is supported on one thrust bearing, set rather high, the shaft being 25 inches in diameter. Each turbine is installed in a concrete scroll case 39 feet in diameter, which has four intakes so shaped as to deliver the water to the runner with equal velocity at every point on the circumference of the wheel. The draft tube is an 18-foot circle in cross section at its top and at its bottom an oblong, 22 feet 8 inches in vertical diameter and 40 feet 2 inches in horizontal diameter. The draft tube delivers the water into the tailrace at a low velocity, at right angles to the latter and the river.

FIG. 4. WEST FACE OF POWER HOUSE—IOWA SIDE.

Note:—About half of the power house on the forebay sideis shown here. Each arch is in front of a power unit and the four intakes to the scroll case. The architectural beauty of thispower house has caused much praise.

THE LOCK AND DRY DOCK.

Between the lower end of the power house and the Iowa shore is first, the lock 110 feet in width (the same width as the Panama locks) and 40 foot lift, as compared with the 28-foot 4-inch lift in each of the locks on the Isthmus, which are tandem and make the elevation of 85 feet by three lifts. Beside the lock is a dry dock with a basin only one per cent smaller in area than the largest in the United States—the navy dry dock at the Brooklyn navy yard. From the dry dock a sea-wall, so-called locally, extends up the short line as the western boundary of the forebay and as a retaining wall for the railroad tracks of the Burlington Route there, which had to be elevated and relocated for fourteen miles above the dam. Incidentally, the dam provides deep water navigation for sixty-five miles up the Mississippi. An ice fender 2,625 feet long guards the upper end of the forebay, and is a concrete bridge with solid concrete always at the surface of the water, whatever the stage of the river. It has a floating boom at the shore end to permit the passage of steamboats. The entire hydraulic plant is one monolith of concrete with a total linear measurement of 13,185 feet, and generally very large cross section.

Since the electrical features of this great work are most interesting to readers of Southern Electrician, the most attention will be given in this article to the electrical installation therein and along the Mississippi river. In addition to the installation in the power house, the transmission lines present many features of interest, and the whole is worthy of close study.

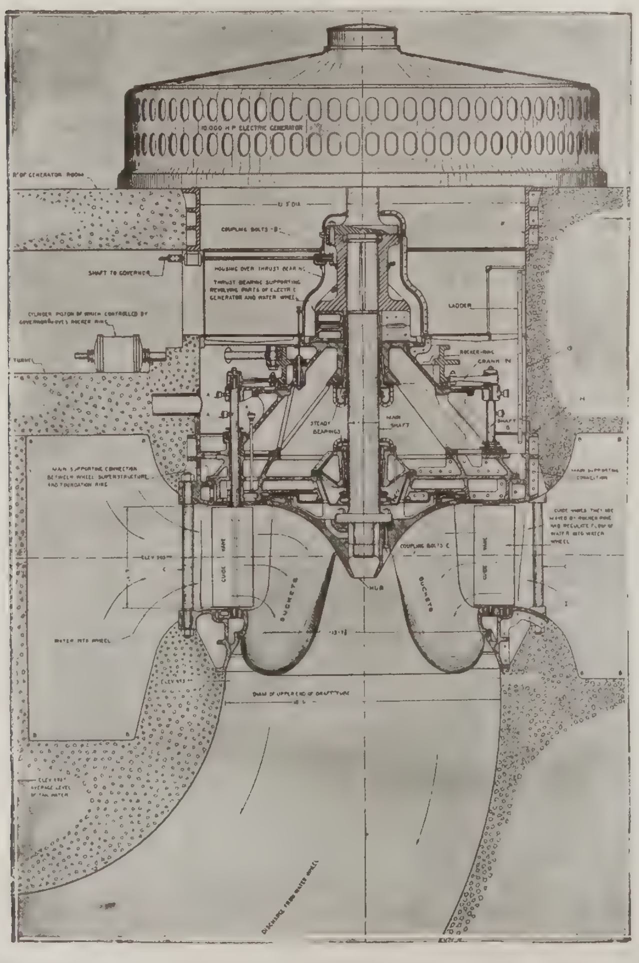


FIG. 5. SECTION THROUGH A WATER WHEEL AND CHAMBER.

FIG. 6. FIELD SPIDER AND RING WITH COILS ATTACHED.

THE GENERATING AND EXCITING UNITS.

The generators, located on the first floor, are vertical shaft units, rated at 9,000 kva., 11,000 volts, 25 cycle, three-phase. They have full load efficiency of 96.3 per cent, and a regulation of 13 per cent at unity power factor. Each generator weighs 614,000 pounds, and the armature is 30 feet 9 inches in external diameter. The coils are buried in the armature at several points from which the internal temperature of the machine may be found. A brake is provided for each unit, in order to hasten the operation of shutting down.

The generators are supplied with exciting current by an unusual system. Turbine driven alternators located on the main floor and having a rating of 2,000 kva., at 460 volts, 25 cycles, supply current to three-phase buses running the entire length of the generator room. From these buses a 100-kilowatt motor generator set, located on a gallery eight feet above the main floor, is tapped off for each generator and furnishes the latter with excitation at 250 volts. As an additional precaution another 440-volt bus is installed for each group of generators. It is excited through a 600 kva., 3-phase transformer from the main power fuses and all motor generator sets are equipped for connection to this bus, as well as to the main 440-volt bus. The voltage of each main generator is controlled by a Tirrill regulator operating on the field of its own exciter.

BUS AND SWITCHING ARRANGEMENT.

The electrical installation is laid out in accordance with a wiring diagram presenting several original features. Duplicate buses are installed on both high and low tension, and all generators, transformers and lines are provided with selector oil switches so that they may operate from either bus. One low tension bus runs unbroken for the entire length of the station and will be used for transferring and in emergency. The other, the normal operating bus, is equipped with sectionalizing switches and current limiting reactances, so that generators and transformers feeding each outgoing line will be on a separate section of the bus. Ordinarily all sections are paralleled through these reactances, and the emergency bus unites the ends of the main bus, forming a ring.

All switches are non-automatic, except the low tension bus section switches. They are arranged so that trouble on one section merely opens its two section switches and by a relay operating on Tirrill regulators, reduces the generator voltage, but leaves generators, transformers and line connected together. In addition, a low tension bus for local 11,000-volt feeders is provided.

FIG. 7. GENERATOR ROOM SHOWING LAYOUT OF UNITS.

Note:—Part of the generator room floor showing pitliners of some of the turbine units is shown here. On the left is a spider of a revolving field of one of the generators. In the middle ground is one of the turbine runners standing on the floor. The 150-ton traveling crane permanently installed is seen at the ceiling.

One high tension bus, serving as an emergency and transfer bus, is cut into sections corresponding to the lines. The other is similar but has section switches installed in addition, so that the sections may be paralleled if desired. This scheme of connection affords a maximum of flexibility and of insurance against trouble from excessive short circuit currents on the low tension and voltage surges on the high tension.

Low tension circuits are protected from internal voltage surges by electrolytic static dischargers connected to each section of each bus. For protection against excessive currents one bus is sectionalized, as before noted, dividing the station into ten groups and the groups are connected together through current reactances with a rating of 240 kva. Each reactance consists of three large concrete cores, wound with copper cable, and weighs complete 27,000 pounds.

From the low tension bus room, leads similar to those from the generators descend to the transformers, which are located on the same level as the exciter sets and are installed each in a separate concrete compartment opening into the screen room. The transformers are 3-phase, 25 cycle, 11,000/110,000 volts, with a rating of 9,000 kva. each. They are connected delta low tension and "Y" high tension, with neutral dead grounded. The transformers occupy a floor space of about 8 x 16 feet, and are 24 feet high over the high tension bushings. Each one weighs 231,000 pounds and contains nearly 10,000 gallons of oil. They are mounted on trucks and can be rolled out into the screen room and picked up by the crane. From the transformers high tension connections of 1¼-inch standard iron pipe extend vertically through a well to the high tension bus and switch rooms located on the top floor.

High tension switches are K-15 type, triple pole, solenoid operated and of 400 amperes capacity. Each switch is mounted on a concrete curb which encloses the operating mechanism and provides a catch basin for oil. These switches are provided with disconnects on one side only and are attached directly to the high tension buses.

High tension buses are installed in separate rooms running the entire length of the power station and on opposite

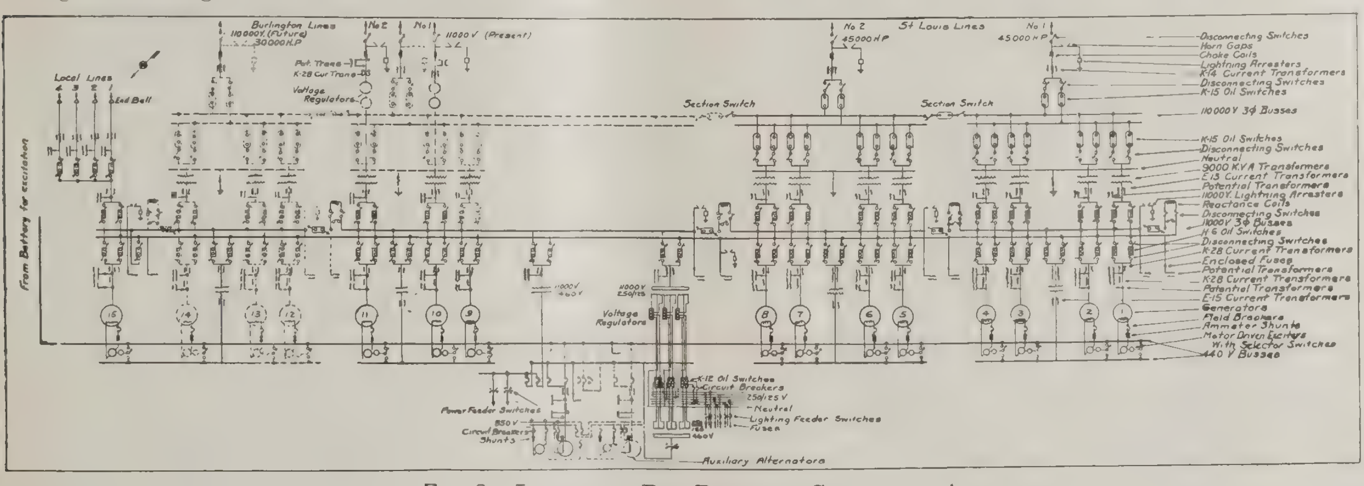


FIG. 8. LAYOUT OF BUS BARS AND SWITCHING APPARATUS.

From the generators, varnished cambric insulated, single conductor, 600,000 c.m. cables lead to the low tension bus room. This is located on the second floor between generator and screen rooms. Buses as well as current and potential transformers are enclosed in concrete compartments.

A low tension switching equipment is located immediately above the bus room and consists of H-6, 11,000-volt motor operated oil switcnes, mounted in concrete cells and equipped with disconnecting switches in sub-cells. The terminals of these switches extend through the floor into the bus room and bar connections are made from them directly to the buses or through instrument transformers to generators and main transformers.

sides of the building. They consist of 2-inch standard iron pipe, supported from the ceiling by seven-unit suspension insulators. They are spaced 6 feet center to center and are without barriers. From the buses line connections are made with 1¼-inch copper pipe. These connections run first to high tension current transformers and then directly up through roof bushings.

Roof bushings are of special design and give a safety factor on line voltage of three under rain test and four when dry. From the roof bushings, lines run through choke coils to an air disconnecting switch of the rotary double break type, mounted 24 feet between phases and having arms 12 feet long. Between choke coil and disconnecting switch taps are taken off to lightning arrester horns, also located on the roof, thence through another set of roof bushings to electrolytic arrester tanks located on the high tension bus room floor and enclosed in a concrete compartment.

SWITCHBOARD AND CENTRAL SYSTEM.

The entire station is controlled from a switchboard room located on the top floor in the center of the ultimate building. The switchboard is of the remote control bench type, with instrument panel mounted behind the bench. The board is provided with a panel for each generator and transformer unit and for each outgoing line. It is divided into sections corresponding to the bus sections and is arranged in the form of an "L" for the present station. With the ultimate equipment it will be in the form of a "U." In the center of this "U" is located the chief dispatcher's desk and switchboard. The former contains a telephone switchboard, giving complete control over the telephone system and fully equipped for testing out the telephone lines. The latter contains a mimic bus arrangement which shows by means of lights the position of every switch in the power house, and also graphic voltmeters and ammeters showing the voltage and current for each outgoing line.

For the operation of this switchboard and control system two storage batteries of 320 ampere hour rating each, are provided. Two 15-kilowatt motor generators serve to charge these and a vertical switchboard located in one corner of the switchboard room serves to connect the various control feeders. The wiring for the control system is multiple conductor cable with 30 per cent para insulation, installed throughout in conduit buried in concrete.

A very complete system for the transmission of intelli-

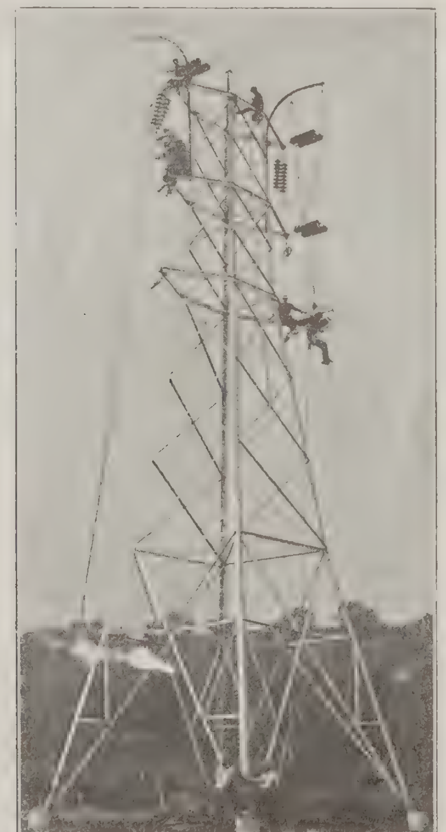


Fig. 9. An Anchor Tower on St. Louis Line.

Note:—One of the towers of the transmission line extending from the power house to St. Louis, 137 miles, and crossing the Mississippi river twice and the Missouri river once. This is an anchor tower with a dead ending, located in Adams county, Illinois.

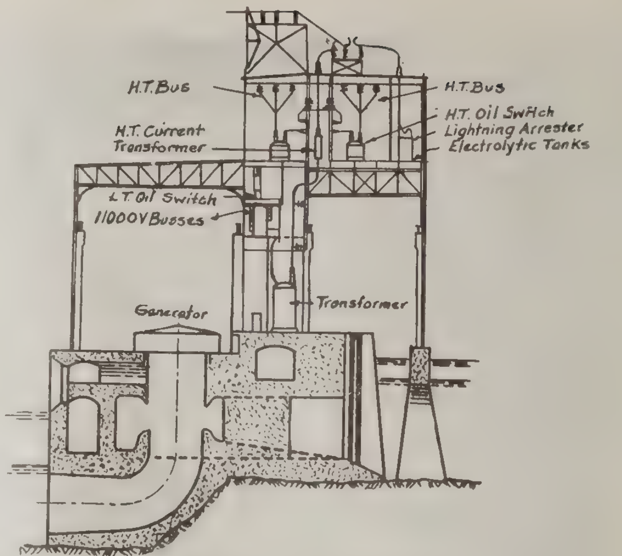


Fig. 10. Section Through Generator Unit and Switching Apparatus.

gence is installed. A telephone system communicating to all floors and tunnels in all sections of the building, to the roof, and by means of the company's private telephone lines to all sub-stations and distributing points, is installed. For the transmission of the more frequent instructions between switchboard room and generator room, a signal system has been provided, similar in a general way to that used between pilot house and engine room on shipboard, but very much more elaborate in that it provides for signalling separately to each generator and for the automatic recording of signals and the time they were sent.

STATION AUXILIARIES.

Turning now to the various auxiliaries about the station, the lighting system first merits attention. Lighting is entirely by tungsten lamps equipped with steel reflectors. Current for lighting may be supplied through three 75 kva., 11,000/125-250 volt transformers, and 7.5 kva. induction regulators, from the main buses, or through three 75 kva. 440/250-125 volt transformers from the exciter bus. About one-third of the lights well distributed over the station, are arranged so that in emergency, causing either over or under voltage on the alternating current side, they are automatically connected to one of the control batteries. This is sufficiently large to operate them for nearly an hour.

Transformers and switches, etc., in this station contain of necessity a large amount of oil, and a very complete system has been installed for handling this between cars, treating tanks and the equipment where used. Transformer compartments have a large drain emptying into the river and transformers are provided with quick-acting valves which can be operated from the generator room, whereby their oil may be discharged into tanks located in one of the tunnels in the substructure or into the tailrace. Two oil filter presses with pumps, ovens and other auxiliaries are provided to treat this oil, and a complete piping system is installed for returning it to the transformers. High tension oil switches and lightning arresters are also provided with discharge and return oil pipes and oil storage tanks.

Three complete water systems are installed. One supplies water for transformer cooling, the second, water for fire protection, and the third, the house service water. Toilet and locker rooms are provided in several parts of the building, a vacuum cleaning system, a compressed air system and a complete heating system are also installed.

Auxiliary power about the station may be supplied either from the 440-volt excitation system, or through a 500 kva. three-phase, 11,000/460-volt transformer from the main power buses.

For handling machinery, two 150-ton traveling cranes and a storage battery truck crane are provided in the generator room and a 75-ton overhead traveling crane in the gate house.

At the north end of the building a large machine shop is installed on the first floor opposite the screen room, and space for storage and machinery repairs is allowed opposite generator room and on upper floors. An industrial track of three feet gauge is provided on the bus room floor to facilitate handling of apparatus. Offices are located just in front of the switchboard room on the top floor, and elevators are provided at each end of the building.

TRANSMISSION SYSTEM.

The power generated by this system is to be distributed locally at 11,000 volts and to the north and south through the populous country along the river at 110,000 volts. Interest in the transmission system centers about the 110,000-volt line now being built to St. Louis. This is a steel tower line, with 80-foot towers spaced with a normal span of 800 feet and carrying two 300,000 c.m. copper circuits in vertical planes on each side of tower and spaced 10 feet between wires, and a 5-8-inch steel ground wire at the apex of the tower. Standard towers weigh 6,640 pounds, and are designed to withstand the breaking of two wires. Approximately every mile stronger anchor towers are installed. These weigh 10,200 pounds, and are designed for the breaking of all seven wires. All tower foundations are of concrete. Seven part suspension insulators are employed, having a dry flashover test of 440,000 volts and a wet test of 330,000 volts.

The line crosses the Mississippi twice and the Missouri once, each time by a single long span. For these spans, special high towers are employed with foundations extending to bedrock. Conductors are of high tension steel and are spaced 24 feet apart.

The construction will be completed early in 1913, and is done by administration entirely. Mr. Hugh L. Cooper is vice-president and chief engineer of the Mississippi River Power Company. The electrical installation and the coordinate superstructure of the power house is being done by the Stone and Webster Engineering Corporation.

Resolutions Adopted by A. I. E. E. on American Patent System.

Whereas, there are pending before Congress numerous bills affecting and greatly modifying the Patent System in the United States, and

Whereas, the Patent System has been, and is, a tremendous factor in building up the present industrial prosperity of this country, thereby greatly contributing to the prosperity of the country as a whole, and

Whereas, any untoward change in the patent situation might disastrously affect this condition of industrial and general prosperity, and the conditions contributing to their continual augmentation, and

Whereas, in view of the intimate relation of the Patent System to the general welfare, no action looking toward any radical change in the Patent System should be taken without most careful consideration, and

Whereas, in our opinion, proper consideration of such important changes as are proposed can be had only by an unbiased, non-partisan commission, made up of men from various walks of life and not from any one vocation, or interest,

Be It Resolved, that the American Institute of Electrical Engineers, acting through its Officers and Board of Directors, respectfully urge the Congress of the United States that they provide for a Commission, made up of unbiased, independent, non-partisan men of such national standing as will commad the respect of the whole coutry; and chosen from different walks of life; and not more than one from any calling or interest; and serving without pay. Such commission to hold public hearings, and otherwise, as may appear to them best, to make a thorough and careful study of the American Patent situation, and to prepare and submit a comprehensive report and recommendations to Congress for such changes, if any, as may, as the result of their study, appear to them expedient, whether in the Patent Office, in the method of Court procedure, or in the organic Patent Law, and recommendations as to the Legislation they would propose for effecting said changes. And that we further respectfully urge that the Congress make ample provision for the expenses of said Commission, and

Be It Resolved, that we respectfully urge the Congress of the United States to hold in abeyance all proposed Legislation affecting the Patent System in whatsoever way until such time as the said Commission shall have had ample opportunity to hold the said hearings, and make the said study and report, and

Be It Further Resolved, that these resolutions be printed and a copy be sent to each Senator and Representative of the United States who is a member of the Senate or House Committee on Patents.

RALPH D. MERSHON, PRES.

Work of Organization Committee, Society of Electrical Development.

The Organization Committee which was appointed at Association Island September 3 for the purpose of suggesting ways and means for the organization of a cooperative movement to carry out co-operative work for the benefit of the electrical industry at large, held its fourth meeting in the Engineering Societies Building, 29 W. 39th Street, New York, December 2. The committee reports that a great deal of progress has been made in the development of a practical plan, but that the subjects to be taken up and the variety of interests to be considered to successfully carry out such an organization, still necessitate a great deal of work before their suggestions for the contemplated organization will be in concrete enough shape to present to the industry at large.

Definite by-laws and plans for the operation of The Society for Electrical Development are still being considered. A sub-committee was appointed on Finance and Administration to carry out further plans in connection with the orgaization work of the Society, and a sufficient amount was advanced by the members of the Organization Committee to carry on the work.

The next meeting will be held some time during the month of January, and at that time it is hoped that it will be possible to lay before the industry at large, a concrete plan which will assure satisfactory results to the industry and to which the individuals of the industry will give their co-operative support.

A Review of Water Power Development in the South During 1912

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

BY J. A. SWITZER.

TO THOSE who closely observe the trend of hydro-electric development in its larger aspect, the close reading of the technical press of the day cannot fail to bring an overpowering realization of the immense economic importance of water power. Moreover, such a reading cannot fail to convey a profound impression of the rapidity with which the process of concentration of ownership and control is taking place. When it can be said that the entire water-power situation in a number of states has within a single twelve-months been completely altered (and this is true of Virginia, North Carolina, Georgia, Alabama and Tennessee), then it is surely time for the people of the country to be aroused to the meaning of the process. The writer has attempted in this article to weave together into a connected whole the history of the important events of 1912. While there may be some errors of omissions and perhaps some unintentional statements of fact, every effort has been made to keep this chronicle in accordance with the facts. For convenience the history is grouped under the headings of the states concerned.

J. A. SWITZER PROFESSOR HYDRAULIC ENGINEERING, UNIVERSITY TENNESSEE, AND HYDRAULIC ENGINEER. STATE GEOLOGICAL SURVEY.

Virginia.

The water-power map of Virginia has undergone striking changes during the year. At the beginning of 1912, the Virginia Railway & Power Co., owned by F. J. and Edwin Gould, was the dominant water-power interest in the state, owning about 65 per cent of the developed power and holding about 21,600 of developed and 28,500 undeveloped horsepower located on the James and Appomatox rivers; and the company, besides its holdings of water-power, owns a large number of trolley systems, both urban interurban.

The total developed water-power within the state at the beginning of the year, including the developments cited above, amounted to a total of 51,320 horsepower. During the year, the Virginia Western Electric Co. has come into existence. This new company has taken over the holdings of the Clifton Forge Public Service Corporation on the Jackson river. It has also taken over the Rockbridge Corporation of Buena Vista, Va., with its two hydro-electric plants on the James river, together with the Bueno Vista Light & Power Company's steam plant which it will use as a steam auxiliary. The company has erected a number of transmission lines and announcement is made that additional hydro-electric developments will be inaugurated during the coming year; notably one development of 8,000 horsepower at Goshen Pass. While this company therefore looms up large, the really great event of the year consists of the rise of the Appalachian Power Company into a commanding position.

Possibly no event in the recent history of water-power development is of more profound significance than the successful launching of this project. The significance of this work does not lie in the size of the developments but rather in the fact that the developments are located in the heart of the Virginia coal fields and that the water-power is to find its market largely in the operation of the coal mines themselves. The property belongs to the Byllesby group of interests, and referring to these developments in a paper recently read by Mr. Jas. E. Hughes, of the Byllesby Co., before the American Institute Electrical Engineers, in Chicago, Mr. Hughes said: "This installation on the New River is unique in that almost half of the entire market of the power developed is to supply electrical energy to coal mines. Now, we have often been lead to believe that the further away water-power development was from cheap coal the more profitable it would be; but I can assure you that these developments on the New River have just been put into operation and we cannot tell you from the actual operation of the plants what the profit will be; yet the signed contracts for service in the Pocahontas coal field will show a return on the investment greater than my company dared to predict in its perspectus." I commend the thoughtful consideration of this frank statement to that group of water-power engineers in whose public utterances the effort is so frequently made to lead the public into the belief that water-power properties are not particularly lucrative and that therefore the proper attitude of the public should be to "keep hands off" and leave these matters to those who understand them.

The company has its office at Bluefield, which is just across the state line in West Virginia; but its developments are located on the New River in Virginia. These are five in number, and will aggregate 75,000 horsepower. Two of the five plants, Nos. 2 and 4, having an installed capacity of 29,000 horsepower, were put into operation within the last two months. Plants Nos. 1, 2, 3 and 4 will all be located within a distance of about five miles just northeast of Galax, while site No. 5, seven miles west of Pulaski, will be about twenty miles lower down the river.

Transmission lines have been built from the transformer house which now serves plant No. 2 and plant No. 4, to

Galax, Danville and Martinsville on the south; Marion and Saltville on the west; Christianburg and Roanoke to the northeast; Pulaski, Wytheville in Virginia, and Bluefield, Pocahontas, Switchback, Coalwood and Welch in West Virginia, to the northwest. Transmission is at 88,000 volts, and it is expected that the entire 75,000 horsepower will be absorbed within a radius of 50 miles of the generating stations. Already a contract has been made to supply power to the Roanoke Railway & Electric Company of Roanoke; and contracts have been placed for supplying power to the following coal mining companies: Virginia Pocahontas Coal & Coke Co.; American Coal & Coke Co.; Zenith Coal & Coke Co.; Crystal Coal & Coke Co.; West Virginia Pocahontas Co.; Coal Dale Mines; Flannagan Coal & Coke Co., and Vaughn Coal Co. The company has acquired the 7,500 horsepower steam turbine plant of the Pocahontas Consolidated Colleries Co., together with the steam-operated plants of Marion, Wytheville, Pulaski, Bluefield, Pocahontas, Welch and Keystone.

As to the engineering features of this development, there is little which is unusual except perhaps the fact that a single transformer house will receive current at 13,000 volts from four of the power houses.

West Virginia.

The important event of the year in this state is undoubtedly the beginning of work on the Cheat river development. The West Virginia Development Co., one of the Kuhn properties, has let contract for its initial construction to the T. A. Gillespie Co., of Pittsburgh. This developmnet is located on the Cheat river at the boundary between West Virginia and Pennsylvania. For a time it appeared that the prosecution of this work would be prevented through a decision of the Circuit Court of West Virginia to the effect that the Cheat river is navigable; but the river is not navigable but only floatable, and the decision of the court simply necessitated a minor change in the details of the dam for the accommodation of the waning logging interests. For the present, the dam will be built to a height of 80 feet with the expectation of carrying it later to 100 feet. The initial installation will be for 48,000 horsepower, to be increased later to 100,000 horsepower. The contract for $1,000,000, which contains bonus and penalty clauses, calls for completion of the dam by December 1, 1913; it does not include machinery and equipment.

A second development within the state has been initiated during the year. This is for a dam at Government Lock No. 19, on the Ohio river at Bellville. The writer, however, is not advised as to the details of the development.

Turning to the projected developments, we find three new companies to have been formed; the first of these is the Virginia Power Co., of Charleston, West Virginia, incorporated with a capital of $10,000,000, and the second the Black River Water Power Co., incorporated with a capital of $27,000,000. This latter company is prosecuting investigations of power sites on the Black Fork river in Tucker county, but it is not understood that either of these companies has reached the construction stage. For the third, it is reported that a new company is projected which shall take over the property of the Old Dominion Power Co., of Radford, Va., and will make large water-power developments. It is claimed that some $25,000,000 will be expended, and 350,000 horsepower will be developed for transmission over a wide territory.

Kentucky.

The state of Kentucky can hardly rank as a water-power state of the first magnitude, there being at present no large developments in actual operation within the state. During the year, however, construction work has begun on the plant of the Dix River Power Co., which is located at Kennedy's Mill on the Dix river near Richmond. We are not advised as to the details of this development, but understand that the contract is in the neighborhood of $3,000,000. Mr. L. B. Harrington, of Richmond, is president of the company, and Brown & Clarkson, Washington, D. C., the engineers.

While this is the only plant actually under construction within the state itself, interest attaches to the holding of the H. M. Byllesby Co. at Cumberland Falls on the Cumberland river near Williamsburg. Although the development of this project is not imminent, it is more than probable that when the development is made it will constitute one of the plants of the Tennessee Power Company described in the section on Tennessee.

It is reported that a company entitled the Interstate Power Co. has been incorporated at Louisville to investigate water-power sites within the state, but to the best of our information, the plans of this company are still nebulous.

North Carolina.

According to the report of the United States commissioner of corporations on "Water-Power Development in the United States," issued on March 14, 1912, it appears that of the developed commercial power in this state, 45 per cent is in possession of the Carolina Power & Light Co.; 39 per cent in that of the North Carolina Power & Electric Co., and 9 per cent belongs to the North Carolina Electrical Power Co. The Yadkin River Power Co. is a subsidiary of the Carolina Power & Light Co. At the beginning of the year, however, the amount of developed power in the state was comparatively small, and the present year, together with those immediately to follow, will see rapid changes in the water-power map of this state.

The Southern Power Co., which at present completely dominates the power situation in the state of South Carolina, finds much of its market for power within North Carolina, and owns as well three valuable power sites on the Catawba river within this state.

During the year, the 32,000 horsepower plant of the Yadkin River Power Co., situated eight miles from Rockingham, has gone into commission. This plant, consisting of three 3,000 kilowatt and three 4,500 kilowatt units, generating at 4,000 volts, supplies power at 100,000 volts to the towns of Hamlet, Wadesboro, Lumberton, Raleigh and Durham, and at 22,000 volts to Cheraw, South Carolina. The company has recently acquired the steam plants of Wadesboro and Cheraw, South Carolina.

The Carolina Power & Light Co., in addition to owning the Yadkin River Power Co., owns and operates the water-power plant at Buckhorn Falls on the Cape Fear river about ten miles below the Montcure river, with a capacity of 3,500 horsepower, a small 400 horsepower plant on the Neuse river six miles above Raleigh, and last but by no means least, the 30,000 horsepower plant at Blewitts Falls, which went into commission last spring; and in addition to these, the company owns auxiliaries as follows: One 5,000 horsepower plant at Raleigh, one 1,000 horsepower plant at Goldsboro. The company is reported to have acquired the Asheville Electric Co., which does the street railway, light and power business in Asheville, North Carolina. This is somewhat puzzling to understand, inasmuch as the field of operation of this company is in the eastern central portion of the state, entirely removed from Asheville. The company's transmission lines which are tied together through a common sub-station with the Yadkin River Power Company's lines, extend from Buckhorn Falls to Raleigh, Raleigh to Goldsboro, passing through Selma, Smithfield and Paine Level. From Raleigh to Henderson and Oxford, from Buckhorn Falls to Fayetteville and Sanford. It would thus appear that the importance of this company has been greatly enhanced during the year 1912.

The year appears to have brought no change to the Carolina Power & Light Company save that they have acquired the municipal plant of Goldsboro, North Carolina, for a steam auxiliary.

At the west end of the state there are a number of developments clustering about Asheville. Within a radius of 25 miles of this city, there are now in operation seven water-power plants: The Waynesville Light & Power Co., on Pigeon river, which furnishes light and power for Waynesville; the Henderson Light & Power Co., on Big Hungry creek, furnishing light and power for Henderson; the Brevard Light & Power Co., the plant of the Asheville Power & Light Co., on Hominy creek, and the three plants of the North Carolina Electrical Power Co., on the French Broad and Ivy rivers. The plant on the Ivy river was completed in 1900, and develops 750 horsepower. The second of these developments, that at Weaver on the French Broad, was placed in commission in 1904, and develops 3,200 horsepower, while the third development at Marshall on the French Broad developing 5,500 horsepower, went into commission in January, 1912.

Thus it would appear that the year 1912 has seen the developed horsepower of this state practically doubled. Notwithstanding this, the most significant events during the year in this state consist of the formation of new companies which will shortly begin extensive building operations. Among these a prominent place must be assigned to the Southern Aluminum Company. This in reality is a French company, organized in Paris under the name of L'Aluminus Francaise, with a capital of 15,000,000 francs. The American company is capitalized for $8,000,000. This company has purchased extensive deposits of bauxite, the mineral from which aluminum is manufactured, near Whitney, North Carolina. The company has also purchased a partly completed hydro-electric plant of 50,000 horsepower capacity from the North Carolina Electric & Power Co., located on the Yadkin river. Completion of this plant will be pushed rapidly forward. Orders have been placed for seven units of 5,000 kilowatts capacity each and two units rated at 2,500 kilowatts each. For the purpose of aluminum smelting, a direct current is required, and each of the major units will deliver 20,000 amperes of 250 volts. These are probably the largest direct current units ever built.

Before the close of the year 1913 this company will be in position to produce 2,000 tons of aluminum a month. Probably it is but a strange coincidence that while this French company has come to locate its aluminum works in North Carolina, the Aluminum Company of America is also proposing to develop water-power partly within North Carolina and partly in Tennessee on an enormous scale. This company will be more fully described among the water-power developments of Tennessee, inasmuch as its reduction works will be located within that state. It may be said in passing, however, that the company has acquired the entire Little Tennessee River with its most important tributaries and that its ultimate plans call for the development of 400,000 horsepower, of which the larger portion will be developed on the North Carolina side of the state line.

Among the projected companies there remain four deserving of mention. First, the Alamance Power Co., which will construct a plant at River Falls on the Haw river in Alamance county. Second, the Virginia-Carolina Power Co., incorporated early in 1912 to develop 25,000 horsepower on the Roanoke river near Welden. The third of these is the Carolina-Tennessee Power Co., which has taken over two power sites on the Hiawassee river in Cherokee county. The first of these sites is but a few hundred feet from the Tennessee state line, and the second is fifteen miles higher. At each site a dam 150 feet high will be built and a total of 50,000 horsepower is expected to be developed. While the project is as yet in the engineering stage, there appears to be little doubt that its plans will be carried to a consummation. The company is capitalized for $5,000,000 by New York capitalists, and the Amberson Hydraulic Construction Company, together with Prof. Wm. H. Burr, of Columbia University, have been employed to make the preliminary examinations and plans. The fourth of these projected developments is probably not so near to the construction stage. W. S. and J. S. Kuhn, the Pittsburgh bankers, have purchased the Toxaway Water Power property near Asheville with a view to developing at this point 20,000 horsepower.

South Carolina.

Affairs in this state appear to have been rather quiet during the year. The most notable event would seem to be the acquisition by the Columbia Gas & Electric Co. of the Parr Shoals Power Co., and the consequent beginning of construction of the Parr Shoals plant. This plant is located on the Broad river about twenty miles above Columbia, and will develop 25,000 horsepower. The dam will be 34 feet in height and will create a pool approximately 12 miles long, flooding an area of 2,400 acres. The present power equipment will consist of eight units of 2,000 kva. each. Power will be transmitted to Columbia at 66,000 volts over a double steel tower transmission circuit. The president of the company is E. W. Robertson, and the contract which calls for an expenditure of about $2,500,000 was secured by J. G. White & Co.

While the construction of the Parr Shoals project is thus insured, the Columbia Gas & Electric Co. also seeks to develop power on the Congaree river. This river being navigable, however, the permission of the national government is required, and it is understood that this has not yet been secured.

Possibly the event of greatest significance in South Carolina is the sale of the Anderson Water, Light & Power Co., which owned 7,600 developed horsepower, to a new company, consisting of W. S. Lee, the vice-president and general manager of the Southern Power Co., C. E. Smith, president of the S. Morgan Smith Co., and D. G. Stevenson, of Toronto, Canada. It is believed further that this new company expects to lease the plant of the Savannah River Power Co., at Gregg Shoals, on the Savannah river, which recently passed into the possession of the Georgia Railway & Power Co.; and also to erect a 10,000 horsepower plant at Cherokee Shoals, ten miles lower down on the same river. The acquisition of this property quite probably is a move to still further strengthen the position of the Southern Power Co., which owns already 75 per cent of the developed horsepower in the state.

Turning to the consideration of the Southern Power Co., the only items of news which we have are that this company has built a 10,000 horsepower sub-station at Mr. Holly, and has awarded a contract for the construction of a 10,000 horsepower steam auxiliary plant at Charlotte, N. C. According to the report of the United States commissioner of corporations, previously referred to, the Southern Power Co., at the beginning of the year, owned 101,680 horsepower of water-power developed and under construction, and 104,000 horsepower undeveloped; all of its developed power and 73,000 horsepower of its undeveloped power being in South Carolina, the balance of the undeveloped being in North Carolina.

It is beyond the power even of so high an official as the United States commissioner of corporations to keep pace with the developments and acquisitions of these great and dominating power companies, and of the inter-connections, agreements and communities of interest between them. As we shall see when we take up consideration of the year's history in Georgia, the concentration of ownership in that state is proceeding with great rapidity, and it appears to be quite evident that the relationship between the dominant interests in that state and the Southern Power Co. are to say the least very close.

Before closing our resume of events in South Carolina, we should call attention to the successful year experienced by the Piedmont Traction Company. This company is regarded as being a subsidiary of the Southern Power Co. The Traction Co. has no generating stations of its own, but receives power from the parent company. The Traction Co. is unique in that it is the only trolley system in the United States operating under 1,500 volts direct current. For this reason, the experiences of the Piedmont Traction Co. are being watched by electrical engineers throughout the world. The system has the advantage that the same cars that operate between cities at 1,500 volts may pass through towns and cities on a 600-volt service. The Piedmont system as now projected when completed will comprise a total of 280 miles of track; but at the present time, two sections have been finished; first, a 35-mile line from Charlotte, N. C., to King's Mountain; second, a 95-mile line from Greenwood through Greenville, S. C., to Spartanburg, S. C. These two will shortly be joined together. The gap between Spartanburg and Greenville still to be bridged is about 40 miles in length. The service to be rendered will consist of four distinct types; namely, the limited passenger service, the local passenger service, light freight and express service, and heavy freight service. Unlike the system of the Illinois Traction System, the Piedmont cars are drawn by electric locomotives, of which six have already been purchased. These locomotives are capable of exerting a maximum tractive effort of 27,500 pounds, and will be able to handle an 800-ton train at a speed of 25 miles an hour on straight level track. The cars used are the largest interurban cars with which the writer is familiar, and it can be stated with much confidence that altogether this traction system represents the very latest and best development of the interurban trolley system.

Alabama.

In no state in the Union has the year 1912 brought to pass more sweeping changes in the water-power situation than in the state of Alabama. Up to the beginning of this year, there were no large developments in the state unless we call that of the Montgomery Light & Power Co., of 6,000 horsepower, a large development. The changes wrought by the year do not consist so much in the inauguration of large developments as in the absorption of nearly all of the existing water-power interests by one colossal company. On January 5, 1912, there was organized in Canada the Alabama Traction, Light & Power Co., capitalized at $50,000,000. This company has taken over the Birmingham, Montgomery and Gulf Power Co., the Alabama Power Development Co., and the Little River Power Co. In addition to these water-power companies, it has also absorbed a number of steam plants and traction systems throughout the state.

Conditions for a gigantic power trust in Alabama are indeed favorable. We quote from the "Electrical World" of March 16, 1912, as follows: "In 1900, the state of Alabama granted to the Birmingham, Montgomery & Gulf Power Co. a charter unlimited in time and non-forfeitable for non-use, giving it the rights (a) to build dams and reservoirs on the Tallapoosa river or its tributaries, (b) of eminent domain, (c) to exercise all powers belonging to manufacturing companies under the Alabama law, (d) to distribute electricity in all towns and cities in Alabama, (e) to exemption from taxation for ten years from commencement of its works. The company controls water-powers on the Tallapoosa, Coosa and Tennessee rivers capable of developing about 400,000 horsepower during the dryest season on record, for ten hours."

Work has begun on the first development of the new company on the Tallapoosa river at Cherokee Bluffs where ultimately 100,000 horsepower will become available. The initial development will be for 60,000 horsepower, and the estimates place the cost of this development at the amazingly low figure of $83.00 per horsepower. The dam will be 130 feet high. Construction was commenced in August on the development at Lock No. 12 on the Coosa river. Contract for this development was awarded on August 1 to McArthur Brothers, of New York. The development will consist of a dam 68 feet high and 1,500 feet long, for an initial development of 70,000 horsepower. The first installation will consist of four turbines each capable of yielding 17,500 horsepower.

The holdings of the Little River Power Co., which this company takes over, consist of three power sites on the Little River. The first of these is located near Fort Payne, and 50,000 horsepower under a head of 59 feet will be developed.

The plan for a developmet on the Coosa river, at Lock No. 18 has been defeated through President Taft's veto of the bill granting to the company the right to build this dam. This action was taken by the president on the ground that the bill made no provision for compensation to the government, and on the further ground that the grant to the company would be in perpetuity, which is not consistent with the present policy of the government.

In comparison with the ambitious developments begun or projected by this Alabama water-power company, all other efforts in the state sink into an insignificance rather pathetic to contemplate. It seems scarcely worth the effort to record any of these. However, passing mention should be made of the plans of the Birmingham Water, Light & Power Co., which has proposed to Congress that it be permitted to build a 63-foot dam site No. 17 on the Black Warrior river. The plans of this company are the more interesting because of the fact that the company offers, if Congress will approve the project, to pay for all flowage rights and to pay for the power rights at the rate of $1.00 per horsepower annually for 20 years, and thereafter the rate to be fixed by the secretary of war at 10-year intervals. This is for power developed from the annual flow of the river; but the company proposes to construct a large storage reservoir further up the stream, and the power developed at the government dams in this way in addition to that from the annual flow is to bring the government an income of 50 cents per horsepower annually. We are not advised as to what action Congress has taken on this proposition, but are fain to believe that the project will be approved. The minimum power development for which this would provide is 15,000 horsepower.

At the present writing, the Ragland Water-Power Co., organized by M. H. Lyde, of Birmingham, is making preliminary arrangements for the construction of a plant at Lock No. 4, on the Coosa river, for the development of power. We understand that the contemplated plant will cost $500,000, but are not advised what power possibilities are to be realized.

Missouri.

Undoubtedly the big event of the year in this state is the inauguration of work on the developments of the Ozark Power & Water Co., on the White river. This company, which is being financed by H. L. Doherty & Co., of New York, proposes to develop ultimately 45,000 horsepower. Construction was begun early in the year on the first unit at Forsyth, where 15,000 horsepower will be generated. The contract for this construction, which was placed with the Amberson Hydraulic Construction Co., calls for completion of the dam and power house by April 1, 1913. At the present writing, construction is so well advanced as to insure completion by this time. The transmission lines are nearly completed to Springfield, Missouri, 43 miles distant, and from Springfield to Joplin, an additional distance of 8 miles. The dam will be 50 feet high, and the power equipment consists of five 2,250 kva. units generating at 2,300 volts, step-up transformers to 66,000 volts. Sub-stations at Springfield and Joplin are nearly completed. The company has entered into a twenty-five-year contract to operate the Springfield Traction Co., and the Springfield Gas & Electric Co. It has also entered into an operating agreement with the Empire District Electric Co., at Joplin, whereby that company will take the excess power of the Ozark Co. and will at the same time operate as a steam auxiliary to the water-power developments. The Ozark Co. will supply the power required by the railroad shops of the 'Frisco system near Springfield, and will also operate the city water plant of Springfield. It is of interest to note that although the securities of this company were not placed on the market until the spring of 1912, the entire issue of stocks and bonds has been over-subscribed more than twice.

The only other event worthy of note in the water-power history for the year is the formation of a $5,000,000 company to develop power on the Osage river for the purpose of serving the central section of the state. The project will call for a development of 65,000 horsepower and will involve the construction of two dams.

Texas.

This great state appears to be enjoying a veritable water-power boom. Two plants are under construction and a third is projected on the Colorado river. Two plants will shortly be put under construction on the Guadalupe river, while still another plant is in process of building on the Medina river. Of the developments on the Colorado river mention may be made first of that under prosecution by the City Power Co., of Hartford, Conn. Interest attaches to this plant by reason of the fact that the company is proceeding under a thirty-year tenure. The plant will cost $1,500,000, and the contractors are the Wm. P. Carmichæl Co., of St. Louis. The second development is that of the Colorado River Power Co., which is building its dam near Marble Falls. This plant will serve a number of cities, including San Antonio.

On the Guadalupe river, the United Power Development Company, of Shiner, Texas, has under construction a 1,000 horsepower plant. E. P. Leahy, of Yoakum, Texas, has the contract.

The plans of the Guadalupe Water-Power Co., organized at Saguin, Texas, appear to be quite ambitious. The company has under contemplation the erection of six dams on the Guadalupe river, the building of transmission lines to San Antonio, Saguin, New Brownfels, San Marcos, and other towns. The plans do not appear to have passed the engineer stage.

On the Medina river, an immense irrigation project is under construction by the Medina Valley Irrigation Co. The plans of this company call for an expenditure of some $8,000,000, and the development of water-power is incidental to the main purpose of irrigating a tract of 60,000 acres. If the power developed will be sufficient to serve this tract with trolley service and at the same time furnish light and power to the settlers, the project is certainly destined to share with the similar projects of Southern California a large measure of prosperity.

Oklahoma.

We are advised of but one projected development in this state; namely, that of the Muskogee Water Power Co., which proposes to develop 15,000 horsepower on the Grand river near Muskogee. The president of the company is S. P. Mann, of the above named city, while W. H. Roscrans, of Chicago, is engineer in charge. The company holds two additional power sites which, however, it does not propose to develop at the present time.

Louisiana.

Persons looking for water-power sites would scarcely be expected to turn their eyes toward the state of Louisiana; nevertheless, a corporation is reported to have been organized at Baton Rouge with a capital no less than $15,000,000 for the purpose of developing electrical power to be used in the reclamation and drainage of a large tract of extremely fertile territory. We shall watch with a great deal of interest the plans of this company.

Arkansas.

No steps have been taken during the year to further the actual development of water-power in this state. The Dixie Power Co., of Little Rock, which had planned to develop power on the White river, was prevented from carrying its plans into effect by the action of President Taft in vetoing the bill which would have permitted the company to construct its dam.

Two prospective developments should be mentioned in passing; that of the Garland Power & Development Co., which hopes to erect a plant on the Ouachita river, and that of the Northern Arkansas Power Co., which hopes to place a plant on the King's river, near Berryville. The plans of this last company call for the building of a dam 30 feet high with a transmission line 30 miles in length at a cost of approximately $250,000.

Georgia.

By all means the dominating event of the year in Georgia is the formation of the Georgia Railway & Power Co. The formation of this company consummates a consolidation of consolidations. According to the United States commissioner of corporations, the Georgia Power Co., which was only recently organized, took over all the properties of the North Georgia Electric Co., except the Gainesville Railway & Power Co. The North Georgia Electric Co. was incorporated in 1901 to develop water-power. It passed into the hands of a receiver and at the receiver's sale was bid in by the S. Morgan Smith interests and re-organized under the name of the Georgia Power Co. The S. Morgan Smith interests also owned or controlled the Atlanta Water & Electric Power Co., and the Albany Power Manufacturing Co. The Georgia Power Co. has a present wheel installation of 3,250 horsepower about three miles from Gainesville, and as is well known, was engaged at the time of its absorption by the newer company, in the construction of the 90,000 horsepower plant at Tallulah Falls. It also owned three large undeveloped sites, one near Cartersville, another near Newnan, each of 24,000 horsepower, and the third at Buford, estimated at 32,000 horsepower. The company has a transmission line completed from its development near Gainesville to Atlanta, a distance of about 50 miles, and thence to Tallulah Falls.

The Georgia Railway & Power Co. was organized in September, 1911, with an authorized issue of $30,000,000 in bonds and $27,000,000 in stock. In addition to taking over the Georgia Power Co. the new company took over as well the Atlanta Hydro-Electric Co., and the Atlanta Water & Electric Power Co., besides leasing the Georgia Railway & Electric Co. It is claimed that the new company will not be affiliated with any of the large electrical interests, but that it is an entirely new company.

Besides developing the newly acquired power sites as rapidly as its market will justify, the company will construct 300 miles of steel tower transmission lines to transmit power at 110,000 volts. Beside its undeveloped power sites already listed is one on the Chattahoochee river between the North Georgia Electric Co. at Gainesville and Columbus, Ga., the Franklin Shoals site in Hurd county on the same river, and sites on the Chestatee and Etowah rivers. The construction work on the Tallulah Falls project is being done by the Northern Contracting Co., of Detroit, and the total development, including a dam 115 feet high, a tunnel 6,663 feet long, a surge tank 95 feet deep of concrete in the earth, a power house and switch house, will cost about five and a half million dollars. Power will be developed under a head of 600 feet, and the installation will consist of six units of 15,000 horsepower each.

In addition to the development in process at Tallulah Falls, the company has also let a contract to the Amberson Hydraulic Construction Co. for the building of a reservoir dam 96 feet high and 662 feet long at Mathis, higher up on the Tallulah river. This dam creates a large storage primarily for the benefit of the main development at Tallulah Falls but incidentally to develop a small amount of power at the reservoir site itself. Thus it would appear that Georgia, like Alabama and South Carolina, is to have its single dominant water-power interest.

Few changes have occurred during the year in the holdings of the older power companies. The Central Georgia Transmission Co., which is a subsidiary of the Central Georgia Power Co., has increased its capital by $4,500,000 for the erection of the transmission line from Griffin north to Atlanta, and the building of a number of sub-stations. The company's development on the Ocmulgee river, 37 miles north of Macon and 43 miles south of Atlanta, consists of 16,000 horsepower now in operation with provision for additional installation of 8,000 horsepower. The company owns in addition three undeveloped sites of 40,000 horsepower each, or a total of 120,000 horsepower. At the present time the company is handling electric light and power service in the cities of Macon, Forsyth, Barnesville, Griffin, Hampton, Atlanta, Jackson and Monticello.

In addition to the Georgia Railway & Power Co., there are two other new companies looming large within the state. Of these the first is the Georgia-Carolina Power Co., which will own and control the Augusta-Aiken Railway & Electric Corporation. This company will very shortly begin construction of an 18,000 kilowatt development at Stevens' Creek on the Savannah river about 90 miles northwest of Atlanta. This power will be used for the operation of the interurban line from Augusta to Aiken. It is expected that a new plant will be in operation by the middle of the year 1914, and a clause is found in the franchise of the company requiring that energy be sold in Augusta by the middle of October, 1914. The power house at Stevens' Creek will be at the Georgia end of the dam. The length of the dam will be 2,300 feet, and the spillway section 2,000 feet. Since the Savannah river is navigable, a lock will be provided. The dam will be 34 feet high, and the power installation will consist of ten units of 200 kilowatt capacity, although at present but half of this amount will be installed. It would thus appear that this company does not propose to enter the power business on a large scale in competition with the other hydro-electric companies.

The second new company referred to is the Appalachian Electric Power Co., formerly the Appalachian Power Co. The company is not understood to have passed the engineering stage of investigation, but it has under consideration the development of five power sites and expects to finish power to Toccoa, Ga., Walhalla, Seneca, and West Minster, S. C. The work of investigation is in the hands of J. G. White & Co.

Passing mention should be made of the Franklin Light & Power Co., recently organized to develop water-power on the Broad river in Franklin and Hart counties. It is understood that 5,000 horsepower will be developed for transmission to Royston, Carnen and Bowersville.

Tennessee.

Coming finally to Tennessee, we find that here, too, the water-power interests have been working over-time. First in the order of importance comes certainly the developments of the Tennessee Power Co. The following description of the organization and plans of the company is quoted from the "Electrical World" of April 13, 1912:

"Negotiations between H. M. Byllesby & Co., Chicago; E. W. Clark & Co., Philadelphia; William P. Bonbright & Co., and Hodenpyl, Hardy & Co., New York, have resulted in the formation of a plan for developing water-power resources in the state of Tennessee and the transmission of energy throughout this state and Kentucky and parts of Georgia. The plan calls for the formation of the Tennessee Railway, Light & Power Co., under Maine laws, and the Tennessee Power Co. under Tennessee laws. The authorized capitalization of the first company will consist of $50,000,000 preferred stock, of which $10,250,000 will be outstanding, and $20,000,000 common stock, all of which will be outstanding. The capitalization of the Tennessee Power Co. will consist of $50,000,000 first-mortgage fifty-year 5 per cent gold bonds, dated May 1, 1912, of which $7,500,000 will be outstanding, and of $20,000,000 common stock, all of which will be issued. The Tennessee Railway, Light & Power Co. will own the following: All of the capital stock of the Tennessee Power Co. (excepting the qualifying shares of the directors); a large majority, and probably all, of the common stock of the Nashville Railway and Power Co., all the bonds and capital stock (except directors' qualifying shares) of the Cleveland Electric Light Co., of Cleveland, Tenn.; a large majority, and probably all, of the preferred and common stock of the Chattanooga Railway & Light Co. The company will have approximately $882,000 in its treasury as working capital. The Tennessee Power Co. will own, free from all encumbrances (other than its first-mortgage bonds mentioned above), the following properties: The 27,000 horsepower hydro-electric plant on the Ocoee river near Parksville, Tenn., now in operation; the transmission lines now in use from this plant by way of Cleveland to Chattanooga; the transmission line from Cleveland to Knoxville, Tenn., which is nearly completed; the transmission line from Cleveland southward to the Georgia state line; the Great Falls power site and reservoir at the junction of the Caney Fork and Collins rivers, near Rock Island, Tenn., capable of development of 80,000 horsepower, and said to be the most desirable water-power site in Tennessee; two additional sites on the Ocoee river, in addition to the first-named above, one capable of development of 16,000 horsepower and the other of 30,000 horsepower. The company will have in its treasury $2,478,000 which it is proposed to use for construction and other purposes. A large part of the properties named above was acquired by purchase from the Eastern Tennessee Power Co., with the approval of the stockholders of that company. The following construction work will be undertaken immediately by the company: An addition of 11,000 horsepower to the first development on the Ocoee river, now in operation as above; construction of a 16,000 horsepower hydro-electric plant on the second site on the Ocoee river, to operate under a 250-foot head; construction of additional transmission lines from Parkville, by way of Great Falls, to Nashville, Tenn., and from Nashville through the surrounding country, to reach the various power users."

The second development on the Ocoee river referred to is now well along toward completion. At the present writing, it is not possible to say whether the third development on the Ocoee river will next be taken up or that of the Caney Fork power site. Quite recently the company has entered into a significant arrangement with the Georgia Railway & Power Co., whereby that company takes over as much of the transmission line of the Tennessee Power Co. as has been built in the state of Georgia, agreeing to take power at the state line from the Tennessee company. It is a part of the agreement that the Georgia company will respect Tennessee as the happy hunting grounds of the Tennessee company upon which it will by no means encroach.

Since April, 1912, the Tennessee Power Co. has been furnishing all the electric power for the city of Chattanooga, and since October that for Knoxville. The transmission line to Knoxville is shortly to be extended on to Mascot to supply the American Zinc Co. with power for its mining operations. The line to Nashville is under construction and will probably be completed early in the year 1913. The Aluminum Co. of America is said to have contracted to take a block of 20,000 horsepower, beginning on June 1, 1913, for a minimum period of five years. At the present writing, the people of both Knoxville and Chattanooga are most curious to know which of the transmission lines is destined to carry this load.

Next in immediate importance to the development of the Tennessee Power Co. comes the plant of the Chattanooga & Tennessee Power Co., now nearing completion at Hale's Bar, on the Tennessee river. As an engineering accomplishment, this plant will take rank among the foremost projects of the day. Located twenty-one miles below Chattanooga by road—thirty-three miles as the river winds, and but thirteen as the crow flies, at the lower end of what is termed the "mountain section" of the Tennessee river, the 40-foot dam will back the river up for a distance of 38 miles, and will convert this section of the river from one hazardous navigability into a lake of serene tranquility, wonderful beauty and entire safety to navigation. The power equipment will comprise fourteen units, each consisting of three turbines and the generator mounted upon a vertical shaft, and developing 4,200 horsepower each. Thus, the capacity of the plant will be 58,800 horsepower. The total length of the dam, including the lock, is 2,500 feet. Beginning at the western embankment, we have first the lock, in which the lock chamber measures 60 feet wide by 312 feet long; next, the concrete spill-way masuring 1,200 feet in length; then the power house 350 feet long, and to the east of this an 800-foot earth dam built over a concrete corewall. At times of extreme flood, there will be a larger volume of water flowing over this dam than over any other dam now existing in the world. Some interest attaches to the lock also, because it will be the highest single lift lock in the world. The great lock gates measure 58 feet in height, and they will be operated by electric motors.

Construction was begun in October, 1905, with the expectation that three or four years would suffice for the completion of the project. However, unforeseen difficulty was experienced in obtaining suitable foundation, and this has greatly retarded the progress of the work. At the present writing, the earth dam, the power house and the lock are completed and the spill-way is about 80 per cent complete. The present expectation is that work will be finished early next summer, and that by July, 1913, the generation of power will have started. A transmission line to Chattanooga and a sub-station in that city were built some two years ago, and there is some talk of building a transmission line to Birmingham. The dam is building under a grant from Congress which gives the company the use of the power for a term of 99 years. The Chattanooga & Tennessee River Power Co. is in reality Mr. Anthony N. Brady, of New York. Hence, it belongs to the group of properties known as the "Brady interests," and, according to the United States commissioner of corporations, is, like the Tennessee Power Co., indirectly allied to the General Electric Co.

The first development of the Watauga Power Co. was completed in September, 1911, and it was the first large hydro-electric plant to go into operation in Tennessee. The plant is situated on the Watauga river, about six miles above Elizabethton. The dam is of cyclopean concrete, is 50 feet high above low water; the spill-way is 240 feet long, and during the probable heaviest flood discharge of the river the water will stand 12 feet deep on the crest of the dam. The installation is designed to consist of three units, developing 1,600 horsepower each, but up to the present time but two of these have been placed. Electricity, generated at 2,300 volts, is transmitted at 44,000 volts to Elizabethton and to Bristol. The power requirements of Elizabethton being moderate, the bulk of the power is taken to Bristol and is sold to the Bristol Gas & Electric Co. In addition to this power site, the company owns two others, one located higher up on the Watauga river, and one on the Doe river. The officers of the company are L. F. Miller, president; W. E. Hunter, vice-president, and J. H. Grayson, secretary and general manager; all are residents of Elizabethton.

The project of the Tennessee Eastern Electric Co., is the latest of the developments now under construction. It consists of a dam and power house on the Nolichucky river, 9 miles south of Greenville. The dam is being built with foundation adequate for an ultimate height of 100 feet, but for the present the dam will be carried to a height of but 45 feet. The ultimate height will create a pool about 9 miles long, and will develop approximately 13,300 horsepower, four units being used. For the present, 7,500 horsepower will represent the total plant capacity. The company, of which W. U. N. Powellson, of New York City, is president, R. L. Warner, of Boston, treasurer, and Amzi Smith, of Johnson City, manager, has purchased the electric plants of Johnson City, Greenville and Jonesboro. These plants will give the company steam auxiliary power to the extent of 1,800 horsepower. The company proposes to furnish power to these three cities, and later to extend its field as power demands warrant.

Except for a comparatively small development on the Duck river in Middle Tennessee, this completes the list of developments completed or under actual construction.

Turning to the projected developments, we find that there are three of large magnitude under contemplation. Of these the most important is that of the Aluminum Company of America referred to in the section on North Carolina. For some months past the Aluminum Company has been busy acquiring title to all the power rights and riparian privileges on the Little Tennessee river, from Franklin, N. C., a distance of 65 miles, to a point 20 miles south of Maryville, Tenn., where the river finally emerges from the Unaka Mountains, and exchanges the exuberant vigor of a mountain stream for the more sedate habit of a mature river. In addition to this the company has acquired the tributary streams—the Cheoah, the Tuckaseegee and the Nathala rivers. Complete surveys of this water-power domain have been made, and the sites of power houses and storage reservoirs have been quite definitely determined. The ultimate plan contemplates the construction of dams, one beyond another, so placed that each will back water nearly or quite up to the toe of the dam next above it. Some of these dams, owing to the steep and narrow character of parts of the river-bed, will impound but small quantities of water; while others more favorably situated for storage purposes will form lakes of large extent. For instance, at one point on the Cheoah river a dam 135 feet high will impound about three and a half billion cubic feet of water. There are a number of fortunate reservoir sites; and the ultimate development now projected will not only utilize practically all of the fall of the streams (about 1,200 feet on the Little Tennessee river alone), but will to a very large extent conserve the flood waters of spring to spread them over the dry months of summer, and thus develop in an ideal manner the total power of all the annual stream runoff. This power will exceed 400,000 horsepower.

The Aluminum Company, by purchasing the stock of the Knoxville Water & Electric Power Co., has acquired a franchise for furnishing light and power in Knoxville. However, furnishing light and power in Knoxville will merely be pastime for the Aluminum Company; for the serious purpose of the company is to erect reduction works for the production of aluminum. Aluminum is made from the mineral bauxite. This the company now mines in Missouri and Arkansas and ships to the concentration plant located at East St. Louis. Five tons of ore produce two tons of concentrate. The concentrate is then shipped either to Niagara Falls or to Massina, N. Y., where are situated the electrical reduction furnaces of the company. Two tons of the concentrate yield one ton of pure aluminum, and this metal is then sent to the company's works at New Kensington, Pa., where finally it is fabricated into wire and the aluminum products of commerce.

The productive capacity of the company's two reduction plants having become wholly inadequate to supply the market, it is the expectation that a new plant will shortly be built at or near Knoxville; and as each succeeding unit of power development on the Little Tennessee river is completed, the capacity of the reduction works will be correspondingly enlarged. It is said that the first development will be of such size as to give employment to about 5,000 men.

The Aluminum Company is understood to have contracted with the Tennessee Power Co. for a supply of 20,000 horsepower for a minimum period of five years, beginning on June 1, 1913. Presumably a part of this power will be used in construction work on the company's own projects; but probably most of it is desired to enable the company to begin ore smelting without the delay necessary before its own water-power can be made available.

Construction on some of the dams would undoubtedly have been started some months ago except for a difficulty that arose over the interference of the water-power development with the proposed Murphy extension of the Southern railway. For months parties of engineers representing the Aluminum Company and the railway have been at work in an effort to make a satisfactory relocation of the railroad line. At the present writing, the solution of this difficulty has not been reached, although it is believed to be near at hand. Construction work for the power development will probably not be delayed much longer.

The second of projected developments is that of the Tennessee Hydro-Electric Co. This company, chartered on April 16, 1912, proposes to develop all of the power afforded by the Clinch and Powell rivers both in Tennessee and Virginia. The plan contemplates erection of five dams as follows: Dam No. 1, 40 feet high across Clinch river just above the mouth of the Emory river in Roane county; dam No. 2, 60 feet high, on the Clinch river just above the Louisville & Nashville railroad crossing in Anderson county; dam No. 3, 150 feet high, on the Clinch river just above Island Ford, and a short distance below the mouth of the Powell river between Anderson and Campbell counties; dam No. 4, 260 feet high, on the Powell river, 500 feet above the Southern railway bridge, in Claiborne county; dam No. 5, 260 feet high, on the Clinch river about two miles above the Southern Railway bridge between Claiborne and Grainger counties. The elevation of the crests of dams No. 4 and 5 will be the same, and the dams will constitute a single development. That is to say, one of the dams, that on the Powell river, will be a diversion dam, and the water of the Powell river will be diverted through a tunnel which will discharge just above dam No. 5 into the Clinch river. The power house located at No. 5 will then utilize the flow of both rivers, under the head of 260 feet thus rendered available. The writer is not advised as to the horsepower to be installed at each of these four power houses; but the company claims that their total development will aggregate 400,000 horsepower. For the realization of any such total as this, it will be essential for the company to build storage reservoirs to impound the flood waters of the streams and by this means equalize the flow

The officers of the Tennessee Hydro-Electric Co. are: president, J. R. Paul, of Pittsburgh, Pa.; vice-president and general council, James B. Cox, United States district attorney, of Knoxville; treasurer and chief engineer, F. M. Butler, Newcastle, Pa.; secretary, J. R. Cox, of Knoxville. The company is capitalized for $10,000,000, and the same men have incorporated the Virginia Hydro-Electric Co., with the same capitalization, in order that the right of eminent domain may be exercised in both states. The plans contemplate an expenditure of $20,000,000.

The third and last of the projected developments is that of the French Broad River Power Co., which proposes to develop 30,000 horsepower at a site on the French Broad river just above its confluence with the Holston, five miles from Knoxville. While this company is not new, having been incorporated in 1908, no progress has yet been made toward construction work. The company claims, however, to have spent $30,000 in preliminary examinations of foundation sites, preparation of plans and specifications, and for the purchase of riparian rights.

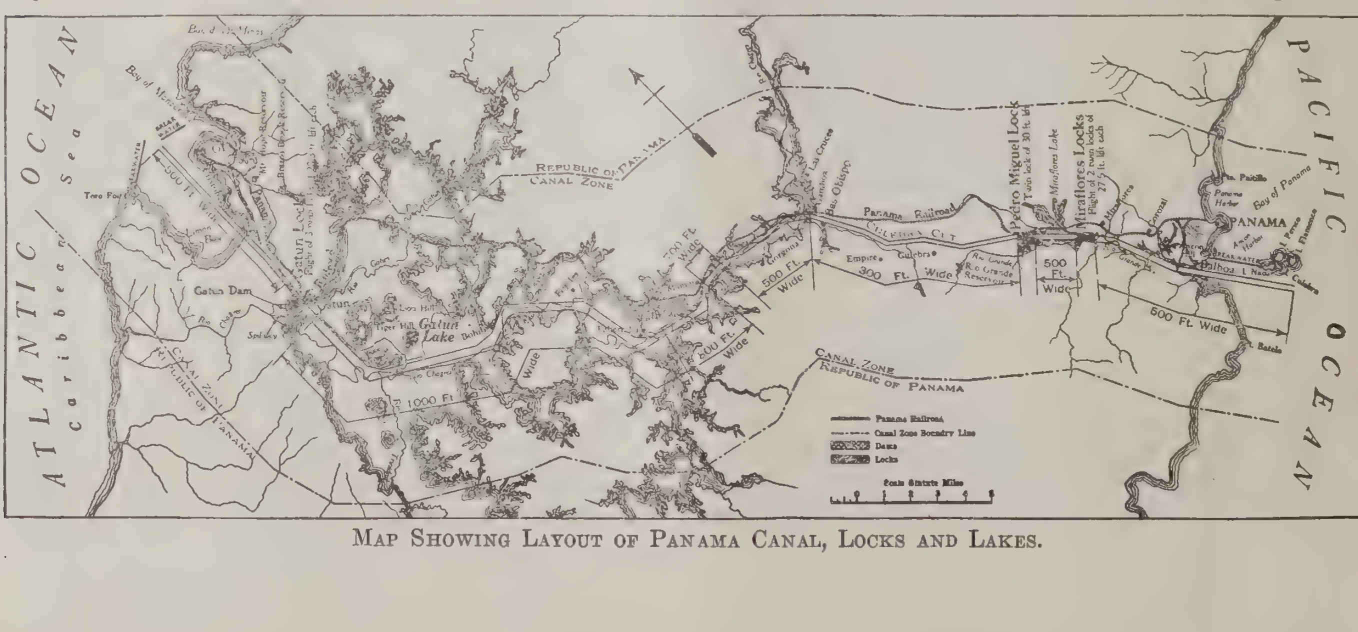
The Engineering and Electrical Features of the Panama Canal.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN).

BY M. C. TURPIN.

IT WOULD be difficult to name a peaceful point on the earth's surface just now towards which the eyes of the nation are turned with such intense interest as to Panama. The reason for this world-wide attention is that the impossible is about to be accomplished and the barriers erected by nature and which since the creation of the world have separated the great Atlantic and Pacific oceans, and united the continents of North and South America, are to be thrown down. This achievement is of particular interest to those living in the Southern states because of the immense advantage accruing to this portion of the country from the use of the canal by the commerce of the world. The maximum benefit to be derived from it will be obtained by trade between the Atlantic and Pacific coasts of the United States. The distance from New York to San Francisco via the Straits of Magellan is 13,135 miles, by the Panama route 5,262 miles, or a saving of 7,873 miles, or a saving of over a month's time for an average coast-wise vessel. Between New Orleans and San Francisco the saving is even greater, amounting to 8,868 miles. These figures might be continued indefinitely and the saving in various routes shown, but such is not the purpose of this article.

A glance at the history of this wonderful undertaking may refresh our memories and prove of interest. Colombia, of which until 1904 Panama was a part, and Nicaragua, were the scenes of many wars, revolutions and piratical raids, and various efforts were made to start a canal through one



MAP SHOWING LAYOUT OF PANAMA CANAL, LOCKS AND LAKES.

or the other by adventurous kings, statesmen or promoters. A treaty was made by the United States with Great Britain, which had soon acquired territorial rights in Central America, regarding a proposed canal which would join the two oceans. This was known as the Hay-Pauncefote treaty and it outlined the principles on which such a canal should be built and operated.

Ferdinand De Lesseps, a Frenchman, and a great engineer, inspired by his success in building the Suez Canal, organized a company, of his countrymen, entered into an agreement with the Republic of Colombia, and finally began the gigantic task of separating two continents in 1881. For five years they worked and succeeded in spending $260,000,000, and then the company went into the hands of a receiver.

When the subject of the canal was revived, the advocates of the Nicaragua route, ably led by the late Senator Morgan, of Alabama, became very active and the question of Panama or Nicaragua was argued in Congress long and bitterly. Finally, Congress authorized the president to conclude a treaty with Colombia and build the canal. Negotiations were at once entered into with the Republic to whom liberal terms, including a payment of money, were offered. Then came a display of those dilatory tactics for which the Spanish races are well known. Promise after promise was broken by them until finally the inhabitants of Panama to whom the canal meant everything, led by Amador, who afterwards became the first president, revolted from Colombia and formed the Republic of Panama on November 3, 1904, and four days later, November 7, President Roosevelt, without waiting for any other nation, recognized the new republic and at once began negotiations with it for the canal. The French company was paid $40,000,000 for all its machinery, work done, maps, surveys, the Panama railroad, etc. It is interesting to note that in a subsequent appraisal the value of the French legacy is placed slightly over $42,000,000, which would certainly indicate a good bargain.

The Canal Zone is a strip of land 10 miles wide, five miles on each side of the center line of the canal, and contains about 448 square miles. This is owned by the United States and is a separate country from Panama. The two cities of Panama and Colon are not in this zone, as is often stated, but the United States reserves the right to enforce sanitary ordinances and preserve order whenever it deems it necessary, a right it has exercised on several occasions in the past, and doubtless will continue to do in the future. Contrary to the popular belief, the canal does not run east and west, it has a general southeast, northwest direction, which fact accounts for the usual map of the canal appearing to be upside down. Panama City, on the Pacific, is 22 miles east of a line due south of Colon on the Atlantic.

Fig. 1. The Gatum Locks. A General View LookingSouthwest, Showing North End of Locks With Temporary Coffer Dam in Place.

The route followed by a ship in passing from the Atlantic to Pacific oceans will be traced briefly and then the main points of interest described more in detail. Entering at Colon, the Atlantic port, it proceeds at sea level for seven miles to the Gatun locks and dam through a channel, 500 feet wide and 41 feet deep. Here in three successive steps it is raised to a total height of 85 feet above sea level. From Gatun it steams along on this level at full speed to the famous Culebra Cut, a distance of 23 miles. The first 16 miles of the channel is 1,000 feet wide and is marked by buoys on the surface of the lake, lighted at night by electric or gas lamps.

Gradually narrowing in width the channel becomes 300 feet (at the bottom) in the cut which is 9 miles long. Passing through here at reduced speed, it will arrive at Pedro Miguel locks, where it is lowered 30 feet or to 55 feet above sea level, passing into Miraflores Lake. Then it reaches the Miraflores lock through a channel 500 feet wide and thence down through two lifts 55 feet on to sea level again. From here through a 500-foot channel it sails 8 miles to the Pacific ocean. The total length of the channel is 50½ miles. Forty miles of this length will permit full speed of the vessels, there being 15 miles of sea level, and 25 miles of open lake, leaving the 9 miles in Culebra Cut, and 1½ miles through the locks. The time in passing varies from ten to twelve hours, according to the speed of the vessel. Three hours are consumed in going through the six locks.

Fig. 2. Gatun Upper Locks, West Chamber, Looking North, Showing Construction of Three Sets of Gates.

Breakwaters are being constructed on the Atlantic end a distance of 1,000 feet out to protect the Limon Bay as it is called, from the "Northers" which often sweep down and make the sea so rough that it is impossible for a boat to remain at dock and they have to lift anchor and get out in the bay. There is no danger anticipated from the trade winds.

Breakwaters are also located on the Pacific coast. Beginning now again on the Atlantic end the main features of interest may be described. Water for the canal on the Atlantic end will be supplied by the Chagres river a turbulent stream rising in the hills of Panama and draining 1,320 acres of land. In 1910 the volume of water discharged at Gatun, equalled one and one-half times the amount of water that will be in the immense Gatun Lake which forms the 1,000-foot channel mentioned before. It has been known to rise 40 feet in 24 hours, and in this period to discharge 100 times the water it does in the entire dry season. It has a flow of 170,000 cubic feet per second, or two-thirds of that passing over Niagara Falls.

Stringent measures then had to be taken to control and utilize this unruly force. Therefore, it was decided to erect at Gatun, where there was a break of about a mile and a half between two ranges of hills, as a connecting link an immense dam, which would hold back this water up to a height of 85 feet, the maximum height of the canal above the sea level. The dam is in reality a small mountain 1 1-4 miles long, nearly one-half a mile wide at its base and will be 400 feet wide at water surface and 105 feet high, at which height it is 100 feet wide. The original height intended was 135 feet, but it was decided to reduce this. It is composed entirely of earth, with the exception of the spillway, as the nature of the soil would not permit a masonry dam.

er than the largest known discharge of the Chagres. The area of the backed-up water or artificial Gatun lake, is 164 square miles, so immense that it would take the greatest known flood of the Chagres nine hours to raise the level one foot in the lake and no water going over the spillway.

There are six locks in the canal as has been stated. Three at Gatun on the Atlantic end, one at Pedro Miguel and two at Miraflores on the Pacific. They are built in pairs so that vessels may go through in opposite directions and are of concrete and are decidedly the most impressive looking objects the visitor sees. The masonry work of these massive locks was mostly put in place by means of cableways spanning the work over which traveled the buckets. The cableways take the buckets from the cars and by a combination of the movements of the trucks and the transverse movement of the cableway dump it in the desired position. There is one tower on each end of the span but the operation of both is controlled from one, which is equipped with three electric motors. One of these, 150 horsepower, drives the hoisting and conveying drums; one, 25 horsepower, operates the dumping arrangement, while the remaining one, 25 horsepower, drives the tower along the track. The other tower also has a remote controlled 25 horsepower motor for its propulsion. The total amount of concrete estimated for the canal is 5,000,000 cubic yards, of which the Gatun locks and spillway will require about 2,000,000 yards at an approximate cost of $7.75 a yard.

An interesting point in this connection is that this immense construction, probably the largest concrete structure in the world, is rendered so much simpler by virtue of the fact that two of the ingredients of the concrete were

FIG. 3. THE GATUN SPILLWAY. VIEW LOOKING SOUTHWEST, SHOWING DOWN-STREAM FACE OF OGEE DAM.

To control the flow of the turbulent Chagres and thereby regulate the height of the water in the canal, a spillway was erected of concrete about midway of the dam, being built right into a natural hill which stood at an elevation of 110 feet above the sea level, and was of solid rock. A channel 300 feet wide was cut through and lined with concrete. A dam was built on this with gates so arranged that the water can be allowed to flow either over or under them, by which the level of the lake will be controlled.

This is necessary because of the difference in rainfall and therefore available water, between wet and dry seasons. At the end of the rainy season, the gates will be closed and the level increased from 85 to 87 feet, or enough water to make 58 lockages a day during the dry season. That is ten more than could be made with vessels following one another at intervals of one hour. The spillway is capable of discharging 154,000 feet per second, or great-

within easy reach. The crushed stone was delivered to the stock piles at an average cost of $2.49 per cubic yard, and the sand to the same point at $2.24 per cubic yard.

The water is conveyed to the locks by 18-foot tubes or tunnels running under the side and center walls, and thence by transverse tunnels or laterals through openings in the floors of the locks. These openings will be regulated by gate valves of which there are 116, each one operated by a 50 horsepower electric motor controlled from a central point. The valve stem is operated by a 3-horsepower motor, and the valve motor is equipped with solenoid brakes to bring it to rest in case of emergency. The water from the center wall and in the lateral culverts is controlled by 7½ horsepower motor-operated valves, of which there are 20 in each of the six chambers, or 120 altogether.

In order to lift a vessel from a lower to a higher level, the valves at the lower end are closed, and those at the

Fig. 4. The Pedro Miguel Locks. Birdseye View from Hill on East Bank.—July 28, 1912.

upper end are opened. The water then flows from the upper level into the lock, passing down the tunnel in the side wall and out through the laterals under the floor coming up through the openings in the floor and seeks its level. To lower a vessel, the process is reversed. The tunnels through the side walls are generally used, the ones in the center being used as auxiliary, or used to assist in filling the chamber at the latter part of the process when it is slow, due to decreased head and consequently rate of flow. The average rate of fill is two feet per minute, or a 30-foot lift requires fifteen minutes.

The 1,000-foot lock chambers are divided by a set of gates into 600-foot and 400-foot lengths, so that in the case of a smaller vessel it is only necessary to use either one of the chambers and thereby save the water and time required to fill the 1,000-foot chamber. By means of interconnection of valves it is possible to pass water from one side of the lock to the other, effecting a saving when vessels happen to be going in opposite directions at the same time.

The gates and their construction form an exceedingly interesting part of the work of building the canal. They are built very much on the order of our modern sky-scrapers; consisting of big steel girders of from twelve to eighteen tons each, with vertical framework between them and this covered by steel plates. These immense gates, due to the method of construction and balanced pressure on each side, only require a 27-horsepower motor to operate them. This motor is connected through intermediate gearing to a large horizontal gear wheel to which is attached, eccentrically, a 5-ton beam or connecting rod, the other end of which is attached to the gate. As the gear wheel, actuated by the motor, slowly revolves, the gate will be drawn shut or open, depending on the rotation of the motor. As stated above, there are 92 gates, and this number of 27-horsepower motors will be required to operate them. In order to completely close the gates and lock them after they have been brought together by the device just described, use is made of a miter forcing machine. This is driven by a 7½ horsepower motor. A test made on one set of completed gates showed a time taken to swing a gate, without water, of one minute and 48 seconds.

Most of the accidents that have happened in the passage of vessels through other canals have been due to some misunderstanding of the signals between the engineer and those giving the orders. In passing through the locks of the Panama Canal, a vessel will be taken through by the canal operators, the motive power being four electric locomotives, replacing the familiar old canal mules. In places other than the locks, vessels will go through under their own power.

When a vessel approaches it will tie up to the center or guide wall which extends beyond the side walls, here it is taken in tow by the locomotives, two in front to furnish the motive power, and two to retard or steady the vessel as it gets into position. It should be remembered that, though the vessels are lifted gradually by water from one level to the other, the locomotives are on the banks and must climb this grade constituting the difference in lock levels, about 30 feet is an average height. To assist in this and also afford traction along the level, a cog rail is laid along the center of the track with which a pinion on the locomotive engages. The maximum speed under these conditions is two miles per hour. When returning, however, the locomotive switches to another track without a cog rail and a speed of five miles an hour is obtained. Forty of these locomotives will be used, one having already been purchased and the other 39 are under construction. They exert a draw bar pull of 3,400 pounds.

Should a vessel not obey the signal but come ahead into the lock, it would be stopped by an immense chain forged out of 3-inch iron stretched across the entrance. This chain is raised by huge hydraulic cylinders operating in the side walls and controlled from above. As the vessel runs on the chain it is stopped and the natural swing of the vessel throws it right again. When not in use the chain, which can stop a 10,000-ton vessel going four miles an hour, lies in a slot in the floor. The pumps for operating the cylinders are driven by 70-horsepower motors.

Every set of gates at the upper and lower end of each

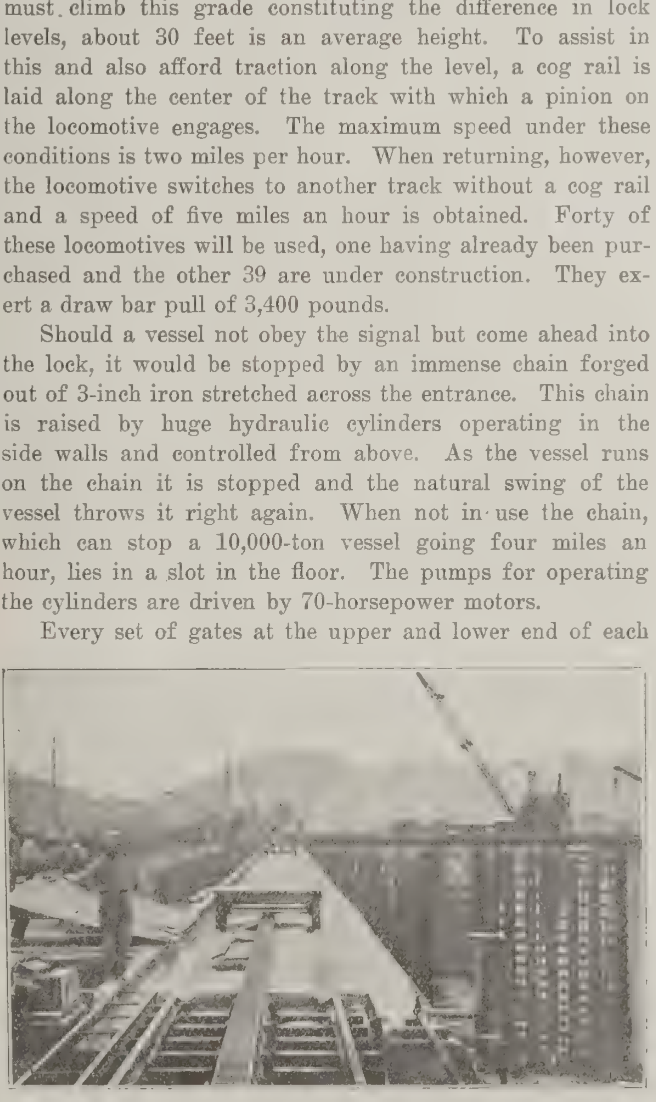


Fig. 5. Pedro Miguel Locks Showing Detail of Construction of Electric Towing Locomotive Rack Track.

lock are built in duplicate, so that should by any chance the vessel get past the fender chain, it would ram the first gate, and the lock would still be protected by the second set of gates. Should all of these devices fail and a free communication be established between higher and lower levels, it would be the most serious accident that could occur, as a flow of 90,000 cubic feet of water per minute would occur.

To counteract this, an emergency dam is provided which looks very much like a big draw bridge. Two of these are at each side of the upper end of each lock. They are swung across the lock and from them open-work wickets are dropped, which engage a grooved sill on the floor. Then gates are slid down over these and a temporary dam is secured which stops the main flow of water—except seepage. A floating caisson or hollow steel float then is sunk by filling it with water, which entirely shuts off the flow of water, the emergency dam is raised and repairs made. The bridge is swung into position by two 150-horsepower motors, and 25-horsepower motors are used to operate the wickets, and the same capacity for the plates previously mentioned.

Proceeding past the Gatun dam and locks, to the Culebra Cut, the work consists mostly of dredging and excavating the channel through what will be the Gatun Lake covering an area of 164 square miles. The famous Culebra Cut is the cutting in two of the range of hills or small mountains which form a connecting link in the Continental Divide, known as the Rocky Mountains in North America and the Andes in South America.

It is said that if all the excavated material from the canal, 212,227,000 yards, were to be loaded on one train of flat cars, it would be 96,000 miles long, or four times around the earth. There are about 35,000 people employed on the canal work, of whom one-seventh are Americans. The laborers get 16 cents an hour. Approximately 35,000 tons of coal per month are used at a cost of $6 per ton delivered, and about 75,000 tons of oil, in the same time at a cost of $1.10 per barrel.

Any mention of the canal is not complete without some reference to the excellent sanitation without which it would have been impossible to build it. The houses of employes are comfortable and home-like, and the remarkably low death rate of 11.34 per 1,000 is sufficient comment.

Electric energy for operating the various motors of which there will be over 1,000 aggregating approximately 35,000 horsepower, and furnishing the lighting will be supplied from a central power plant to be built at Gatun and operated by the water over the spillway, which even in dry season will have a good reserve capacity. The generating equipment will consist of three 2,000 kilowatt, 25-cycle, 3-phase, 2,200-volt generators direct connected to water wheels running at a speed of 250 revolutions per minute; three 50-kilowatt exciters to be direct connected to the water wheels, and one 100-kilowatt exciter to be induction motor-driven. The average head available throughout the year will be approximately 75 feet, and even in the dry season more than sufficient water will be available as the maximum amount required is only about 7 per cent of the minimum supply in Gatun Lake. The present steam plant at Miraflores will be retained as an auxiliary, but all operating current will be obtained from the hydraulic plant at Gatun.

The operating voltage is 220 and will be obtained through transformers installed in various sub-stations located along the canal. Duplicates are provided and every method practicable used to prevent any interruption to service, such as "fool proof" switches, interlocking and automatic devices, etc. In connection with the remote control of the lock machinery, the movement of each machine is indicated visually to the operator on an indicator-board on which are outlined the various steps through which it passes. In addition to these uses in units of larger capacity, electricity is also used for lighting, fire alarms, telegraph, telephones, signals, etc.

The action of the climate is very destructive to insulation so that it must be specially prepared in order to prove of service. To secure this, the government, before purchasing any lot of motors, secures samples from different manufacturers and subjects them to rigid tests, including storing in a steam-filled room at a temperature of 50 degrees centigrade, for a period of ten days, during which periodic tests are made on the insulation.

For lighting the locks concrete standards containing 400-watt tungsten lamps, 100 feet apart, will be used. These standards will be thirty feet above the wall and intended to throw light over the vessel as well as furnish general illumination. The route of the canal will be well illuminated all the way across, so as to permit passage at night, the lights being placed on buoys, range towers and on land. Wherever a turn is made, the lights are strung out on the tangent so as to enable the pilot to make the turn easily. For inaccessible places, where it would not be practicable to run electric wires, compressed acetylene will be used. A total of 7,000 incandescent lights will be used on the locks. The canal will cost, it is estimated now, $375,000,000, and will be officially opened January, 1915, but vessels will go through in September, 1913.

Jovian Electrical Street Parade in New Orleans.

Reigning Apollo, L. S. Montgomery, has recently returned from New Orleans, where he advises the Louisiana Jovians, under the leadership and dirction of Statesman F. B. Stern, assistant general manager of the Interstate Electric Company, are planning for an elaborate electric street parade for the night of February 1, and for a rejuvenation to be held at that time. This date is at the time when the Carnival season of New Orleans is being celebrated and on this account there is surely to be considerable interest taken in it. The first Carnival parade will be held on Thursday night, January 30, and the last on Tuesday night, February 4, the Jovian parade taking place on Saturday night. This affair will be novel in every respect and cost about $5,000. Those who plan to attend should notify Statesman Stern early in order to secure hotel reservations.

Nebraska Quits State Ownership.

Nebraska has found state ownership of lighting and power plants a failure, and the Board of Public Lands & Buildings has decided to contract with privately owned concerns to furnish light and power to the state institutions. The plants which have furnished light and power to the state properties will be closed and probably sold. According to Secretary of State Wait, the state-owned lighting plants are operated at a loss, and power can be purchased from private concerns at less money. For years it has been a fixed policy of Nebraska to install state-owned light, power and water plants in all state-owned institutions. These plants were under direct control of the Board of Public Lands & Buildings. According to Secretary Wait, the state will save considerable money.

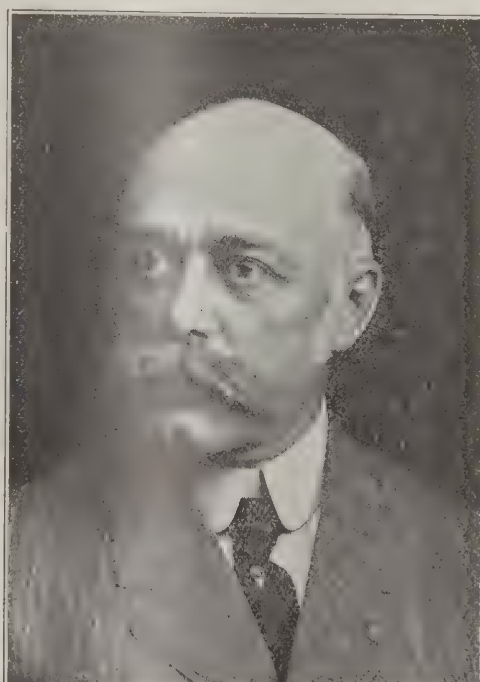
Progress of National Electric Light Association During 1912

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN).

BY T. COMMERFORD MARTIN.

THE National Electric Light Association is closing an exceedingly busy and prosperous year during which its membership and influence under Presidents Gilchrist and Tait, have extended far beyond what was once deemed possible. The membership at the present moment (December 15), is just about 12,700, as compared with 10,354 early in January, 1912; thus showing a net gain of 2,350. There has also been a growth in the number of state or geographic sections and as the readers of the SOUTHERN ELECTRICIAN are aware, this has included the work done to enlarge the Georgia Section so that it will include several other states along the South Atlantic coast, making one of the largest groups within the body. Several new company sections have also been organized and the company section idea is very much in favor.

The convention of 1912 was extremely successful in spite of the fact that for the first time in its history the Association went to the Pacific coast. The Seattle meeting was attended by some 1,500 people. of whom 1,000 came from east of the Rockies; and the three days of meeting were full of hard and useful work. A very marked impress was made on the central station industry of the coast and one of the results has been the formation of a strong company section at San Francisco, while steps are being taken to form another one at Los Angeles and to organize a state section as well. One notable feature of the Seattle convention was the issuance of a Meterman's Handbook by the meter committee—a handsome volume of 1,200 pages which was printed in three weeks so that copies were actually distributed at the convention. During the year 2,500 copies of this book have been sold and an edition of 2,500 more left the press in December for which advance orders for 500 copies had already been received. Such results are highly encouraging in view of the splendid and self-sacrificing work done by the committee for its fellow members and for the industry.



T. C. MARTIN, SECRETARY NATIONAL ELECTRIC LIGHT ASSOCIATION.

Another highly successful performance on the part of the Association has been the issuance of the rules prepared by its commission on resuscitation from shock. This work has been carried out by a body of distinguished physicians and experts and has at once been accepted as authoritative, not only by central station companies and electrical manufacturers, but by the United States navy. In fact, the rules have also been reprinted by the United States Bureau of Mines, as well as by some of the state bureaus of mines and of kindred character. The rules are also being printed for itself by the Chilian navy, and it is now proposed to issue them as well in German, French, Spanish and Italian. Although the rules were only issued in September, some 40,000 copies of the chart and booklet, being the forms in which they are issued, have already been sold—while the rules have also, by permission, been abstracted or reprinted in newspapers all over the country and have already been embodied in some of the latest text-books. The association is entitled to high credit for its activity in this broadly humanitarian work, which is in line with the other work recommended by its Public Policy Committee in regard to the welfare of employes.

During the year the work of the Commercial Section was carried forward in an aggressive way and in order to make it even more effective the secretaryship was concentrated in the main office of the association. The Section now has nearly 1,500 members in good standing and has already issued a great deal of useful literature, particularly its Commercial Digest, for which there has been a great demand. Some idea of the work now done by the Section may be formed from the fact that since the headquarters of the Association took over its publications in September, nearly 100,000 copies of its various books and pamphlets have been issued and sold in a period of four or five months.

The Association has just decided to hold its 1913 convention at Chicago, next June, in the El Medinah Temple, and great interest is already being manifested in the matter. In New York in 1911 a total attendance was reached of 6,400 so that some of the more sanguine members of the body, especially those in Chicago, predict for 1913 a total attendance of not less than 7,500. This is no small crowd to look after, and when it is considered that there will be four days of business it will be realized that the annual conventions of the N. E. L. A. are becoming events of the first importance to the central station industry in particular and to the electrical industry in general.

Electrical Inspection—Its Problems and Its Development

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN).

BY HUGH T. WREAKS.

DURING the last several years the science of electrical inspection, especially as applied to buildings in cities, has made considerable progress, and it may be of interest to analyze its trend, as well as some of its problems, and see what the future is likely to bring forth. In the first place, the electrical industry is a much inspected industry, much more so than other competing forms of light and power production and distribution. This is probably due to several causes, among which are the following: Unlike gas or steam, defects in electrical conditions cannot easily be checked by the senses, *viz.* the sense of smell in escaping gas, the sense of hearing through escaping steam on safety valves. Again, gas has been used for so many years that its dangers through explosion, setting fire and asphixiation, have been learned and passed down from generation to generation and used as jokes in the popular magazines until the sense of its dangers has become intuitive. This is not so with electricity. In addition, there have been, and even are today, sufficient broad differences of opinions and changes of electrical rules from year to year by authorities to in a measure limit the respect for same by those who have been unable to appreciate the reasons for these various changes and differences; this latter condition being aggravated by the many further changes occurring, due to the rapid development of the industry.

HUGH T. WREAKS, SECRETARY, WIRE INSPECTION BUREAU.

Politics has also played its part on the inspection end, and it is only of later years that the inspection departments, local and national, have obtained that ripened knowledge of experience and measure of real policing authority which would allow them to do their best work. Even today there are many locations where this is not the case, and then there is, in addition, a conflict of authority, such that even the accepted rules are not administered in such a way as serve the public interests or the electrical trade. When one considers the difficulties which even a well-equipped field inspection department has to contend with, the number of rules and requirements to be observed, the number of approved articles to be remembered and noted, the number of jobs to be taken care of by each inspector, and the constant pressure of never finished reinspection, besides periodic inspections on theaters and moving picture shows; the possibilities of inferior work in poorly equipped inspection departments, or in those with a conflict of authority are very obvious.

The fact that in spite of these conditions and at times complications, the loss of life and property on account of electrical hazards has been relatively small, would indicate that the danger from electricity is much less than the refinement of rules and regulations would seem to show. In a measure this is confirmed by the number of freak and crude conditions which are discovered from time to time and yet still allow effective and even satisfactory electrical operation. Still the "power of evil" of uncontrolled electricity is so obvious that public safety demands efficient rules and regulations for its use and competent inspection to see that these are properly enforced.

Proper enforcement is, however, not an easy matter.. Theoretically the object of all rules and regulations and their enforcement through inspection aim at the production of electrical goods, which will have a factor of safety adequate for protection of life and property when new, and which will maintain same during the process of installation, and also for the period during which they may be expected to remain in use. To carry out this practically calls for the following: (a) Adequate specifications giving material and workmanship of construction. (b) a system of inspection and tests at factory, which will check this construction and workmanship as closely as the state of the art will allow; (c) a follow up system which will check the distribution of these electrical goods; (d) a check on the installation of the goods; (e) a check of the lasting qualities of the goods as used or abused in service.

The first, second and fourth conditions mentioned are carried out along a comprehensive plan in most locations. The third is commercially impracticable and undesirable, and the fifth is to date done only in a very spasmodic and inefficient way and without sufficient records being kept so as to make it of any real value. This is unfortunate, as can be readily shown by any one who studies the condition of much of the electrical goods in existing installations and notes the appreciably reduced factor of safety as compared with the standard called for in similar material when new. In some cases this is due to deterioration of natural, unavoidable, aging or use, in others to abuse, and again to original adulteration or poor design or construction of material so that it may conform to specifications and tests when new, but failed to have those "service value" qualities aimed at by those responsible for the rules, regulations and inspections.

The remedy for this latter condition is not a difficult one. On the face of it, it would seem to call for an additional volume of re-insection and clerical work in the way of records all out of relation to the possible value of the results to be obtained. As a matter of fact, much could be accomplished with the present electrical machinery, or by a relatively small addition to this machinery working under the jurisdiction of local field inspection departments but along a national plan.

Starting off with the theory that a given factor of safety in electrical goods cannot be reduced more than a certain amount under service conditions without these goods constituting an element of danger, this amount being easily determinable from the experience of the heads of the more prominent field inspection departments, the problem becomes one of checking those responsible for goods which deteriorate below this allowable reduction in factor of safety. Such deterioration may be due: (f) To adulteration in manufactured goods or incorrect construction; (g) to damage in distribution; (h) to damage in installation; (i) to abuse in service.

At first it would be extremely difficult to differentiate so as to tell where the blame for deterioration could properly be placed, and yet on the law of averages, and under a comprehensive national plan with several important field inspection departments co-operating, information would soon segregate on manufacturers, jobbers, contractors or users and show pretty clearly where responsibility should obtain. Automatically, this would concentrate re-inspection on those who showed the need of it and in this way raise the service value standard for all. At first glance such a plan of re-inspection would appear retroactive, but this would not be the case, as today there are apparently no records of any account in the hands of inspection departments as to those whose material is used, even in the more important installations, and without such records no comprehensive plan would mean anything or be practical. At least one trade organization has spoken in favor of such a plan as evidenced by a resolution passed by the Electrical Supply Dealers' Association in their convention at Atlantic City in May of last year.

Again a trend of engineering opinion voicing the necessity for checks on "service value" of electrical goods is illustrated by the recent specifications of the navy department, Bureau of Steam Engineering for 30 per cent rubber covered wire issued September, 1912, and those of the American Telephone and Telegraph Company for copper clad twisted pair distributing wire, which calls for a medium grade rubber insulation and bears date of issue November, 1912. The first specifies an aging test on samples filed for three years, the second a similar test on samples filed for one year. Similar aging tests are being considered by the underwriters on house wire, and by some of the railroads on their signal wire.

This is a commercial as well as a factor of safety aspect to the general situation and the moment the service value of electrical goods, as explained in the preceding paragraphs is called for, a pressure for quality will be exercised on the trade in a measure as an offset against the continual cry for lower price now in evidence. This would almost seem to indicate an economic value to the plan justifying an assessment on the electrical trade of the cost of the follow-up system of records and re-inspection especially as the cost would be a very small percentage of the total electrical inspection cost of today.

Southern Contracting and Electrical Supply Business

Suggestions Contributed to and Compiled by Southern Electrician in the Interest of a Deserving Industry.

In nearly all sections of this country where a distinct activity in electrical development is taking place, the electrical supply and contracting business is passing through a critical period. The business as a whole is one of the youngest connected with the electrical industry and has grown so fast and seemed so profitable that numbers have been attracted to it who know little about the technical and less about the business details. In those cases where the amount of business has been limited, the overcrowding of the field has worked a hardship on the responsible interests forcing them to come down to the methods of their competitors and solicit much of the business regardless of the profit. Demoralization naturally has followed and cheap, unsatisfactory work has resulted. It is in the majority of cases on this account that we find fewer prosperous concerns doing electrical contracting and retail supply business than are to be found in any other line of commercial activity.

Many contractors known as the "fly-by-night" class get their work by methods that hinder progress in their own business, which is a state of affairs at this stage of electrical development that merits serious attention. In securing a job where there is considerable competition, they will resort to most unscrupulous methods to reduce the cost of the job and often induce a customer, or take advantage, to install work which cannot be satisfactory in the end. The cutting of specifications and plans to eliminate provisions for fans, small motors, cooking and heating devices, or to trim illumination requirements to enable a bid of a low figure on any job and incidentally giving little more than average wage as a profit, are the milder forms of this unsatisfactory handling of the business. It surely reflects not only to the disadvantage of the central stations promoting heating and cooking device loads but thus deprives the home of many of the advantages which can be easily made at the time of constructing and wiring a building. Many installations are turned over completely to such contractors with little provision made by architects or owners for the details of the work. Advantage is further taken of this fact by contractors of the type mentioned and the unsatisfactory systems installed.

What follows here under the above heading, has not been written to prove these statements but to suggest changes and improvements that can be used to elevate this industry to its proper place in every community. It seems that a proper mixture of cooperation and legislation would do much in this direction. Local organizations affiliated with the National Electrical Contractors Association have in many places relieved demoralization due to unfair competition and examinations required of all doing electrical contracting would tend to permit only those technically fitted for the business to establish in it.

In regard to the organization and the credit condition of the electrical contracting business in the South we quote as follows from a letter received from a prominent jobbing house:

"There is no doubt of the fact that the southern electrical contractors and small dealers are not organized at all. Their credit as a class is not of the best and I believe there is no vocation where this is worse than in the electrical line. The main reason for this condition is cut-throat competition and ruinous business propositions among themselves. I expect you would find that any jobbing house that does a general business in the South, can show that over 60 per cents of their losses are among electrical contractors, the rest being divided among central stations, telephone companies, isolated plants, department stores and miscellaneous.

One of the principle reasons for the poor showing of the Southern contractor is the fact that he quotes the lowest possible prices and handles the cheapest goods, irrespective of quality or preference of customers in a great many instances. Provided the goods have been passed by The Underwriters quality consideration is a matter of little weight. Other reasons can be summed up as follows: They do not have the nerve to turn down a job when they often see little money in it, for fear they may get no further business from that source. They take on more work than they can possibly handle properly, and they bid and accept work they are not capable or equipped to do. Finally and worst of all they never know how much if any profit any particular job may net.

"In the opinion of the writer the best method to get the electrical contractors and dealers together is through luncheon clubs tri-monthly, monthly or weekly organized in the different sections. That these be educational in their purposes and that they do everything they can to show the contractor how much it costs him to do business. A great many of the contractors figure that if they can make daily wages they have done well. There are some good contractors in the Southern territory, as good as can be found anywhere in the country and these can do much to help clear up the situation."

Without a question the manufacturer and jobber together with the central station are mutually interested in this situation and much can be done through a properly directed activity by these three factors to straighten out the situation. As the situation now stands it seems that the question with the central stations not seriously considering this problem in the contracting and supply business is whether they shall perform the duty of the supply man and contractor in competition with these factors in the electrical industry or whether they shall turn the business over to the contractors and let them fight for it on a price basis or whether they shall dole it out to the best of the many and keep them all above the dead line of mere existence.

Too often a feeling of indifference is found both on the part of the central stations and the manufacturers and jobbers. First of all, it is of decided interest to the central station that the condition be straightened, for it is surely to work a hardship in their field if not already, at some future time. As for the manufacturer and jobber the situation is being felt already. This is evident from the activity of some of those operating under narrow policies and sending salesmen to various sections of the South and allowing these salesmen to place orders direct with customers at the same price as would be quoted to a local dealer on quantity orders. Other manufacturers, rather than to exert an influence to bring about a better condition in the field, are looking elsewhere for an outlet for their goods and such established concerns as are found in every city, the hardware store, the drug store, and the department store appeal to them. If this state of affairs continues the electrical supply man will be forced to lower the grade of his goods to compete with the cut-rate establishments and the department stores' special day sales. Standardization and quality standards will then be a thing of the past and poorly constructed devices unsuited to service conditions and voltages of distribution systems will give central station management plenty of complaints if not seriously effect new business activity.

We present here a few letters from electrical contractors who have seen the light of day and are willing to cooperate with the various interests that can elevate the plane of their business to one which will mean a fair profit on their labor and investment. We welcome letters of this character and we further invite them. This is a subject which cannot be handled by a few but must receive the general approval and action of all interested. The following letters refer to the following questions which were a part of a circular letter sent to contractors and supply companies on this subject.

(1) Are Southern Electrical Contractors and Dealers organized so as to protect themselves against cut-throat competition and ruinous business methods? (2) If not how can this be done?

(3) Is the credit of the average contractor good? If not, why not?

(4) Do you believe Southern contractors get the cooperation they deserve from the manufacturers and jobbers of the products they sell?

Comments by D. R. Shearer, E. E., General Manager Acme Electric Co., Knoxville, Tenn.

Editor Southern Electrician:

Your letter deals with some of the most vital troubles to be met by Southern contractors in the near future. Contracting in electrical work must be placed on a more definite and stable business plane or it will retrograde instead of advance to its position in the commercial world. Electrical contracting has ceased to be a matter of guess work and has grown in comparative volume to such an extent that the very best methods must be used in order to achieve a moderately successful business. As a general thing, those directly interested in commercial electrical work are coming to realize that antiquated methods must be dispensed with, and replaced by accurate cost records and systematic, exact business routine.

Some of the evils encountered are in a sense inherent to the business, others are easily mitigated or eradicated. It is the opinion of the writer that Southern contractors are insufficiently organized and lack a close, intimate business and personal relationship that means unity of interests and co-operative methods. Too often we find contractors with the same ideas working at cross purposes when so much more might be done toward the advancement of their interests by working in unity.

The National Association should be the basis for a more localized organization, followed of course by a State Association and that by local or city organizations of some form. The National and State Associations are doing a great amount of good but a local body working in unity through its members can do even more for an individual contractor. However, a city organization is hard to get started and even more difficult to control. The members are usually competitors and frequently the personal relationship is strained by friction arising from local conditions. Some contractors have an idea that they can further their own interests by "knocking" competitors when as a matter of fact they can really advance themselves by boosting their own business and that of the other fellow too. When once a local organization secures the true spirit of united interests and co-operation in all its members, there is no limit to the good that may grow out of the interchange of ideas and business methods.

It is a regretable fact that the credit rating of the average electrical contractor is bad, but this is due, in the writer's opinion, almost entirely to improper business methods and lack of adequate system in handling accounts payable and receivable.

While some manufacturers co-operate with the contractor and lend all assistance possible, others seem to have no thought beyond unloading their product on the unwary electrical contractor. What the Southern electrical contractor really needs, is: First, accurate, conservative, modern business methods and a systematic routine. Second, organization and co-operation with other contractors, looking to the advancement of united interests. Third, assistance, co-operation and advertising ideas from manufacturers, with the idea of selling and creating a feeling of satisfaction in the mind of the buyer.

Comments by N. L. Walker, President Carolina Electrical Co., Raleigh, N. C.

Editor Southern Electrician:

I have before me your letter of recent date. The subject is interesting and the problem hard to solve. Taking up the questions as you ask them, my views are as follows:

I do not think Southern electrical contractors and dealers are in a class to themselves in regard to not being organized, and not having a good credit standing. In fact practically all contractors and sub-contractors, except manufacturers, can be put in such a class. The plumbers seem to be better organized than any other sub-contractors, but in nearly every town you will find one or more plumbers who handle their business in an unsystematic manner, and whose credit is questionable. You will find that there are just as many electrical contractors and dealers whose credit is not good in the North as in the South. Each case in the South, however, is more noticeable than those in the North for two reasons: The cities in the North are more populous and there is room for one or more large contractors with an office force, whereas a large majority of the Southern contractors are in small towns and do a small business. Practically all manufacturers of electrical supplies are in the North and figuratively speaking, can keep their fingers on the Northern contractor. The Southern contractors are at quite a distance, and more or less out of reach of the manufacturers' or large jobbers' credit department. They have to rely largely on information received from salesmen, and the latter are more likely to have an eye to increasing orders than to collecting accounts.

There are probably two or three ways in which electrical contractors can organize their business and this should be done for protection against cut-throat competition and for properly conducting their business. One should join the Electrical Contractors' Association and take advantage of their co-operation and information as to business methods, etc. The printers have recently organized a standard system of estimating, etc. Any printer who is a member of the organization is glad to furnish information as to their system, and it would be a good one to follow. At the present time a large number of contractors have no one in their shops to look after sales, and their employees take out any amount of material on different jobs without making any notation of it. I think every contractor should have some system of keeping up with material on every job, and he should have some one at his place during the day to see that each article taken on a job is properly charged, and material returned credited. The person looking after this could also look after the selling, and should be able to increase sales enough to take care of their salaries. Some contractors in small towns will argue that their business is too small to justify their paying any one to stay in their offices, to keep records, make sales, etc. I would call their attention to the fact that large power companies are buying up small plants, the managers of which here-to-fore had no system, and could not figure that it would pay them to employ help for this purpose. Instead of showing a profit they were operating at a loss—they did not know what they were doing. The new owners are putting in a manager, and a record clerk, keeping tab on the current, supplies sold, etc. By keeping these records they learn where to cut and where to add, and in the long run come out with a profit.

In the other case I think the manufacturers should cooperate with dealers and contractors and give them proper protection, but in a large number of cases they make direct just as low a price as they allow the dealer. Some times they make a difference of 10 per cent, but that is not real protection, when you consider the fact that the dealer's overhead expense is largely 15 or 20 per cent. Generally speaking, I do not think the manufacturer of electrical supplies should sell direct to a consumer at all. Notable among those who are not doing so, is the Emerson Company, and I believe they have about as much business as they can take care of.

Answers to Questions by Sylvan M. Byck, Manager Byck Electric Supply Co., Waycross, Ga.

Editor Southern Electrician:

In regard to yours of the 12th will say that in the following the writer has endeavored to give expression to a few thoughts on the subject under discussion. In regard to your first question, "Are the Southern electrical contractors and dealers organized so as to protect themselves against cut throat competition and ruinous business methods?" The writer believes it is a conceded fact that Southern Electrical contractors are not organized. This can best be accomplished by, first, becoming a member of the National Electrical Contractor's Association and, second, by contractors organizing State associations in every state and having said State association keep in closer touch with the Underwriters. The Underwriters and the State association of electrical contractors should secure legislation requiring electrical contractors in all cities and towns over twenty-five hundred inhabitants to pass an examination or have in their employ at all times, a man who has passed said examination. Also that they be required to give bond ranging from $100.00 to $1,000.00. It seems as if this would be rather easy to enforce should the proposition meet with the approval of the Underwriters. In going into a town, they could lay the proposition before the City Council, showing that the improper installation of electrical work was dangerous to the community and advising the adoption of an ordinance calling for the above. The National Electrical Contractors' Association and the state associations could no doubt induce the manufacturers and jobbers to establish consumers and trade discounts on all material. This is now done on motors and generators and there is no reason why it should not be done on all material.

The manufacturers and jobbers can do a great deal to improve conditions in this matter. At the present time it is only necessary for a letter-head bearing the term "Electrical Contractor" to be forwarded a jobber in order to obtain trade discounts. Speaking of this matter brings to mind an occurance in London, Eng., some time ago. A certain business man engaged in a non-electrical business, stated to a firm of house furnishers that he could obtain trade terms on electrical material anywhere in London, naming three electrical manufacturers, one of these being the Simplex Conduit Limited. The Simplex Conduit books were examined and it was discovered that the man in question had described himself as an electrical contractor. At once the Simplex Conduit Limited served processes on this man and he was forced to pay the difference between the price he had obtained as an electrical contractor and the price to which he was entitled as a consumer, together with all cost. They were of course praised for their prompt action in protecting the electrical trade. The point the writer desires to make is why should the mere presentation of a card and the ready cash obtain trade discounts? Cannot the manufacturers and jobbers protect themselves and us by selling at trade prices only to bona-fide members of the electrical trade? I will venture to say that the sending of a C. O. D. order to almost any jobber in this territory will obtain prices equal to those obtained by the best contractors. The writer's idea is not to keep the little fellow down, because most of the electrical contractors, like ourselves, are still little fellows; but do give some little protection to those legitimately engaged in business.

The writer was shown a picture the other day which, as the saying goes, is "Sad but true." The senior member of an electrical jobbing house was standing at the front door sympathizing with a legitimate contractor over the loss of a job while the junior member of the same house was standing at the back door congratulating a curb-stone contractor for getting the same job at a very much lower price.

One thing is very necessary in the contracting business and that is to do good work. What little success we have had in trying to build up a business has been due to always trying to follow the motto "Do it well," having always said that we would rather lose a job than do one of which we would be ashamed.

In regard to the credit standing of electrical contractors, will say that our greatest fault is in the fact that we do not collect our bills promptly and are therefore unable to pay same when we should.

Comments by Frank Steffner, President Chattanooga Armature Works, Chattanooga, Tenn.

Editor Southern Electrician:

As we are neither contractors nor dealers, we are unable to answer your first question as to how protection should be had against "cut-throat" competition and ruinous business methods. We do not know of any organization among the Southern Electrical contractors and dealers.

In regard to the credit of the average contractor, we would say decidedly, that it is not good for the simple reason that the majority of contractors in the South become contractors when they obtain a smattering of electrical knowledge and the possession of a screw driver and a pair of pliers and many of them carry their place of business under their hat and do work for less than the wages of a good workman, plus the cost of material.

We know of some electrical contractors in the South who are first-class men and do their work in a thorough manner and conduct their business on business principles. These men, however, do not try to compete with the screw-driver and pliers man and secure contracts only on their ability and the recommendation of their friends.

The writer believes that the Northern manufacturer is more than willing to do his part to secure Southern trade when the party seeking his help is of undoubted integrity.

Answers to Questions by C. S. Barnes, Barnes Electric Construction Co., New Orleans, La.

Editor Southern Electrician:

We have your favor, which has been read with intense interest. The writer could write a volume on this subject, but will confine himself to answering your questions:

No. 1. Are Southern electrical contractors and dealers organized so as to protect themselves against cut-throat competition and runious business methods? The answer is No.

No. 2. If not, how can this be done? We do not know. The writer has personally taken a very active interest, for several years, in the organization of local jobbers and contractors and found that no matter how good the scheme of organization the cupidity or jealousy of some of the parties has always led them to break faith. In answering this question, we would ask you another—Tell us how.

No. 3. Is the credit of the average contractor good? If not, why not? Our answer is no. This is probably due to the cut-throat competition that the average contractor has to face. The local jobbers seem to take a keen delight in supporting financially the curbstone contractor.

No. 4. Do you believe Southern contractors get the co-operation they deserve from the manufacturers of the products they sell? The answer is no.

Comments by A. D. Peabody, President Peabody Electric Company, Muskogee, Okla.

Editor Southern Electrician:

Replying to your requests of the 12th in regard to electrical conditions of the South and Southwest we take great pleasure in saying or doing anything that will tend to better the present conditions which are very good compared with three and more years ago. The greatest abuse of the electrical trade in this section of the country is caused by the non-organization of the jobbers who handle 95 per cent of the wholesale business. This abuse is brought about in this way. Each sales manager is so anxious to have his men to take orders at each point that they will sell to any man who has a kit of tools and in nine cases out of ten this man is not only financially irresponsible but he has had neither an ordinary education or any business training whatever. What are the results? This man in most cases is intentionally honest, but he does not know that he has to make quite a large profit to cover his overhead expense. He does not know what his materials cost him put on his shelves. He does not know what profit each job shows so as to look out for the pitfalls of the next job similar to it when he makes another estimate. Eventually the jobber that is backing this fellow goes to his tow to attend a bankrupt sale to see several hundred dollars swept away. In many cases this stock is put on sale at a demoralizing price for some speculator to get first cost out of his investment. This causes all legitimate dealers to have to reduce their prices to compete. The only remedy for this abuse is for the jobbers to form a strong organization and sell only to those dealers who are in the business to make a legitimate profit and know what a legitimate profit is.

The contractors in the State of Texas, in the writer's opinion, are better organized than any class of electrical contractors in the United States. In fact, they are so well organized that a jobber would not think of selling to one out of the organization. This is only one section, and what the other sections need is some encouragement by the jobber and manufacturer or better still, compel the contractors to organize. This, however, can only be done by having the jobber and manufacturer organized.

There is as good an element and at the same time as bad an element in the business in the South as there is in the business anywhere, but there is no reason why the good should suffer with the bad in this section if our wholesalers will only use a little discretion in selecting their trade.

Comments by E. K. Strain, of Henderson Electric Co., Henderson, Ky.

Editor Southern Electrician:

Realizing that the subject of your communication may be a step further towards a general reform for the existing conditions in the contracting field, I take pleasure in stating my views and hope that other Southern contractors will do likewise. That Northern manufacturers and jobbers entertain a non-cooperative feeling, toward Southern contractors and dealers, is a lamentable fact, and it is held that the organization and credit of the Southern contractor is poor, which condition is true of the trade from coast to coast and Lakes to Gulf. These conditions have prevailed for some time, yet no concerted action has been inaugurated by those immediately interested.

In answer to your first inquiry, as to whether or not there is an organization of the trade that will protect from cut-throat competition and ruinous business methods, I am as yet unaware of its existence, and if existing at all must be obscure and inefficient. As to how organization can be affected and made effective, no doubt this is the dominant question, and the prime reason that I hope your letter will be answered by many, for surely some one has a pet idea for organization that is a winner. It could probably be accomplished by establishing a centrally located office in charge of an executive head, or some agency similar.

In regard to the credit situation I regret to say that the credit of the average contractor is not good, and the most logical reason is lack of organization, and in addition to that, failure to ask a decent price for the work.

Whether or not the contractor gets the proper co-operation from the manufacturer whose goods he handles, is a question open to discussion. In most instances the product of the manufacturer is sold to the trade through a jobber who by force of good credit standing and large sales, demands and gets exclusive territory. Personally I know of a jobber who sends his salesman to a town, where the contractor's credit is unstable and sells direct to the consumer, same being good credit risks. Worse than that he makes them regular trade prices and thereby utterly baring the local contractor from ever doing business with this consumer at a living price. This can hardly be called co-operation and would probably come in the category of cut-throat competition.

The Northern jobbers and manufacturers maintain a good credit standing. Why? The answer is organization. If the Southern contractor would do likewise he must get in touch with his brother contractor and organize.

Answers by J. S. Welborn, Welborn Supply Co., Highpoint, N. C.

Editor Southern Electrician:

Replying to your first question, contractors and dealers are not organized in the South as they should be for their own interest. Every State should have its own organization and every contractor and dealer that has a good rating should see to it that the jobber who sells to the "curbstoner" would have a hard time getting the business from them. There have been cases where jobbers who fail to sell to the legitimate dealers, try to induce a wireman to go to work for himself and thus establish an unfair competition and when there is a loss on the part of such a jobber he complains in regard to it and runs down the credit of contractors in general. I am sure that contractors do not get the co-operation from manufacturers they should. With an organization these matters could be discussed and the business put on a basis that will mean profit to those carrying it on and credit not to be doubted among those who are seeking to do business with us.

Answers to Questions by John Blake, Manager, Gem Electric Co., El Paso, Texas.

Editor Southern Electrician:

In answer to your first question, will say that electrical contractors are not organized as a whole against anything, a few belong to the National Electrical Contractors' Association, the majority of those do not live up to the by-laws of the organization and could not belong if the organization enforced them at all.

There is not any legitimate competition anywhere in the South that I have been able to discover. I have not been in every city, but have been in a number of those of importance. There exists plenty of the cut-throat competition due to what should be termed lack of business ability. I have asked several what their cost to do business is, and have been met with this query, What do you mean? Such men as these have friends who give them their work just for friendship sake, more probably because they can pat them on the back and get them to cut their price.

Question No. 2 is a puzzler. I only wish I could answer it. Probably if you could remove jealousy and suspicion it could be done.

Question No. 3. I think the average contractor can get credit too easy, and that is one of the very many things that is making it hard for the man that has an established business. I do not say that every jobber does this but enough do to make it easy for the man of small means to open up a contracting business on a small scale and such a one makes it interesting while he lasts.

Question No. 4. Some of the jobbers and manufacturers give protection, the majority do not. It is a well-known fact, that the jobbers in the North sell over the counter in their places of business just as cheap to the trade as they sell to the contractors. This is also true of the jobbers in the South. They will sell you goods, and then they will send their salesman into your city and sell to the trade, giving them the same discount that is given the contractors.

I will cite you a case of a Kansas City firm that sends their man down here to sell fixtures. He has made sales where he has lost money just to keep some one from making a legitmate profit. I manufacture fixtures and have figured against this party and know what he is selling at. He may be able to buy a little cheaper than I do, but at his figures he is bound to lose money. Don't ask me why they do this, for I do not know.

Answers by M. N. Wertz, Manager Busy Bee Electric Co., Thomasville, Ga.

Editor Southern Electrician:

In reply to your first question, I would say that the Southern electrical contractors are not organized and the problem they must confront is the cheap wireman and the cheap building contractor. The building contractor who is constructing cheap houses is always looking for the cheap man and desires to shun the experienced electrical contractor who is capable of planning details and installing good work. Whatever co-operation that must be brought about therefore must consider the enlisting of the architects and carpenters who do contract work in building.

Question No. 2. Credit is not good among contractors because their business in the majority of cases as it is now run is a hand-to-mouth one.

Question No. 3. Northern manufacturers do not seem to care how the Southern dealer is treated for they countenance almost any of the many independent dealers continually springing up. A number of jobbers and manufacturers are selling to the hardware dealers instead of to the electrical dealer, and in some cases this is driving the latter out of business. The hardware dealer as a rule has more capital and can carry the electrical supplies as a side line. They can, therefore, handle the business with little overhead expense, and can sell at a lower price than the man who does electrical work only, in a small town. If this situation continues, the hardware store and the ten cent store will run the electrical supply business.

When this matter is discussed with some manufacturers they tell you to get out and hustle for the business which is all good talk. But take a town of the size which would just comfortably support a live electrical contractor and dealer and then let the hardware and drug stores put in a line of lamps, fans, heating devices, shades and fixtures, perhaps fuse plugs, sockets and such staples as this and then suppose they cut the profit on this material in half on all the stock but lamps and fans to get the customers to come to their store for the other goods, pray tell me what hustling will amount to, when the contractor can not carry more than a thousand dollars worth of all material and supplies?

Electrical Progress and Developments During 1912

(*Written Exclusively for* SOUTHERN ELECTRICIAN).

IN what follows a brief review will be given of recent developments in the manufacture of electrical apparatus, the progress in its application, and the trend of engineering in connection with present-day engineering projects as represented by those systems which have recently been completed and those that are now under way. Without a question one of the important causes for progress along each of these three lines, has been the further development of water powers and the transmission of electrical energy at higher and higher voltages over longer and longer distances. The Niagara river was the first remarkable power to be harnessed; now the Mississippi has been conquered and by means of a dam stretching from shore to shore, power will be made available in the form of head and volume of water sufficient to turn the wheels in a power house than which there is no larger in the world. It is interesting to note in this connection that these two feats from an engineering standpoint have been accomplished by one and the same engineer.

While the larger of hydro-electric developments have been principally confined to western districts in the years past, the past year has seen the work being pushed in tremendous proportions in the east and south, and now wherever nature has furnished a location and there is a constant supply of water, either through natural sources or where an adequate reservoir can be created by man, the possibilities of a hydro-electric power plant are attracting capital and these sites are rapidly being taken up.

As larger and larger systems are being constructed and as these systems are being interconnected to assure continuity of service, all of the details of generation and transmission are receiving careful and special engineering, and better construction is being employed from the hydraulic end to the distributing station. According to the report of the United States Bureau of Corporations, there has been developed through water power in the United States, something like four million horsepower with a possibility of increasing this amount to two hundred thousand. While, therefore, the work has been well started, as regards future capacity it has only begun.

Prime Movers—Generating Units.

The expanding of generating and transmission systems is calling for units of larger single capacity and no definite limit seems to be in sight. Both in steam plants and hydro-electric plants there is a tendency in this direction. Already steam turbines of 20,000 kw. capacity have been installed and it has been suggested that a single unit of 50,000 kw. may be safely accomplished. Negotiations are already in progress with one manufacturing company involving the manufacture of steam turbo-generating units of between 25,000 and 30,000 kw. Further 20,000 kw. water wheel generators are under consideration and it is more than likely that such a machine will be constructed during the coming year. Water wheels are being designed with much larger output for single runners and with higher speed for a given capacity, necessitating improved designs in vertical bearings. This question is being solved in some cases by combined pressure and roller bearing. The efficiency of water wheels has been considerably improved and better than 90 per cent has been obtained in recent tests.

Referring to developments in steam turbines, it may be said of the recent type of turbines that the bleeder type is now justifying expectations and is being built in sizes as large as 4,000 kw. Non-condensing turbines have also been built of a capacity of 3,500 kw. during the past year. The small turbine, however, continues to develop rapidly and a complete line of turbine driven auxiliaries including low and high head pumps and centrifugal blowers are now under development by the Westinghouse Company. The past year saw the first surface condenser installed w Westinghouse steam turbine apparatus, and particularly good service is the result.

Considerable interest is centered in gas and oil engines, the gas producer coming into its own slowly. The tremendous increase in the prices of fuel oil have been a great factor in bringing the producer to the attention of a great many who use gas for both fuel and power purposes. The gas producer, however, is limited to sizes under 1,000 horsepower, as also is the oil engine and these two types of prime movers will probably be restricted by commercial considerations to the sizes that can be best used.

In regard to generators, turbo, waterwheel and engine types, modern practice in power plant construction is constantly advocating lower first cost, higher economies and greater simplicity of operation. The one method of attainment seems to lie in the use of larger capacities in single units. The building of these larger generating units has called for the use of external reactances and an increase of the reactance in generators and transformers. The engineers of the General Electric Company have stated that reactances a shigh as 20 per cent are being contemplated for certain generators combined with approximately straight line saturation curves.

During the past year a number of contracts for hydroelectric stations have been placed, which call for 12,000 to 17,000 kva., and even larger generators are in prospect. These are either of the horizontal or vertical types, and a wide range of speed is covered. Improvements due to a wide experience, have been made in mechanical construction, ventilation details and armature construction, and a relatively cheaper, more efficient, and more reliable unit has resulted.

In steam practice a similar progress is being made. The Westinghouse companies have designed and are building horizontal units of 15,000 and 20,000 kw. for speeds of 1,800 and 1,500 r.p.m., and even larger high speed units are contemplated. Single turbine generators of 30,000 kw. capacity for a speed of 1,500 or 1,200 r.p.m. for 25 and 60-cycle service, is a possibility of the near future. Modifications of design have been effected whereby the materials used are not stressed materially harder than in smaller units, which have already demonstrated the success of their designs, and these companies are prepared to offer the high capacity, high speed outfits upon demand. These units are also being wound for voltages as high as 13.200.

In regard to water wheel driven generators, while there is the demand mentioned for larger sizes at higher speeds approximating steam turbine speed, there is also being received by manufacturers, the demand for low head water power equipment taking the form of large units at very low speed.

There is being installed at the Tallulah Falls plant of the Georgia Railway & Power Co., at Tallulah, Ga., six 10,000 kw. generators running at 514 rpm. These generators are of General Electric design and have the plate form of construction in the field spiders, which construction allows the use of uniform material of known quality practically free from defects and provides good design for high speeds. For these high speed water wheel generating units, it is also considered good practice to make up the revolving center in two or more pieces, division between the pieces being at right angles to the shaft. This construction allows the field spider to be made up of parts that can be easily handled and are less liable to be defective in casting. Progress has also been noticed in the development of alternating current high speed generators in the direction of reducing temperature rise and securing a higher efficiency through the better working out of forced ventilation.

Units of the largest capacity ever built to generate direct current are now being constructed by the General Electric Company, for the new plant of the Southern Aluminum Co., at Whitney, N. C. These generators will be seven in number, of the vertical type, each having a rating of 5,000 kw., delivering 20,000 amperes at 250 volts, and operating at a speed of 170 r.p.m. This plant will rank among the first of those manufacturing aluminum in the United States, only one other plant, that at Niagara Falls, comparing with it.

Where high efficiency and overload capacity are most important in the transforming of alternating current and direct current, the synchronous converter is now a standard piece of apparatus. The troubles in the older converters from pulsation or hunting due to the periodic speed changes per revolution of the alternator applying the power, are now practically eliminated through improvements in the design of engines, the general use of the steam turbine and in the design of the converter pole bridges themselves. Commutating poles as applied to rotary converters fulfill the same functions and result in the same advantages as when applied to generators and motors. This last year has seen a number of this type of rotary built; some of very large capacity, including one of 7,500 kw., with a momentary capacity of 10,000 kw. A particular feature of this rotary is that it occupies but slightly more space than that of the 1,500 kw. converters which it replaced.

There has recently been a demand for high voltage motor generator sets and the conditions causing this demand have also been responsible for the development of converters in voltage of 1,200 to 1,600 volts and units as large as 750 kw. On account of the high rotating speeds of 60-cycle converters, it is, however, difficult to design successful units for higher voltages than 650 to 700 volts.

The motor generator in its present design as found installed in the modern station, usually consists of a commutating pole direct current generator driven by, and mounted on the same bed with, an induction or a synchronous motor. The motors of the General Electric types with synchronous sets are designed as a rule to operate at eighty per cent leading power factor. The field windings of the motors are designed for 125-volt excitation, furnished by either a direct connected or a separate motor driven exciter. The synchronous motors are as a rule wound for 2,300 to 4,000 and 6,600 volts, although in some cases 13,200 volt windings are provided.

High Tension Transmission.

Increasing demand for power for all purposes is leading more and more to large generating stations. Waterpowers more distant from available markets have been developed and as longer distances are involved, higher transmission voltages than ever before have been and are being considered. Plants and transformers are now successfully constructed for 150,000 volt transmission. The efficiencies of transforming apparatus and the reduced cost of operation of large stations tends toward the concentration of generating apparatus in central points and the elimination of the isolated plant. In the tying together of towns by transmission lines, a network has resulted from which are served many communities which it has not hitherto been possible to serve.

One of the most striking developments of the past year has been the installation of small capacity units along transmission lines. The outdoor transformer and switching equipment are contributing in a great measure to the development of small community or farm loads, which are readily appreciated by transmission companies. There has also been a large number of transformer installations by which one transmission company could supply power to another company in case of interruption to the service of either.

The development of the oil-insulated, self-cooled transformer for very large sizes has been a decided factor in the general development work of transmission. Transformers of the self-cooling type are now made in sizes as large as it is possible to transport by the railroads. The elimination of attendance, auxiliary piping, and the cost of water has made many an installation feasible which otherwise, on account of the cost of operation, would not have been commercially practicable.

One interesting development, or phase of the development, is the acknowledgment by foreign transmission companies of the superiority of transformers of American manufacture. An investigation of the export business shows that American-made transformers are being used for most of the high voltage work in foreign countries.

Transmission engineers have during the past year made a statement to the effect that delta high voltage transformer connections appear to be decidedly advantageous on account of changing conditions in the development of apparatus. although there is no objection offered to a high resistance grounded Y. A point of importance is made in the fact that with a delta high-tension transformer connection, disturbances coming in over the line are divided in their effects between the windings of two transformers instead of the whole impulse being impressed upon a single transformer.

In transformer design, after years of construction with the lowest possible reactance there has now been a change made to as much as six or eight per cent. Larger self-cooled transformers are in demand where water supply is limited and also for use in outdoor substations. The kilovolt ampere capacity of high voltage transformers is rapily increasing and keeping pace with the rapid increases in voltages used for transmission and the larger amounts of power transmitted. From the data which has been made public by the manufacturing companies, it is observed that previous to 1901 no transformers for over 50,000 volts were in use, and that since that time there has been no marked increase in the use of transformers between fifty and sixty thousand volts. Transformers for sixty to eighty thousand volts were first built in numbers in 1905, a few were built for voltages between 80,000 and 100,000 in 1904, yet in 1909, seventeen per cent of the total were designed for over 100,000 volts and in 1911 about nine per cent. A large number built during this year were for voltages in the neighborhood of 140,000 volts. It is therefore seen from this information that transmissions from 100,000 to 140,000 volts can now be regarded as thoroughly practicable. The increase in voltage of transmission also indicates that the distance over which power is transmitted is fast climbing upwards, distances of 100 miles and more are now being covered.

The low voltage distribution transformers as a class now may be said to include those up to 11,000 volts and possibly should be considered to reach 15,000 volts, whereas it was considered that 4,400 volts was the safe maximum limit for direct-to-customer transformation. Further, the capacity of these units has grown. The unit of 1,000 kva. capacity was first exceeded in 1899 and not until 1905 were transformers built over 3,000 kva. in a single unit. It has not only been found necessary to build very high voltage transformers in large capacity, but it has also been found advisable to use the parts so developed for still larger moderate voltage sizes year by year. Those familiar with the design of transformers and the requirements hold to the idea that no one can yet see that transformers and therefore, the development of transmissions, has yet begun to reach its limit.

The developments during the year 1912 in transformers have been chiefly from a standpoint, therefore, of increasing the scope of these outdoor distributing transformers and improvement in ruggedness and serviceability. The past year has shown a rapid increase in the use of higher distributing voltages, and, especially in the western portion of the country, large numbers of outdoor type transformers have been installed for such voltage as 6,600 and 11,000 volts, both at large and very small relative capacities, such as 1 to 5 kva. These installations have permitted the addition of a large amount of ranching, farming and irrigation load that was previously not available. The past year has seen a much larger number of transformers installed in subways, in cities, having underground distribution systems. Due to the rapid increase in the amount of transformer oil in use with power and distributing transformers, reliable treating and filtering outfits of the motor-operated filter-press type have been developed to permit ready treatment of this oil in the field, to keep it in the best condition.

In regard to protection of generating and distribution systems, it is now the tendency to install automatic devices as far as possible. In many cases the tendency has gone so far in this direction that safety afforded by such automatic systems is limited by the delicacy of apparatus far in advance of the intelligence and experience of those who are called upon to take care of such apparatus. In feeder regulating equipment, the increasing use of and demand for reliable automatic feeder regulators has led to the further development along the lines of ruggedness of construction and reliability of automatic auxiliaries in such equipment.

In regard to oil circuit breakers, the development during the previous year tended largely towards increase in capacities, and this has been carried still further during the past year, so that now practically all of the larger types of oil circuit breakers are of the modified design. The Westinghouse breakers involve the following features: Brush contacts with butt type arcing tips; tanks are lap welded and are larger, giving greater oil capacity and more air space above the oil. Above the tanks in some of the larger types is a cast bronze gas expansion chamber, with a baffled vent for the escape of gases. The tanks are supported, in addition to the ordinary clamps, by steel rods from the cast base to a steel plate under the tanks, thus preventing any possibility of the tanks being blown off by an extra violent short circuit. The mechanism of the breakers has been improved so as to provide quick action, with dash pots to take care of both opening and closing shocks. With these improvements the instantaneous direct-connected breaking capacity has been greatly increased in the different types. A new breaker of the same characteristics as one of the well-known masonry types has been brought out for mounting on the wall or pipe framework. It requires no cell structure, and because of this omission has a larger breaking capacity than the corresponding size for masonry-mounted breakers.

A newly developed line of circuit breakers, known as the "Reactance" type, has been supplied in some forms, and designs are available for application of the reactance principle to other breakers. With the double break and a reactance inserted in the second or final break, the ultimate breaking capacity to which the breaker can work is unlimited.

The Westinghouse electrolytic lightning arrester in the higher voltages has been changed so as to include smaller diameter tanks. The same degree of insulation is obtained by lining the tanks with a substance which is absolutely impervious to water; thus providing constant and adequate insulation at all time. For the highest voltages, this type is now supplied upon special order with elliptical instead of round tanks. These tanks allow of mounting two stacks of trays side by side, and this design is used where there is not sufficient head room to allow for the standard round tanks with all trays in one vertical stack.

The modern high voltage insulator may be said to take the form of the series suspension insulator. This type of insulator is now considered an important factor in reducing the direct loss of energy in the air due to corona and eliminating the arcing over or puncture of the line insulator. Transmission engineers are now confident that with the insulator in its present state of design and satisfactory operation that it will not be an electrical factor that eventually limits the transmission voltage, but rather an economic or natural one, the suspension insulator made up of single units in series being capable of taking care of transmission voltage for some time to come.

The Synchronous Condenser.

The application of the synchronous condenser has of late received considerable attention and its installation and successful operation has borne out all the good things that were expected of it. In the planning and designing of a generating and distributing system, the opportunity is not missed in the newer systems if synchronous motors can be installed on feeders carrying important low power factor loads. If there is no opportunity to install synchronous motors or synchronous condensers on the feeders, it is now considered advisable to install generators sufficiently larger than their prime movers to be adapted to commercial power factors and with field designed consistently rather than to install in the generator station synchronous condensers to raise the power factor. On the other hand, where the prime movers of an existing plant are running underloaded with generators loaded, or by raising the power factor, a generating unit can be shut down, or that its generator fields are overheated or that its exciting system is not able to deliver sufficient voltage to maintain the generator voltage, or that its wires and cables are overloaded on some feeder due to the low power factor, then it is generally recognized that the installation of a synchronous motor or synchronous condenser on the feeders or a synchronous condenser in the generating station is decidedly economical and good engineering. Further, it is considered good practice to install a synchronous condenser at the end of the transmission line so as to maintain the voltage constant at that point on the transmission line.

Standard generators can now be used as synchronous motors or condensers by making proper changes in the field poles and windings to render tem self-starting and insulated against voltages induced in the field when starting.

Electric Traction Developments.

There have been a number of developments in the railway field during the past twelve months that have contributed very greatly to the high state of perfection which electric railway engineering has reached. These developments indicate that more attention has been paid to the economic side of railway operation, such as improvements in car and locomotive equipments; generating and converting apparatus. Among these improvements may be mentioned the following:

The use of high voltage direct current for traction systems; thus retaining the advantages of the D. C. series motor, which have been found so satisfactory on low voltage work. This system is frequently used where alternating current is available and it is not feasible to distribute high voltage in the towns served by the road. The high voltage direct current system can be installed as an addition to an existing 600-volt system, which is a decided advantage for interurban lines. A 1,500-volt D. C. equipment can be used over the interurban section, and also over the 600-volt city tracks, on which latter the smaller cars can continue to operate.

The supply of this high voltage direct current, has called for a corresponding development in generating equipment, which has reached an unusually high degree of perfection. The current is furnished by either motor-generator sets or rotary converters; two direct current armatures being connected in series to deliver 1,200 or 1,500 volts. The equipment recently furnished the Piedmont Traction Company, of North and South Carolina, by the Westinghouse Electric & Mfg. Company is of particular interest in this connection because the voltage, 1,500, is the highest direct current pressure ever used in this country for electric traction, and its use marks an important epoch in the advance of direct current traction. The current is not generated, but is supplied by the Southern Power Company through substations, being obtained from two synchronous, motor-driven, 750 volt D. C. generators connected in series. The switching equipment follows the same lines as for the 600-volt equipment with the addition of precautionary measures, such as heavier insulation, longer breaking distances, and removal of live parts from the operation. The breakers are mounted higher than the lower voltage type, and are generally operated by a rod similar to oil switches.

Electric locomotives continue to gain favor, and a number of roads already using them have increased their equipment, and several other roads have bought their initial equipments during the year. Among these roads, purchasing Baldwin-Westinghouse locomotives, are the Piedmont Traction Company, the Southern Pacific Company, the Oakland, Antioch & Eastern Railroad Company; all of which are equipped with high voltage direct current motors. The Southern Pacific Company has ordered 12 locomotives for use on the coast for freight haulage and switcher service, but these may be used for passenger service if desired. The New York, New Haven & Hartford Railroad Company has purchased an additional equipment of 39 locomotives; three of which are for either alternating current or direct current operation, and the remainder are for straight single phase operation.

In the early part of 1912, the new Cambridge Subway of the Boston Elevated Railroad was opened. This comprises 3.2 miles of route and operates 40 cars, each equipped with two Westinghouse 300-D commutating pole motors. The cars are of steel and specially designed to facilitate rapid loading and unloading.

Several cities have adopted radical departures in car construction, embodying some novel features, tending to reduce weight, and to facilitate rapid handling of passengers. These include the stepless and double deck car of New York, the "near side" car in Philadelphia, the center entrance car in Brooklyn, and the light-weight car in Pittsburg. Probably the most noticeable advance in railway motor design is the "light-weight" motor for Pittsburg Railways Company, which was built by the Westinghouse Co. for use on a car with 24-inch wheels. This design is the outcome of the tendency towards light-weight city cars, and the adoption of the 24-inch wheels by the Pittsburg Railways Company. This is the lightest weight per seated passenger, double-truck motor car every built.

Electric Power Utilization.

Considerable development has taken place in the application of A. C. slip-ring, phase-wound induction motors. The development of self-starting synchronous motor for direct connection to air compressors, while not really a new development in 1912, has now been perfected and is practicable for all commercial purposes.

There has been practically a universal endorsement of the commutating pole, D. C. motor, including various classes of industries. Much improvement in the mechanical features, such as frame, bearings and shaft, insulation, type of winding, etc., has been devised, but it is only recently that the commutating pole feature of motor design has reached such a state of perfection; this being due to a fuller understanding of the principle involved. At the present time, the commutating pole feature is incorporated in motors for machine tool drives and similar applications, and for the more severe classes of intermittent service, such as street railway and steel mill applications, where the work is of widely varying and often reversing nature. In machine shop work, the commutating pole motor is capable of a wide range of speed variations, with heavy overloads, and the intermittently rated motor gives greatly improved commutation through a wide range of load conditions which, as a rule, includes peak load during acceleration, and even higher loads during reversing for such as cranes and general mill service.

No radical departure of the general features of design of A. C. or D. C. small motors has been made but marked progress has been made in the details of design and process of manufacture tending to lighter weight, more compact construction and reliable operation. Materials are used to far better advantage than they were, say, five or six years ago, and A. C. and D. C. motors of the same capacity are practically interchangeable insofar as mounting is concerned, a feature of supreme importance to manufacturers of the motor-driven machines.

The old "cut and try method" of applying small motors has been abandoned in favor of systematic method based on engineering information—just the same as the larger applications. A large amount of technical data on this subject is now available. The range of application of the small motor is wide but the demand in the past year has centered in the home and office, more particularly on washing, dictating, tabulating, mailing and similar machines and vacuum cleaners.

Many new types of automatic starting devices and magnetic switches have been developed during the past year. These are made in small and large capacities and for both A. C. and D. C. motors. As the electric motor becomes more universally applied each year there is an increasing need for motor starters and other regulating and controlling devices. The output of automatic or self-starters has been greater during 1912 than for any previous period. Special type automatic starters and controllers for mine service have been developed for use in connection with mine fans and pumps. In the alternating current line many new styles of starters, regulators and automatic controllers have been added to meet the requirements of A. C. motor installations. A small regulator for small motor-driven and heating devices has been added to the regulator line.

The automatic contactor type steel mill, and coal and ore dock controllers of Cutler-Hammer designs are in demand. In this line automatic features, sureness of operation, and simpleness and strength of construction are in demand to a greater extent than ever before. The drum type enclosed crane controllers which were brought out the latter part of 1911 have been augmented by the addition of types for alternating current service.

Electric Heating Apparatus.

Many new pieces of heating apparatus have been developed during the year. The following by one large concern indicates the variety: Electric Saute Pan, Domestic Iron, Laundry Iron, Cozy Glow Radiator, Pot Type Coffee Percolator, Soldering Iron, Tire Vulcanizer and Frying Pan. The Saute Pan is a universal cooking utensil which may be used for frying, boiling, baking. The domestic iron is provided with a device whereby the current may be controlled at the iron without disconnecting the cord, though the cord is easily disconnected when desired. The heating element of this type is improved to the point where it can be guaranteed for life. The laundry iron is of the same design as the domestic iron, but is not provided with a cutout at the cord, which enters through the handle. The cozy glow radiator is a small radiator of unusually attractive design, consisting of two units, which is sold at the popular price of $6.00. The reflecting surface is in the form of a shell which gives maximum efficiency in reflection. The entire surface of the radiator is finished in nickel.

These devices are rapidly being added to central station lines and are fast making possible a substantial heating load.

The Electric Vehicle Business.

Contrary to expectations, the greatest advances have been made in pleasure vehicles rather than in commercial trucks, though much progress has been made in them. The coupe type of body continues to be the most popular for pleasure vehicles, having become a most attractive and comfortable vehicle. Five-passenger cars, a novelty a few years ago, are now very popular.

Certain distinct features mark the advance and increase in popularity of the "electric." Better operating characteristics due to improvements in motor, controller, battery, transmission. The motor is more efficient and rugged, quieter, and lighter in weight. Chain drive has been largely replaced by some form of gear drive in which the motor is either mounted directly on the rear axle or on the chassis and connected thereto by a jointed shaft.

Central stations are appreciating the value of vehicle load and many of them are establishing charging points at various points in and out of the congested districts.

The electric truck is increasing at a remarkable rate. Companies including various industries which had tried them out in individual cases are now using them in large fleets. Excellent and accurate data on operation and maintenance being secured and disseminated, is doing much to advance the cause of the electric truck. One particularly interesting feature and a very praiseworthy one is the close co-operation of the three interests most closely affected, viz.: the manufacturers of the vehicle, the manufacturer of its component parts and the central stations which supply the current. The Electric Vehicle Association of America and several of the largest central stations have done much to promote the use of electric vehicles by publicity along broad lines.

Progress in Electric Lighting and Lighting Units.

During the past year the art of incandescent lighting has marched steadily forward. The new developments although not great in number, are none the less important and are the result of a vast amount of research work done by the leading scientists of the world. Probably the most promising of the new lamps is the concentrated filament Mazda lamp. This lamp has a drawn wire tungsten filament constructed in the form of a long spiral spring. The advantage of this form of construction is that a high wattage filament can be placed in a small space and a high power lamp obtained for headlight work and all kinds of lighting where a point source light is used. This lamp has made practical the small portable stereopticon lantern. Special high efficiency reflectors have been developed for use with this lamp and give wonderful results.

The 10-watt, 110-volt lamp is another product of the year and is now a very rugged and serviceable lamp. It is used in lighting in general and especially in electric signs, simplifying the circuit to a straight multiple circuit.

In the lighthing of automobiles 6 volts has been almost universally adopted for gasoline cars.

The public is rapidly becoming educated to the economics of high efficiency lamps and each day marks more plainly the passing of the old carbon and tantalum lamps. Great industrial corporations have investigated high efficiency lighting and have found it the most desirable and have adopted it. Big business has also recognized the value of good illumination in giving increased production and contented employees and are installing scientifically laid out systems. It is in this line, the education of the people in the value of good lighting, that illumination has made its greatest stride this year.

Reflectors and illuminating glassware have made great strides, the present types are being improved and many new ones added. One-piece balls for indoor and outdoor use and semi-indirect units are now built to accommodate any lamp or combination of lamps. Semi-direct and indirect lighting systems are very popular and a great many of the new installations are of these types. In steel reflectors much attention has been given recently to condition of enamel and shape, to give highest efficiency and the desired and most advantageous distribution. Enameled steel in industrial illumination is practically displacing aluminum finish.

Street railways in every section of the country are installing Mazda lamps and in many places reflectors are being used with the lamps and very satisfactory results obtained. The old carbon lamp is giving way to the high efficiency one in all places where it was previously thought it was the only lamp that could be used. In summing up the whole year the most important points are the realization of the general public that much valuable time and material are lost due to poor lighting and that high efficiency lamps and reflectors are necessary for good illumination.

Developments during the past year in arc lamps have been confined almost exclusively to flame carbon arc lamps of the long burning type. Ten to forty-hour lamps have been used very extensively abroad for some time, and their general adoption in this country has been only delayed by the comparatively high maintenance cost due to the necessity of frequent trimming and high price of carbons. The long life lamps, however, have overcome these obstacles and are now being used in large numbers not only for street but also for display lighting, and especially for industrial plants, wharfs, docks and large public buildings. The fact that carbons giving either white or yellow light may be used renders the adaptability of the lamp more flexible.

Perhaps the most notable interior installation made during the year in a large building is that of the Fifth Regiment Armory, Baltimore, Md., immediately prior to the holding of the Democratic National Convention therein. The rapid and very satisfactory progress made by carbon manufacturers in providing suitable carbons has materially aided in the development of the lamp and its adoption, for certain purposes, and inasmuch as the demand is for more light at a lower maintenance cost the outlook for this lamp is very bright.

Telephone Systems and Apparatus.

The progress in telephone systems and apparatus has largely been through executing numerous improvements and refinements in types of apparatus already on the market. The following recounts some of the developments in the telephone business and apparatus of the bell system as manufactured by the Western Electric Company.

Switchboard development work during the past year has been confined to improving, in every possible way, the more recent types placed on the market. This applies to the sectional unit type, the magneto, and the central battery lamp signal boards for small magneto offices and private exchanges. Convertible switchboards have also met with great success. These are so designed that they may be used for either magneto or central battery service, or both, without changing any of the appartus. This enables the small telephone company to change from magneto to central battery gradually and at a minimum of expense. It thus becomes unnecessary to buy a complete new central battery exchange before the "cut-over" and go through the confusion incidental to such a change. One of the most important developments of the year in switchboard apparatus is the "line and cut-off" relay for subscriber line use. It is considerably smaller than the old standards used in the past.

For use on magneto line switchboards, there has been developed a combined jack and drop which is similar to the combined jack and signal but differing from it principally in that a shutter type drop is used in place of the familiar spherical indicator. The shutter is restored when a plug is inserted in the jack.

A new "loud speaking" telephone has been developed and was tried out with great success at the Boston Electric Show in October for paging visitors and show officials, for announcing scores of the world's series baseball games and for rendering musical selections in conjunction with a phonographic attachment. The loud speaking telephones are fitted for use in hotels, railroad stations, amusement parks and baseball parks for making announcements or furnishing music.

The field of the telephone in railway train dispatching is fast increasing and new roads are continually following the lead of those that have already equipped section after section and making plans to still further add to the system. It is without a doubt one of the greatest factors in the saving of time, labor and life that the railroad has as yet made a part of its system.

The telephone continues to find its application for private service in the home, office and factory and new developments of the year are code signaling sets for extensive systems, with simplified and inexpensive sets for the small number of stations.

Southern Developments.

The trend of developments along electrical lines in the South is discussed by fields in various sections of this issue. What follows therefore under this heading will simply supplement the above information and refer to developments as seen by the central station covering the various industries and to those developments that have shown up through the demands for electrical apparatus received by electrical manufacturers.

In regard to the developments as shown by the central station load curve, we quote from a statement given by the management of the Southern Power Company, the first transmission company in the Southern field and the one at the present time serving by far the most typical combined and diversified demand of any Southern system. The following material shows the character of their recent connected load and its growth:

"During the past year we have seen many new ideas come to a development, and note also that the established business of the past three years has grown most rapidly. The trend of the municipality load is upward about 10 per cent. This increase is due to the better lighting systems, more convenient heating and cooking appliances. Contrary to opinions of the past the tungsten lamp has increased the municipal load by creating a desire for better illumination. Toasters, stoves, electric irons, chafing dishes, electric washers, etc., which show a tendency towards refinement in living, have also contributed very largely to the greater kilowatt output of the central station. One of our central stations show a 10 per cent increase on irons and toaster stoves of over 100 per cent on heating stoves. One other central station in the Carolinas reports a 20 per cent increase of output in 1912 over that of 1911.

"Our lines supply many cities and intervening towns between the same, and it is the exception where an incorporated town does not have a lighting system supplied by us. The traveler along the Southern Railway between Greensboro, N. C., and Greenville, S. C., has abundant evidence of the great service that our company is rendering in this territory.

"The trend towards the use of electricity by the farmer and in the farming districts generally, is noticeable mainly in the number of installations supplied to "gentlemen farmers" who do all their pumping, lighting of residences and barns, wood-cutting, feed-chopping, etc., by electric power.

"The industrial load is shown very markedly by our kilowatt output. The highest peak in 1911 was exceeded in 1912 by fully 10 per cent. The effect of this industrial load is very well exemplified or shown by the output curve on our stations. The "daylight load" or between 6 a. m. and 6 p. m. (omitting the noon hour) shows a variation of only four pe rcent. The industrial part of our load is by far the greatest, and while as stated above we show a decided increase in our cities, we are led to believe that the country towns of 10,000 inhabitants and less, are the greatest gainers, due to the fact that they have an unlimited supply of current at their demand which enables them to have a well-lighted town with all the conveniences of the electric utilities so dear to the heart of the household where previously it was impossible to render any such service.

"Small manufacturing plants are springing up along our lines encouraged by the fact that power is plentiful and cheap. The Southern Electro-Chemical Company, whose nitrogen plant is at Nitrolee, S. C., began operations in October, 1912, and they consume approximately 5,000 horsepower in the production of nitric acid and nitrate of lime.

"The Interurban System is gradually growing. The Greenwood, Greenville and Anderson division being opened for service on December 2, with regular passenger trains and freight service. A discussion of the equipment, line construction, trolley system, etc., was presented in the September issue of SOUTHERN ELECTRICIAN, it being remembered that the system is a direct current system of 1,500 volts fed from substations where the alternating current is changed to direct current.

"On July 4, of the present year, a branch of 24 miles between Gastonia and Charlotte was opened for public service, and over 20 passenger trains per day are being run on this branch. Ten thousand people were carried the first month, but the last four months shows an average of over thirty thousand passengers every month. Four freights per day ply between stations, giving quick deliveries of freight, and it is expected that a regular express service will be installed very soon by one of the companies. A $5.00 mileage is sold which gives $6.25 worth of travel. The mileage is pulled on the train and may be used by any holder of the same. Special holiday rates and "twilight excursions" are established, the latter being much used during the summer season and the theatrical season. The operators on these trains are men who have been promoted from our city railway systems, and in every case are men who have proved faithful and noted for their carefulness and experience.

"Having a large latent load, we find our water-powers taxed to the utmost to fill the demands upon us, and our company has expressed its intention of going ahead with another water-power development."

Electric equipment of General Electric design has been ordered and installed by the following stations for making extensions to present systems with one exception, that of the Alabama Power Co. Six 10,000 kva. vertical water wheel generators, a switchboard and 110,000 volt distributing transformers, together with one 4,000 kw. turbo-generator set, one 3,000 kw. frequency changer set and one bench board equipment, is the apparatus being now installed in the Tallulah Falls station of the Georgia Railway and Power Company, and the substations at Atlanta. The Birmingham Railway, Light and Power Company has installed a 10,000 kw. turbo-generator set and the Savannah Electric Co., two 5,000 kw. turbo-generator sets in its new steam station. The Alabama Power Company has placed an order for two 5,000 kw. turbo-generator sets for its new developments. The Woodward Iron Co., of Birmingham, has installed two 1,000 kw. mixed pressure turbines and three 55,000 cubic feet per minute turbo furnace blowers which are operating with decided satisfaction. The largest mill equipments electrified during the year were the Duncan Mills of Greenville, S. C., using 1,330 loom motors, 235 spinning frame motors, with transformers for stepping down from 11,000 to 220 volts for power service. The Southern Paper Company of Moss Point, Miss., installed three 937 kva. turbo-generators, one 20 kw. engine generating set and one 25 kw. motor generator set as exciters and one 50 kva. engine driven generator with exciter. In addition a switchboard and 975 horsepower in motors was installed.

The Amalgamated Phosphate Co., of Chicora, Fla., installed General Electric equipment as follows: Three 1,250 kva. high pressure condensing turbo-alternators, a complete switchboard and Tirrel voltage regulator. Sixteen 150 horsepower variable speed induction motors were installed and for each a motor panel for control was installed. These motors are used as mine pumps. Besides 470 horsepower of induction motors was installed all but two being 60 and 100 horsepower and each having a control panel. A 50 kw. motor generator set was also installed.

Those companies recently installing Westinghouse equipment or ordered it for operations to soon begin are the Alabama Interstate Power Co., having recently purchased four 1,350 kva. water wheel type generators for a development on the Coosa river and twenty 4,500 kva. transformers to step up to 110,000 volts for transmission. The Aluminum Company of America in Tennessee has placed an order for nine 2,500 kw. 500 volt rotary converters for industrial work in connection with their new plant. J. G. White & Company of New York has recently ordered for the water power development at Stephens Creek plant on the Savannah river, an equipment consisting of five 2,700 kva. water wheel generators and three 5,400 kva. transformers to step up to 45,000 volts, with the complete switchboard and other details.

There is considerable activity on the part of small towns in the South in the installation of generating equipment for lighting and in some cases for maintaining both commercial lighting and power business. The following towns in Georgia and Florida serve to indicate the sizes of equipment in demand and the nature of the towns installing same. The equipment installed is largely Fort Wayne, this company installing a majority of Southern municipal plants, many in towns of less than a thousand people: Ashburn, Ga., addition 60 kw. generator engine type; Bainbridge, Ga., addition 100 kw. generator belted type; Barnwell, S. C., new plant, 60 kw. engine type; Blackshear, Ga., new plant, 200 kw. engine type; Baxley, Ga., new plant, 125 kw. engine type; Claxton, Ga., new plant, 60 kw. engine type; Clinton, S. C., plant rebuilt, 310 kw. engine type; College Park, Ga., new plant, 125 kw. engine type; Eau Gallie, Fla., new plant, 60 kw. engine type; Edgefield, S. C., new plant, 100 kw. engine type; Fort Pierce, Fla., new plant, 150 kw. engine type; Haleyville, Ala., new plant, 37½ kw. belted type; Manchester, Ga., new plant, 100 kw. engine type; Marianna, Fla., addition 100 kw. engine type; Meigs, Ga., new plant, 60 kw. engine type; Madison, Ga., addition, 100 kw. belted type; Oglethorpe, Ga., new plant, 60 kw. engine type; Perry, Ga., new plant, 25 kw. gasoline engine type, direct; Jacksonville, (South), Fla., new plant, 125 kw. engine, connected; Tallahassee, Fla., addition, 250 kw. engine type; Wrightsville, Ga., 100 kw. belted type.

English and Continental Developments During 1912.

(*Contributed Exclusively to* Southern Electrician).

BY R. E. NEALE, B. SC., A. C. G. I.

THE general electrical prosperity predicted by the writer in the annual review prepared by him for the January, 1912, issue of Southern Electrician has been realized despite the labor troubles which have created an unwelcome and disquieting record. The tremendous developments of electricity supply during the past few years seems likely to continue. Increasing attention is being paid to the development of foreign trade and the vast possibilities of the Chinese field have stimulated energetic measures in most large engineering firms and at least one important association has been formed to exploit it.

The effects of the national coal strike have already been considered in these columns—briefly, they include enormous immediate loss of trade and wages, disorganized contracts and a permanent increase in the costs of production and living. The latter transport strike on the Thames, though sufficiently far-reaching and calamitous, ended in the complete and well-deserved defeat of its deliberate promoters. The insurance act is undoubtedly largely responsible for the recent rapid advance in costs of production—ultimately, the whole burden of labor troubles and concessions falls on the consumer.

The capital at present sunk in electricity supply undertakings in Great Britain, (in millions of dollars), exceeds 190 in municipal and 95 in private undertakings, while in London alone, the corresponding figures are 30 and 67 million dollars. The gross profit realized is about

7.5 per cent in municipal and 6.5 per cent in private undertakings. As compared with 30,000 horsepower of motors connected to public supply mains in December, 1902, the latest returns, (which are, however, incomplete), show 744,000 horsepower to be thus supplied.

The extension of electricity supply to small towns is an urgent problem. Small independent stations, operated in many cases by Diesel or producer gas engines, will be erected in many cases but, wherever feasible, bulk supply from neighboring undertakings is a more economical system. In Germany, "overland" distribution is proving its ultimate possibilities, though comparatively unremunerative results are at present obtained. The national value of comprehensive "overland" schemes cannot be exaggerated; such a generating and distributing scheme is technically the best and is the only one suited to the realization of an "Electric Age."

Mains are laid in all large English towns sufficient to cover, for some time, the rapid extension of electrical demand which may legitimately be expected. The capital burden due to the provision of these cables is, at present, severe in many cases but the outlay will ultimately prove a remunerative investment. The London C. C. proposes to reduce the maximum periods for repayment of future loans as follows: Buildings, 30 years, (instead of 42 years); mains 25 (30) years; plant and machinery 15 (20) years. It is considered by some authorities that these reductions are prejudicial to the development of electricity undertakings.

CENTRAL STATION MACHINERY, POLICY. ETC.

Two 11,000-horsepower turbo-alternators are now at work in the Dunston power station, (Newcastle), and still larger units are under construction. The A. E. G. have four horizontal 20,000 kilowatt turbo-alternators in service or under construction, in addition to 11 units ranging from 12,000 to 18,000 kilowatts each. These machines run at 1,000 revolutions per minute and occupy extraordinarily little space. The Diesel type of internal combustion engine steadily improves; larger and larger units are built and successful results have recently been obtained with 500-horsepower Diesel engine burning crude tar oil. A light gasoline oil, ($22.5 per ton), is used to start up the engine, and from 8 to 12 per cent is added to the crude tar oil, ($9.00 per ton), to facilitate ignition when running below rated output. Using the poorer fuel, the best efficiency is at about 8 per cent of the rated output on Diesel oil, ($10.00 per ton). When full output is continuously required, it pays to use Diesel oil.

The increasing size of prime movers and electrical machinery is leading to considerable extraordinary expense and trouble in transporting the parts. The loading gauge on British railways is necessarily small, (about 13 feet 6 inches x 9 feet overall as compared with 14 feet 7 inches x 10 feet 5 inches on Continental railways). Freight charges, particularly for export, increase more rapidly than the weight of the part carried and, in turbo-machinery and large motors, etc., indivisible parts weighing from 10 to 40 tons are becoming common. Owing to their great size and weight, the rotor casing of turbines have often to be delivered by road and, in a number of instances, bridges have had to be temporarily reinforced and other similar expensive measures have been required.

A German company has been started to reorganize boiler houses and effect economies in steam generation. The company pays the whole cost of the alterations and extensions, recouping its outlay from the economies effected during a "redemption period" determined by the exact conditions of each case. Very satisfactory results have already been obtained and this method of attacking the problem is certainly the one most likely to meet with success (apart from opening out a new line of enterprise).

TRACTION DEVELOPMENTS.

The absence of large water falls and the high development of steam railways has confined heavy electric traction in England to suburban routes, though there is a prospect of the London to Brighton main line being electrified in the near future. Space limitations forbid any mention of Continental electric railway developments. In the construction of heavy electric locos, the use of parallel crank drive from the motors to groups of coupled wheels, simplifies the support of the motors in the framing and allows latitude in the arrangement of the axle; there is a tendency to arrange for higher center of gravity on high-speed locos. A most interesting type of single-phase locomotive has recently been built for the Ch. de fer du Sud in which the motors are geared to a hollow shaft carrying a coupling disk and flexibly connected to the track wheels. Further novel features of this loco include voltage regulation and current regeneration.

The use of petrol driven locos on main lines has been the theme of numerous discussions and contributions to the press. Many of the proposals brought forward are wildly extravagant and advocates of petrol locomotives generally ignore or disguise the tremendous fundamental advantages of electric locos over any self-contained prime mover. It will be many years before steam locos are entirely replaced by electric locos on main lines, but the advantages which the latter offer are possessed in no degree by petrol tractors. The high thermal efficiency of the petrol engine is offset, (as regards heavy traction applications), by its inflexible speed characteristics and poor overload capacity. The most desirable and probable ultimate arrangement will be the use of electric locomotives supplied from central stations employing large steam, gas or water turbines.

The extension of the Central London Tube railway to Liverpool street and Broad street has been completed and is one of a number of similar connecting links, (completed or under consideration), the importance of which is increasing travel facilities is totally disproportionate to the actual magnitude of the extensions. Owing to the system of moving stairways and lifts at the new C. L. staton, the latter surpasses the arrangement and accessibility of any other London tube station.

A German official commission has recommended that the method of train formation, running and signalling, (particularly the latter), as adopted at the London underground railways, be adopted in Berlin.

At the moment of writing, there is announced the proposed amalgamation of the Central London and City and S. London Tube railway, (carrying respectively 38 and 26 million passengers per annum), with the Underground Railway Company's system. The scheme also provides for the amalgamation of the London United Tramways, (hitherto managed by the Underground Railway Company), with the Mètropolitan Electric Tramways Company. The total capital of the Underground and Tramway undertakings concerned is roughly 130 million dollars. The London General Omnibus Company has been liquidated and reconstructed, consequent to the acquisition of 94 per cent of its ordinary stock by the Underground Electric Railway Company. Tram and motor-bus competition is largely responsible for the amalgamation of the Tubes, though considerations of economy in administration and through running facilities also make entire fusion of interest desirable.

Motor-buses have proved serious rivals to the L. C. C. tramcars, but it is absurd to anticipate the complete replacement of railed by railless road vehicles.

The use of trailer cars has been sanctioned on the L. C. C. tramways and will doubtless lead to great economy of working and increased public convenience during rush hours. A report issued by the Highways Committee in May, last, showed unmistakably the much less street obstruction caused by tramcars as compared with motor-buses and, from observations at typical traffic centers, it has shown that the charge of running unnecessary vehicles was usually more—and in no case less—to motor-buses than to tramcars.

Up to now, examples of steam, compressed air and accumulator traction have been found on Paris tramways in addition to conduit and trolley systems which latter are, however, now to be exclusively used in the central and outer areas of the city respectively. These changes are to be accompanied by a general technical reorganization of the system.

DISTRIBUTION AND WIRING.

New wiring systems are continually introduced in which it is sought to improve the security or appearance of the installation or to reduce its cost. The last consideration is generally the one to which most attention is paid, (the Board of Trade rules being sufficiently stringent to secure safety). Probably simple surface wiring on cleats, as already in wide use on the Continent and in limited use in some English undertakings, will ultimately be used in many house installations. So many distributing and wiring systems are now available that the cost of preparing the alternative schemes often wipes out most of the profit on the job itself.

Improvements in meter construction have been made to meet the needs of small metallic filament installations and to reduce the cost of energy loss in meters. In special cases, tariffs avoiding the use of meters have proved mutually satisfactory to station and consumer alike and quite a number of special meters, (with auxiliary relays, limiters, time switches, etc.), have been devised to enable the application of tariffs framed to encourage the use of electrical energy. Wherever applicable, a central switching and controlling gear, operating through pilot leads, is preferable to individual time switches, relays, etc.

Among the numerous means adopted on the Continent to popularize the use of electricity, may be noted the assisted wiring scheme in force in Strassburg. The supply station arranges terms with contractors and settles wiring bills by cash; the consumers are granted easy repayment terms which it is estimated are equivalent to 10 per cent discount on the current bill.

The extent to which, if at all, municipalities should be allowed to indulge in the sale of electric fittings, execution of wiring work and so on, is still hotly discussed. Legally, such municipal trading appears to be irregular and there is much feeling against it in electrical circles. Nevertheless, if it is to be avoided, contractors must enter into much closer and more energetic co-operation with central stations. The primary business of a central station is to sell current and if the means for the distribution and utilization of the latter are adequately provided by contractors, the central station had best confine its energies to this work.

LIGHTING AND HEATING.

Drawn tungsten filaments are now generally accepted as being the best available though advocates of squirted filaments still claim for the latter increasing strength as compared with more or less rapid weakening of wire filaments in service. It appears, however, that this argument is based on interest, prejudice or experience with second-rate lamps. Low voltage metal lamps still possess marked advantage over high voltage types as regards the production of an agreeable, innocuous illumination from a. c. supply, unless the candle power required is high enough to permit the use of relatively thick filaments or unless the supply frequency is high. The suggestion to use condensers in place of auto-transformers, in conjunction with low voltage metal lamps, is interesting and practically feasible, but the proposal comes too late in the day. The life and efficiency of low candle power, high voltage lamps and the steadily increasing standard of illumination hardly leaves a sufficient margin for the installation of condensers enabling the use of low voltage lamps. It is worth noting, however, that condensers may be used to take the place of any other form of demand limiter.

One is forced to the conclusion that the slow development of electric heating and cooking in this country is chiefly attributable to lack of sufficiently cheap apparatus of suitable design. A number of central station engineers, supplying current for heating and cooking purposes at 0.5d. per kilowatt hour, have formed a "0.5 club;" it is to be hoped that the membership will increase rapidly and the numerical coefficient of the title soon be lowered!

Electrically heated carpets may be expected to come into considerable use in the immediate future though for some time the chief demand will probably be confined to desk and table rugs. The ultimate success of electrical water heating must depend on the use of heat reservoirs and in the design of these, Rittershausen has made ingenious application of the downward heat insulating property of a column of water.

A new power house at Flekkefjord, (Norway), will supply interalia current for domestic electric heating experiments. Heat is to be stored in Swedish tile or faience stoves, as at Gottenburg, where stoves are heated over night and used during the following 10 or 12 hours. This is not a true heat accumulator system since the heat return is under very imperfect, if any, control.

MISCELLANEOUS APPLICATIONS.

It is, of course, impossible to do more than mention a few of the novel electrical applications in this section. Those cited are not necessarily the most important of the year's developments, but merely those which have come within the writer's knowledge. Large electrically driven vacuum plant has been applied to cleaning boiler flues and chimneys. The motor and pump horsepower ranges from 3 to 5 hp. for one nozzle upwards according to the number of cleaning tools in simultaneous use. A suitable equipment for ordinary industrial boilers costs about $550 and the flues of one boiler can be cleaned for $5 to $10. Iron resistances mounted in hydrogen-filled glass bulbs and worked around their temperature of recalescence, (as in the Nernst lamp), are being applied to automatic current regulation in motor, accumulator and train lighting circuits. In controlling demands up to 5 horsepower or so, these "variators" are extremely useful.

The First International Conference of Electroculture held at Rheims in October, produces a number of valuable papers. No specially original information appears to have been presented, but a good resume of work and results to date is now available and, as Conferences are to be held annually, research and progress in this important field should be greatly stimulated. From 5 to 10 kilowatt hours per acre per annum is the average consumption of medium sized farms for lighting purposes and the driving of root-cutters, etc. There is no immediate prospect of wide application of electricity to ploughing. This load offers much greater demand, *viz.,* 10-15 watt hours per cubic yard of soil worked. Supply tariffs must be framed to correct, as far as possible, the tendency to perform root-cutting, etc., during winter evenings—thus aggravating the lighting peak.

TELEGRAPHS AND TELEPHONES.

The night telegraph letter system is now in operation between 36 towns. Messages are transmitted at 12 cents for 36 words or less, (with proportional rates for longer letters), and are delivered with ordinary letters by the first morning post. Very important Trans-Atlantic cable rate reductions have been effected, particularly as regards press and deferred message rates.

Telephone facilities between England and the Continent have been greatly improved by the new loaded submarine cables. Communication is now possible between London and Genoa, via Paris-Lyons, and between London and Basle, via Paris-Belfort. Recent P. O. experiments have resulted in satisfactory telephone communication between London, Amsterdam and Arnheim and direct speech from London to Berlin should soon be possible. The commerical and international importance of long-distance telephones is beyond exaggeration.

The first automatic telephone exchange system in this country was inaugurated at Epsom in May last. Satisfactory results appear to be obtained and the system is to be adopted at Caterham. In small or medium-sized exchanges, automatic working is undoubtedly feasible and economical, but as to its desirability and all-round merits in the largest city exchanges, there is certainly room for doubt. A conservative policy is wisely being pursued in such cases.

The International Conference on Radio-Telegraphy assembled in London in June last and brought the regulations governing wireless operation up to date—pretty much along the lines anticipated, though the revised rules and recommendations are still open to criticism in many points. At present wireless telegraphy can do no more than supplement and act as a reserve to cables, within the field of the latter, though it of course possesses characteristics attributable to its independence of any material connecting link between stations.

The German Wireless Telegraphy Company has arranged for the wireless transmission of letters from outgoing to ingoing vessels, such letters being posted directly the latter boat gets to port. At present the charge is 4 cents per word up to 30 words, and thereafter 2.5 cents per word plus a fixed charge of 12 cents for posting to any part of Europe. The wireless development achieved in Morocco, is extraordinary, particularly when the absence of other facilities for transport and communication is borne in mind.

Report of Annual Convention of Alabama Light and Traction Association

The fifth annual convention of the Alabama Light & Traction Association held November 14th and 15th at Birmingham, Ala., was, as briefly outlined in our last issue, one of the most successful in the history of its organization. It has now grown to include the principal central stations of Alabama, and there is every indication of its membership growing considerably during the coming year. From an association membership of 19 companies, there were at the convention 22 representatives and it was interesting to note that among those present there was at least one executive from each organization, either the president or the general manager. It will thus be seen that this was truly a convention of executives. The retiring president in his address which appears elsewhere, carefully outlined the work of the association and made interesting suggestions in regard to its future. It is through his leadership that the association has gained considerable ground during the past year and enough enthusiasm has been created by him to assure a permanent organization composed of both large and small companies devoted to the electric light, power, gas and street railway business in the state of Alabama.

The meeting place of the convention next year has not as yet been decided upon; however, before the convention closed, a formal invitation was extended by the Mobile Electric Co., for the association to meet in 1913 at Mobile and it is quite probable that this will be the meeting place next year. The following officers were elected for the coming year: President, C. C. Henderson, proprietor Henderson Light & Power Co., Greenville, Ala.; vice-president, R. L. Ellis, manager of the Selma Lighting Co., Selma, Ala.; secretary and treasurer, H. O. Hansen, of the Mobile Electric Co., Mobile, Ala.; executive committee, A. H. Ford, president Birmingham Railway, Light & Power Co.; T. K. Jackson, president Mobile Electric Co.; C. E. White, general manager Montgomery Light & Water Power Co.; Mr. Jasper, of the Jasper Water, Light & Power Co., Jasper, Ala., and R. L. Rand, president and general manager of the Anniston Gas & Electric Co. A sketch of the life and business relations of the new president follows:

New President Alabama Light & Traction Association.

Mr. C. C. Henderson, recently elected president of the Alabama Light & Traction Association and proprietor of the Henderson Light & Power Co., of Greenville, Ala., is of Scotch-Irish decent born in North Carolina and made his appearance in the business world just at the close of the civil war. His family was not poor as we consider the term nowadays, but absolutely destitute so that the subject of this sketch did not have an average opportunity to fit himself for life's work. As many of our young men did in those days he struck out early to make his fortune, and secured work in a machine shop with Lidell & Co., Charlotte, N. C., and served an apprenticeship as a machinist. Mr. D. A. Tompkins, the mechanical engineer, took considerable interest in him and smoothed out his path when he finished his apprenticeship by sending him to the Southern Cotton Oil Co., Montgomery, Ala., to erect and operate a plant for several years. This at the time was one of the biggest cottonseed oil mills South having a capacity of 200 tons a day.

From this place he moved to Greenville to equip the Richmond Cedar Works which was a new enterprise in this country being the first to manufacture slates for the Faber Pencil Works in Germany. From there he went to Bowling, Ala., with the Milner, Caldwell, and Flowers Sawmill Co., who are the pioneers of the rift flooring business in this part of the world. By this time having saved up a little money he decided to go in business for himself and went into the ice business in Greenville. In about three years

C. C. HENDERSON, PRESIDENT ALABAMA LIGHT AND TRACTION ASSOCIATION.

he had sunk his capital and had to put on overalls again and go back in the machine shop as workman. In about three months he was, however, made foreman and in a short time was put on the road as a policy man. It was not long before he was prosperous again and put up a machine shop of his own and by degrees has added a merchants' grist mill, rice mill, sawmill, cotton gin, store, and finally a light plant which brought him into the association. This would ordinarily be trouble enough for one man but he rather likes a fight and is now putting up a cold storage and packing house. In connection with this he is establishing a fancy stock farm.

Mr. Henderson is proud of his Scotch-Irish decent with North Carolina rearing and claims to have risen by the grease and overall route. We are forced to add, however, that there has always existed during his career which is also largely responsible for it, a loyalty to friends, honesty and integrity in business, and a fair fight for the right even among enemies. The latchstring to his abode after the fashion of all good North Carolina stock is on the outside to all machinists, and unfortunate electrical people and these as well as others who drift his way will find that what has been said here is only a modest expression of the character of the man and the hospitality they may expect to receive.

SESSIONS ON THURSDAY.

The first paper of the morning session on Thursday was entitled "Rate Research" and presented by M. W. Offutt of the Alabama Power Co., an abstract follows:

In this paper the author took up the work done by some of the public service commissions and other State associations similar to the Alabama Light & Traction Association on the question of classification of lighting and power schedules. He called attention to the need of studying and analyzing service from two points of view. First, the cost at which the central station can profitably afford to give service, and second, the making of a rate that will secure the business. He then presented an outline with divided lighting service into residential and commercial lighting with various subheads and a miscellaneous classification under which comes temporary installation for summer only, rural districts, summer resorts, etc. Power service he divided into permanent and temporary installations, and the different kinds of service classified according to their nature as to time of connection and hours of connection. Ownership of meters and use of service had a place in this outline also.

Mr. Offutt was a member of the joint committee on gas and electric schedules in the second public service district of the State of New York before coming South, and he referred to the definition of service as found by that body. His quotations from this report compared the service of public service corporations to the service of manufacturers, railroad and street railway corporations, adding that the public service corporations operating gas and electric plants render a service in which is commonly included both the commodity and the availability of the supply.

In commenting upon State associations he mentioned the fact that only three State associations have organized committees to co-operate with the research committee, the National Electric Light Association. The Empire State Gas & Electric Association of New York was the first to take up this work and last spring the Michigan Association started work on the subject in Michigan, while at its recent convention the Ohio Association appointed a committee on rate research. He recommended that the Alabama Association go on record as favoring a more thorough investigation of the various classifications of service which can lead to a more thorough understanding of the widely diversified service which can be rendered under varying conditions. The work, he pointed out, is primarily a study of classification of service without regard to the rate charged. The latter being dependent upon varying elements of cost under the local conditions. He further expressed the opinion that a uniform classification of the different kinds of service rendered by a central station will help to bring about a closer relation between the consumer and the company through a better understanding on the part of the consumer of some of the difficulties under which central stations labor to serve all without discrimination.

In closing, Mr. Offutt suggested that it will be to the advantage of the central station companies that the association voluntarily take up the work of classifying its service and work toward the production of a uniform schedule before this work is done for central stations by other and unskilled hands. He believed that a satisfactory schedule should be published for consumers and if such be done central stations will create a better understanding between consumer and company and will then enjoy a fuller measure of public confidence and co-operation.

Mr. Offutt's paper was discussed by the following: C. E. White, of the Montgomery Light & Waterpower Co.; A. H. Ford, of the Birmingham Railway, Light & Power Co.; T. K. Jackson, of the Mobile Electric Co.; R. L. Ellis, of the Selma Lighting Co., and L. D. Mathes, of the Montgomery Traction Co.

Mr. Ford, in speaking of the lighting business, referred to two positions in which the central station is placed, the unique position of always being ready to supply and meet any demand that is made upon it, and in addition the requirement of producing the commodity at the time it is demanded. These two positions combined demand a large expenditure of money in generating stations and necessarily on account of the differences in the character of the service that is rendered requires an adjustment of rates to meet varying conditions. He pointed out that the larger companies are making rates suited to the different classes of business such as heating business, commercial business, the municipal business, and the residential business. Mr. Ford thoroughly agreed with the author of the paper that the question of rates and the making of adjustments by central stations themselves should be taken up for study and the rates adjusted to meet conditions of the various communities. He pointed out that if this is done the necessity for state commissions or other legislative bodies is done away with.

Mr. Jackson, in taking up the subject of the paper, voiced the opinion that the rate research committee's work does not serve the purpose that many expected it would in that the rates are made and will continue to be made for central station business not on the exact relation of cost to selling price, but upon what the traffic will bear. Rates are now classified in one way or another, but in each case they are classified in a manner to meet actual competition. A higher charge is made to a residence than the retail department stores, not particularly because it costs more to serve the residence, but because a higher rate must be procured from residences in order to meet expenses. He said that the rate research committee in his opinion can do an invaluable work in pointing out the elements of costs so that they can be intelligently discussed and enable central station managers to keep within the range of what the cost of production is for the special service that rates are made for.

Mr. Ellis took up the subject of educating the public as to the methods employed in determining rates and pointed out that as a general rule the customer is less interested in how the rate is arrived at than he is in what the total amount of his bill will be under a new or any particular rate.

Mr. Mathes pointed out that it is difficult for the public to appreciate that rates are not at times discriminatory. However in the average instance, if the subject can be put up to the customer clearly and intelligently, and he is fair-minded, he will usually appreciate the difference in serving different classes of businesses. He expressed the opinion that it is important for all utility companies to carry on a comprehensive educational campaign so that the public can be shown the many elements involved in the cost of producing and distributing energy offered for sale and purchased. This however, is a difficult undertaking, but the sooner the utility companies recognize the value of enlightening the public, the more liberal will be their treatment with such companies. He believed that the suggestions made by the author of the paper should be followed out by the association.

Mr. Offutt in closing the discussion, referred to the personnel of the public service commission, referring to the New York commission where men are serving on the commission who are fair-minded and in the case of a complaint require that any one making a charge prove to the commission and make an affidavit to their figures that the company is charging a price on which it realizes an unreasonable profit. He was of the opinion that if public service commissions are made up of men of this character there is nothing to fear from them. He believed that the one important point is the working up of a schedule classifying the different businesses which permit the offering of different rates and publishing these schedules so that every one can know what his neighbor is paying.

The next paper of this session was entitled "How and Why of Residence Illumination," written by J. C. Henninger, of the National Electric Lamp Association, Cleveland, Ohio, and read by Mr. A. M. Klingman, of that association. An abstract of this paper follows:

The author opened his paper by the remark that there are perhaps no more crimes committed against that most precious of senses——sight—than in the home. Other fields have received onsiderable attention, while homes have received but slight if any attention at all, in regard to illumination. In the majority of cases this condition exists on account of the fact that the illumination problem is not considered seriously when building homes.

The author took up the different qualities to be sought for in residence lighting systems, mentioning first that lighting should be comfortable. That is, there should be sufficient light well enough diffused about the house so that no eyestrain will be caused. A second requisite may be named in the harmony of lighting arrangements and equipment, the ornate lighting fixture presenting an attractive lighting system in harmony with furnishing and decorations of the home. The third requisite mentioned was efficiency, the lighting system being as efficient as is compatable with good appearance. The system should also be flexible, enabling the burning of one lamp or an entire fixture as conditions may demand. Convenience was named as the fourth requisite, the proper switching arrangement being made so that the light is placed where it is needed.

Fixtures were next taken up, both semi-direct and direct system fixtures being discussed. In the direct system lamps should be all frosted or enclosed in diffusing glassware. Side wall brackets should be erected with the lamps upright rather than suspended This aids in the general lighting of the room. The remaindr of the paper took up the requirements of each of the different rooms found in the home, and gave the lighting requirements which have been found best suited.

The paper was discussed by C. E. White, of the Montgomery Light & Waterpower Co.; Mr. Hammond, of the Birmingham Railway, Light & Power Co.; M. W. Offutt, of the Alabama Power Co.; T. K. Jackson, of the Mobile Electric Co.; Mr. Upton and Mr. Simmons, of the Birmingham Railway, Light & Power Co.

Mr. Hammond referred to the necessity of educating solicitors on the proper means of illumination, so that they can educate the people to use better illumination. In Birmingham a considerable study has been made of store and window lighting as well as church lighting and the work done by solicitors has been decidedly satisfactory. A book is furnished the solicitors giving necessary data on illumination and how to arrive at the proper illumination for any particular case. He further referred to the need of cooperation among architects.

Mr. Offutt in discussing the paper, referred to the poor lighting conditions in homes, stating that the architects and contractors are in many cases responsible for some of the bad layouts. The architect is not giving the proper attention to layout and the contractor paying little attention to the illumination features. He recommended that the paper be printed so that the association members could circulate it among architects and contractors. Upon putting a motion to this effect it was voted that the paper be printed.

Mr. Upton mentioned the fact that in many cases where architects specified the arrangement of certain fixtures and switches, no definite location is given and the contractor is depended upon to locate them.

ADDRESS BY PRESIDENT WHITE.

The first business of the session on Thursday afternoon was the address by the president of the association, Mr. C. E. White. While his remarks were brief, they were to the point in regard to the past work of the association and the conditions under which the association must progress in order to be successful. He pointed out the need of cooperation of all members and stated that the membership was sufficient and capable of doing a considerable work if they will get together in regard to it. He mentioned especially the need of the smaller companies in the association and the work that they can do, stating that in some respects the larger companies are represented directly along certain lines in which the smaller companies are not able to be directly represented and therefore the smaller companies through the aid and assistance of the Alabama Light & Traction Association, can do things that they could not do otherwise. Mr. White referred to association work in general, stating that in his opinion the great advancement of the gas and electric industry and particularly that of the electrical industry is due to this work. He said that the association in session is now in its fifth year, has a membership of 19 companies, 21 representatives of which were present at the convention.

The first paper of this section was one entitled "Street lighting as a Public Necessity," by A. M. Klingman, of the engineering department of the National Electric Lamp Association. An abstract of his paper follows:

The author stated that the value of good street lighting to a community is received from progress, sanitation and municipal advertising. Street lighting has been instrumental in providing good pavements and in improving of street curbs and sidewalks. Sanitation follows from the power of suggestion, one improvement suggesting another. Further the municipal authorities have an incentive to be more particular in their street cleaning. Street lighting also incites civic pride. Good lighting is the result of applied common sense by some one who has illumination knowledge and experience. There are no definite rules which can be established and applied to a given problem and each must be handled upon its merits. The factors entering into a street lighting system are distribution and spacing of the unit, diffusion, lack of flicker, and lack of shadow. The distribution of the light source together with the mounting height and spacing are important factors in determining the result of illumination. An ideal unit would have its maximum candlepower of about 25 to 30 degrees below the horizontal.

For the purpose of discussion the subject of street lighting was divided into four branches as follows: One, lighting for business districts; two, lighting of residence districts; three, lighting of suburban districts; and four, lighting of public parks, drives, and boulevards. In importance business districts were ranked first for the first impression of the community is secured thereby.

The multiple 110-volt system of distribution has proven to be most satisfactory The series system of any type is to be discouraged in downtown districts where it is necessary for high tension current to run underground. In the average city or in larger cities where merchants have installed a commercial lighting system, four light posts are generally found, the five light standards being prevalent in the larger cities where commercial street lighting comes wholly or partly under municipal government. The usual mounting height of standards averages 13 feet, 6 inches to the middle of the top globe. This mounting height is to be discouraged and the tendency should be to raise the standard so that the bottom of the pendant globe would be approximately 12 feet over the street surface. This recommendation applies only to streets of the average width and where standards are spaced an average distance. The mounting height should be proportionately greater on very wide streets or streets where the spacing is increased greatly over the average. The spacing of standards should average between 60 and 80 feet. The recommendation for the spacing is from five to six times the mounting height of the lamp. In the three-light lamps, two 60 and one 100-watt lamps are used, or three 100-watt lamps are used; in the four-fixture, four 60-watt, or four 100-watt; and the five-light four 60 and one 100-watt or five 100-watt lamps. The density of the diffusing globes should be such that the filament of the lamp can not be seen through the globe. From an engineering standpoint, considering uniformity alone, standards having the globes upright are much better, while if it is desired to obtain the highest average intensity, standards with pendant globes are to be chosen. Construction is usually placed underground and steel-armored cable placed in a trench covered with an envelope of concrete is advised. A second method is used by installing iron conduit and rubber-covered wire, and a third by the use of fiber or clay conduit with lead-covered cables. The first system has the objection of high cost on repairs, yet armored cable is preferable to iron conduit on account of deterioration.

In taking up the subject of residence district lighting the author of the paper included thickly populated portions of the city, cross streets, and avenues removed from the business quarters. For this lighting an even intensity averaging from one-tenth to two-tenths foot-candles proves satisfactory. Series distribution in these sections is universal and the 6.6 ampere lamp is usually recommended. These units are suspended either from special poles or from telegraph poles. The mounting height is recommended from 12 to 14 feet, and the units placed below any foliage or obstruction. The sources may be placed in a single line either along the center of the street or along one side or they may be located according to a staggered system. A spacing of 125 feet lengthwise of the street, (300 feet on a side, for the staggered system), according to the nature and importance of the thoroughfare; 60, 80 or 100 candlepower lamps are used, the most prevalent being 80 candlepower. A substantial reflector is used in residence districts. For the lighting of suburban districts the systems compare with those of more densely populated districts except that units are spaced greater distances apart and if possible higher. A single line lighting arrangement is recommended.

In referring to lighting public parks, drives and boulevards, Mr. Klingman pointed out the difficulty in that the scheme used in either of the lighting systems already mentioned are not applicable. It is now considered good practice to use an ornamental single light standard or an appropriate lantern post of good design. Along parkways and drives comparatively high illumination should be produced. The mounting height of standards should be as high as possible, especially on drives and boulevards. Around winding boulevards and drives particular attention should be given to placing the units so that curves stand out clearly and not be obscured by units placed so as to blind the driver of a vehicle, but should be on the inside of curves so that a driver is looking away from the light and vision is more distinct.

The above paper was discussed by Messrs. White, Rand, Ellis, Klingman, Flower, Hammond, Sloan, Simmons, Offutt, Smith and Jackson.

Mr. Rand referred to an ornamental lighting system in Anniston where 22-volt tungsten lamps are used in a series system and only two lights have been renewed out of 300 in 15 months. He asked a question of the author of the paper as to whether series or multiple lamps have the longer life.

Mr. Flower referred to the whiteway lighting and its effect upon window lighting in business districts. He also referred to a whiteway system which is contemplated for the residence district of Mobile.

Mr. Hammond, of Birmingham, referred to the low voltage lamps and stated that they were very successful on his system. He did not agree with Mr. Rand, however, in that the effect of whiteway lighting makes it difficult to sell signs. He stated that more signs have been sold in Birmingham since the whiteway has been installed than before. The sign is used by the merchants to bring up his individuality. He also stated that the window illumination secured even after the whiteway was installed has been satisfactory.

Mr. Sloan, of Birmingham, in discussing the subject, stated that he believed the whiteway and sign lighting is more or less a question of what the traffic will stand. He referred to underground construction work, voicing the opinion that the armored cable is the best for all-around purposes, being least expensive to maintain. This type of construction is used in Birmingham.

Mr. Simmons, of Birmingham, referred to a gas whiteway lighting system in Ensley, which is a business district removed from the center of Birmingham. The whiteway is composed of single posts with three-mantel, inverted arcs located 36 feet apart on opposite sides of the street. The system has been very satisfactory to the merchants and gives a large amount of light, and will ultimately be extended. This system is operated on low pressure gas. The system was installed by the Birmingham Railway, Light & Power Co., and this company maintains the lamps on a regular basis of $3 per lamp per month, maintenance and all.

Mr. Offutt was of the opinion that window lighting goes hand in hand with street lighting and that if the lighting of the streets is improved the window lighting will gradually be improved to compare favorably with it. He asked the author of the paper what the relative cost of operation of the new inverted six point six arc lamp is. He referred to its success in New England towns, particularly New Haven, where it is claimed to bring out the building outline.

Mr. Klingman before answering that question stated that he is of the opinion that street lighting by whiteways does not affect sign lighting to any marked extent, for each merchant endeavors to bring out his individuality and one vies with the other in this regard. He explained that the purpose of street lighting is to bring people in the vicinity of the business district and where stores are located. Merchants next try to attract people to their places of business, and put up electric signs. They then endeavor to produce such window display and lighting as to invite purchasers into the stores. This process therefore takes into consideration all three systems of lighting and the one is an aid to the other.

In reference to Mr. Rand's question on the life of lamps Mr. Klingman stated that the multiple system is in existence in larger proportions than the series system and all are working satisfactorily. He stated that the chief objection of the series lamp is the fact that it is impossible to manufacture all lamps with absolutely the same operating characteristics throughout life, and the one has no longer life than the other. In reference to Mr. Offutt's suggestion as to the relative cost of the new inverted lamp, Mr. Klingman said that the ornamental magnetite is higher than the ornamental cluster.

Mr. Sloan in continuing the discussion stated that as to the question of use of a magnite lamp as against the 6.6 series arc lamp, it is advisable to use either the 6.6 magnetite or the 4.4 magnetite lamps against the series lamp.

Mr. Klingman stated that in many towns in Ohio 250 watt mazdas are placed instead of arcs.

Mr. Jackson believes that the next step in street lighting is the illumination of residence districts by modified whiteway lighting. The residence district has been neglected in street lighting and it is here that new developments are likely to take place. Mr. Jackson believes that ornamental street lighting is permanent only when the city pays for the service, but doubtful when the customer pays for it.

The next paper was entitled "Street Railway Matters and the Double Deck Car," and read by L. D. Mathes, of the Montgomery Traction Co. An abstract follows:

In opening the paper the author took up the subject of double-decked cars, stating that the problems of today are the controlling of the entrances and exits of cars to prevent accidents, the proper illumination and ventilation of cars, and the perfection of safety devices. The author stated that while it is generally thought that the double-deck car is best suited to the large city, however he is of the opinion that if this type of car is a success in such cities, it can be adopted on the modified plan for such cities as Memphis, Birmingham, Atlanta and New Orleans. He referred to the recent experiments in New York City with this type of car in an endeavor to relieve the traffic situation. Its advantages are the cutting of platform expenses in two and transporting approximately twice the usual number of passengers, with little increase weight and proportionate increase in current consumption by the equipment.

He then took up the history of the double-deck system and the types that were used in the late 80s and early 90s of the last century. He further stated that the recent experiments in double-deck car operation in New York City were made possible through the development of the stepless and the Pittsburg low-floor car. The total weight of the New York double-deck car completely equipped is 46,000 pounds and the seating capacity of the lower deck accommodates 44 passengers with a similar number on the upper deck. Through operation it is found that this car accommodates during the peak intervals, 171 passengers, or the weight per passenger carried is 266 pounds.

This paper was discussed by Messrs. Harris and Sloan. During the discussion Mr. Mathes stated that pay-as-you-enter cars are about to be used in Montgomery where the passengers will enter from the rear platform and the white passengers be discharged from front platforms, the colored passengers occupying the rear section of the car.

Mr. Sloan stated that he believed the double deck car an excellent proposition for the large city, but said that if used in a city like Birmingham it would run loaded during peek hour only. He stated that the cars in Birmingham are running 360 to 400 pounds per passenger.

The next paper was entitled "Retort House Practice," and presented by C. W. Wallace, of the gas department of the Montgomery Light & Water Power Co. An abstract follows:

The author in discussing this subject took up the technical side of the situation, beginning with the generator or recuperative bench and following the different stages of gas-making throughout. The subjects touched upon were charging and drawing, the furnace, adjustment of dampers, care of a bench, standpipes, scurfing, and hydraulic main. The paper was treated in an excellent manner and much detail in regard to the operation of a bench was given.

The discussion of the paper was taken up by Mr. Simmons, of Birmingham, when he explained the difference between the method outlined by Mr. Wallace and those used in Birmingham. He mentioned the difficulty of working with Birmingham coal and explained how these difficulties were overcome. Mr. Greer in taking up gas making at his plant, again explained the differences in operating benches.

FRIDAY SESSIONS.

The first paper of the morning session of Friday, November 15th, was one entitled "Association Work in the South as Seen by the Editor," and presented by D. H. Braymer, editor of SOUTHERN ELECTRICIAN. An abstract of this paper follows:

A brief review was given of the growth of central station light and power business, referring especially to the commercial side of the industry. The developments in equipment and the extension of systems were also commented upon leading up to the activity in central station work and electric transmission in the South. Attention was called to the fact that 14 years only have elapsed since central station activity first began in the South on anything like a large scale, yet it was shown that through these few brief years so much progress has been made that commercial problems are now being worked out very satisfactorily.

Reference was made to the various organizations among central stations of the South and particular attention called to the recent movement on the part of the Georgia section of the National Electric Light Association in the foundation of a Southeastern Geographical section of that body. The purpose of this association was explained and its benefit to the various stations, large and small, of the States included, taken up in some detail.

The latter part of the paper was devoted to the particular lines of work that remain to be taken up through associations by the central station membership. Particular reference was made to the conditions in the electrical contracting and supply fields, recommending steps to be taken either individually by central stations or through associations whereby a co-operation can be established to relieve the present situation. Reference was also made to the conditions in the isolated plant and municipal fields, it being pointed out that there is ample opportunity to do something to improve the condition in both and to the advantage of not only the central station but that of the average consumer and manufacturer who requires the use of electrical energy in his business.

This paper was discussed in some detail by the following: Messrs. White, T. W. Peters, of Columbus, Ga.; T. K. Jackson, of Mobile; C. C. Henderson, of Greenville; A. H. Ford, of Birmingham; M. W. Offutt, of Birmingham; R. L. Ellis, of Selma, and R. L. Rand, of Anniston.

Mr. Peters commented in some detail upon the organization of the Southeastern section of the N. E. L. A. giving the arrangements under which the various companies had affiliated.

Mr. Jackson in referring to the situation and relation in the contracting and supply fields, stated that the solution of the matter seems to be with the men that supply the material to the contractors, that there should be a co-operation between them similar to that in the plumbers' association where this problem is practically solved. The "fly-by-night" plumber can not get material from jobbing plumbers and this is eliminating the trouble of the small operator in that field.

Mr. Ford, in commenting upon the situation in the contracting and supply field, stated that the unfavorable relations between the supply people and the central station is in a way due to the fact that some supplies are handled by the central stations that the supply men feel belong to them. He stated that his preference is to give up the supply business and confine activity to the manufacture of gas and current. However, if the supply business is left to the supply men, operating as they are at present, the central station suffers.

Mr. Offutt continued the discussion by pointing out the delicate situation which exists in giving up entirely the sale of appliances to be attached to service lines. He thought that it would be a mistake to give up the sale of electrical appliances at the lowest possible cost to the customer but favored giving to the contractors the handling of contracting work and fixtures.

Mr. White touched upon the subject of municipal stations of which there are 30 in the State of Alabama, or approximately one plant to every two counties. He dwelt upon the management of the municipal plant, stating that the efficiency in service and honesty of maagement can not compare with the public utility such as now exists in Alabama. He impressed upon the members that since there were 30 municipal plants in the State of Alabama the association had considerable work to do in the way of education. He pointed out that the accounting of municipal plants is not on the same basis as that of the public utility and therefore it is difficult to compare them in all details. If this were possible it is very probable that interesting deficiencies would be found.

Mr. Henderson, in discussing the subject of the sale of appliances, believed that this proposition is more vital to the small central station than to the large one. He stated that unless the central station sells these appliances they are not connected to the line and it is quite essential that the customer get the best type of equipment at the lowest price.

The next paper of this session was entitled "The Small Tenement Consumer," prepared by A. F. Kersting, superintendent of the Mobile Gas Co., and read by R. E. Flower, new business manager of the Mobile Electric Co. An abstract follows:

This paper took up the promotion of gas appliances and gas stoves among the negro element. The subject has been carefully studied in Mobile due to the fact that it was found that the negro cook was established in nearly 100 per cent of all homes and that they were in many cases not inclined to use gas as fuel. This was mostly due to superstition, and it was therefore considered that an educational campaign as to the economy and use of gas was needed. The gas cooking appliances were introduced into the homes of the negroes themselves and a competent demonstrator hired to teach the negro the use of the range. A prepayment meter was used and the rate for gas was set for 25 cents in advance of the regular net rate, to cover interest and depreciation on the installation and the expense of caring for the business. The negro churches were offered a bonus of $1.00 for each pupil they would send for 8 consecutive lessons to cooking classes held in the offices of the company and several negro churches. Here a domestic science kitchen was installed and fully equipped with the necessary cooking appliances. During the two years the class was continued 600 cooks were graduated. The result of the campaign is that about 500 of the small tenement consumers have been secured. Further, it is estimated that a considerable business is secured from the better classes where negro cooks are employed.

This subject was discussed by Messrs. Simmons, of Birmingham, Ellis, of Selma, and Rand, of Anniston. Each of these parties related experiences in regard to an endeavor to promote the sale of gas among negroes, and each failed to report any progress. The cause given was the different conditions in the different localities and the tremendous cost entailed in securing such business. Mr. Rand related experiences in trying to sell gas among white cotton mill operators in Anniston. While he accomplished considerable in an educational way, he failed to secure any profit from the business. He connected the stoves with a ten-cent prepayment meter.

The first paper of the afternoon session of Friday was on "Store Room Accounting," by V. B. Day, secretary and treasurer of the Mobile Light & Water Power Co., and read by Mr. Hanson. An abstract follows:

This paper took up the methods of store room accounting in small stations and the different systems for handling supplies. The author recommended a loose-leaf store ledger to show quantity and value of material received, the quantity and value of material issued, and also the quantity and value of material on hand. A separate sheet should be taken for each class of material and the ledger will then constitute a perpetual inventory. He took up the details in regard to reports and the part of it that must be understood by the foreman and storekeeper in order that all materials drawn and left over on any job can be returned and the proper credit given. The paper is important from the details that are given, and the forms that were presented, and should be interesting to all small central station managers.

The paper was discussed by Messrs. Simmons and Hanson, each taking up the different systems used by their company. The one in Birmingham and the other in Mobile. The system given by Mr. Hanson was unique in that it explained a perpetual inventory for fittings on gas jobs.

The next paper presented was entitled "Increasing the Day Load," and was read by Mr. F. V. Underwood, of Birmingham. This paper took up in detail the arguments which a solicitor can use in securing new business and dwelt on advertising and other methods which can be used as conditions dictate.

A part of the paper was given up to the general reason for electric drive which can be taken up with factory managers in securing electric drive load. A second part of the paper was devoted to the arguments in favor of central station service as compared with isolated plants, some 20 reasons being given in detail. This paper was discussed by Messrs. Henderson, Simmons, Upton and White.

General Electric Annual Dinner at Atlanta.

The Atlanta office of the General Electric Company, gave the annual dinner to its representatives at the Capital City Club, Saturday evening, December 14. About 140 members of the company's offices in the South and their guests were present, many coming from distant points especially for the occasion including officials from the Schnectady and other offices.

The arrangements for the dinner were in charge of E. H. Ginn, district sales manager of the Atlanta office. District Manager A. F. Giles, well known to Southern electrical men, acted as toastmaster. In opening the speaking of the evening Mr. Giles reviewed the business conditions in the Southern field during the past year and commented in a general way on the future prospects.

Judge H. E. W. Palmer, the first manager of the General Electric Company in the South then the Thomson-Houston Company referred in an interesting way to the early days and paid a splendid tribute to the master mind of the General Electric Company, Mr. C. A. Coffin. He concluded by referring to the work accomplished by Mr. Giles and the successful way in which he has built up a Southern sales organization, second to none in the whole organization. The other speakers were as follows: Ernest Woodruff, president, Trust Co., of Georgia; William Glenn, vice president of Georgia Railway and Power Co.; Forest Adair, capitalist of Atlanta; C. M. Young, Columbus Power Co., Columbus, Ga.; Harry Fisher, Virginia-Carolina Chemical Co.; Arthur Redding, electrical engineer, Ga. Ry. and Power Co.; Adam Jones, and Harry Meikleham, Massachusetts Cotton Mills, Rome, Ga.

The following G. E. employees were present: E. D. McKeller, New Orleans, La.; V. Livingston, Atlanta, Ga.; J. E. Sims, New Orleans, La.; W. L. Barker, Atlanta, Ga.; D. W. Billingsley Atlanta, Ga.; W. S. McGraw, Atlanta, Ga.; D. W. Peabody, Atlanta, Ga.; R. A. Riley, Birmingham, Ala.; G. C. Henry, Jacksonville, Fla.; M. A. Ladd, Jacksonville, Fla.; J. V. Anthony, Atlanta, Ga.; H. E. Bussey, Atlanta, Ga.; A. F. Giles, Atlanta, Ga.; W. E. Hannum, Atlanta, Ga.; C. P. Townsend, Atlanta, Ga.; C. E. Mohns, Atlanta, Ga.; J. C. Tuttle, New Orleans, La.; W. E. White, Atlanta, Ga.; C. W. Bartlett, Schenectady, N. Y.; F. C. Greene, Schenectady, N. Y.; S. S. Smith, Atlanta, Ga.; H. E. Stoy, Atlanta, Ga.; C. B. Tucker, New Orleans, La.; George Brown, Atlanta, Ga.; F. N. Palmer, Atlanta, Ga.; H. H. Blakeslee, New Orleans, La.; H. P. Powell, Atlanta, Ga.; P. A. Weeks, Atlanta, Ga.; H. W. Key, New Orleans, La.; B. Willard, New Orleans, La.; R. T. Brooke, Birmingham, Ala.; W. C. Coles, Atlanta, Ga.; E. H. Ginn, Atlanta, Ga.; T. W. Moore, Atlanta, Ga.; J. O. Hardin, Atlanta, Ga.; F. H. Hollister, Atlanta, Ga.; L. H. Whitten, Atlanta, Ga.; J. T. Kerens, Atlanta, Ga.; F. T. Williams, Atlanta, Ga.; L. W. Carnagy, Atlanta, Ga.; E. F. McLaughlin, Atlanta, Ga.; J. D. Myrick, Atlanta, Ga.; F. H. Henley, Chattanooga, Tenn.; D. M. Diggs, Schenectady, N. Y.; E. P. Coles, Charlotte, N. C.; J. E. Thigpin, Atlanta, Ga.; M. B. Carroll, Schenectady, N. Y.; R. H. Carlton, Schenectady, N. Y.; W. M. Deming, Schenectady, N. Y.; L. Callender, Atlanta, Ga.; H. V. Lips, Atlanta, Ga.; H. S. Roberts, Atlanta, Ga.; J. M. Anderson, New Orleans, La.; Hugh Bickerstaff, Seale, Ala.; Edward Clark, Jr., Charlotte, N. C.; R. B. Parker, Harrison, N. J.; W. M. Stearns, Pittsfield, Mass.; R. E. Woolley, Schenectady, N. Y.; A. B. Lawrence, Schenectady, N. Y.

The following were the guests present: Forrest Adair, Atlanta; H. J. Arnold, Rome Railway & Light Co., Rome, Ga.; Thos. Arnold, Greenville Trac. Co., Greenville, S. C.; D. H Braymer, Editor Southern Electrician, Atlanta; W. E. Boileau, Chattanooga Ry. & Lt. Co., Chattanooga, Tenn.; W. B. Bloxham, Ga. Ry. & Pr. Co.; T. A. Burke, Western Electric Co., Atlanta; L. H. Beck, Ga. Cotton Mills, Griffin, Ga.; E. Campbell, Atlanta; J. T. Chambers, Ga. Ry. & Pr. Co., Atlanta; S. A. Carter, Gate City Cotton Mills, Atlanta; W. E. Collier, Republic Iron & Steel Co., Birmingham, Ala.; W. R. Collier, Ga. Ry. & Pr. Co., Atlanta; J. C. Cook, J. B. McCrary Co., Atlanta; Chas. Collier, Ga. Ry. & Pr. Co., Atlanta; N. A. Cocke, Southern Pwr. Co., Charlotte, N. C.; M. L. Chrisman, 321 Chestnut street, Philadelphia, Pa.; E. C. Deal, Aug. Ry. & El. Co., Augusta, Ga.; T. W. Dunk, Fla. Elec. Co., Jacksonville, Fla.; George Denny, Savannah, Ga.; J. N. Eley, Empire Bldg., Atlanta; Dr. W. S. Elkin, Atlanta; H. C. Fisher, Va.-Car. Chem. Co., Atlanta; W. A. Ford, Rome Ry. & Lt. Co., Rome, Ga.; L. P. Foster, Int. Agri. Corp., Atlanta; W. H. Glenn, Ga. R. & P. Co., Atlanta; W. T. Gentry, Sou. Bell T. Co., Atlanta; P. J. Gilham, Carter Elec. Co., Atlanta; T. M. Girdler, Atl. Steel Co., Atlanta; R. M. Harding, Columbus Pwr. Co., Columbus, Ga.; F. W. Hadley, Ga. Ry. & Pr. Co., Atlanta; L. P. Hathorn, Consumers' Elec. Lgt. & Pr. Co., New Orleans, La.; Roland B. Hall, Third Nat. Bk. Bldg., Atlanta; John Hill, Third Nat. Bnk. Bldg., Atlanta; J. D. Hudson, LaGrange, Ga.; G. K. Hutchins, Col. Pwr. Co., Columbus, Ga.; M. A. Hendee, Augusta Ry. & Elec. Co., Augusta, Ga.; W. R. Jennison, Grant Bldg., Atlanta; A. W. Jones, Equitable Bldg., Atlanta; T. B. Livingston, Livingston-Yonge Co., Jacksonville, Fla.; L. A. McGraw, Cen. Ga. Pr. Co., Macon, Ga.; M. L. Mann, Perry-Mann Elec. Co., Columbia, S. C.; Fred L. Markham, Brill Co., Forsyth Bldg., Atlanta; G. E. Mellett, Ga. Ry. & Pr. Co., Atlanta; H. P. Meikleham, Lindale, Ga.; H. Clay Moore, Empire Bldg., Atlanta; E. H. Moses, Sumter Ltg. Co., Sumter, S. C.; J. B. McCrary, Third Nat. Bk. Bldg., Atlanta; I. F. McDonnell, J. B. McCrary Co., Atlanta; R. S. McMichael, Alfriend Bldg., Atanta; C. S. McMahan, "Southern Electrician," Atlanta; G. R. McNamara, 646 Colquitt avenue, Atlanta; A. W. McLimont, Nor. Cont. Co., Atlanta; H. H. North, Newnan, Ga.; H. A. Orr, Anderson, S. C.; Judge Howard W. Palmer, Sou. Bell Tel. Co., Atlanta; T. W. Peters, Col. Pwr. Co., Coumbus, Ga.; W. M. Perry, Perry-Mann Elec. Co., Columbia, S. C.; W. J. Pollock, Chas. Con. Ry. & Lt. Co., Charleston, S. C.; E. P. Peck, Ga. Ry. & Pr. Co., Atlanta; S. A. Redding, Ga. Ry. & Elec. Co., Atlanta; L. W. Roberts, Jr., with P. A. Dallas, Candler Bldg., Atanta; S. W. Roberts, Atlanta Steel Co., Atlanta; C. A. Spooner, N. O. Ry. & Lt. Co., New Orleans, La.; R. F. Sams, Va.-Car. Chem. Co., Atlanta; G. G. Slaughter, Greenville, S. C.; S. O. Sauls, Savannah, Ga.; W. H. Smaw, Ga. Ry. & Pr. Co., Atlanta; E. M. Seabrook, 819 Empire Bldg., Atlanta; Claude Smith, Duncan Mills, Greenville, S. C.; L. L. Shivers, Carter Elec. Co., Atlanta; R. A. Thayer, Lockwood-Greene & Co., Atlanta; W. J. Tilson, Atl. Nat. Bank Bldg., Atlanta; R. W. Underwood, Supt., City Lighting Plant, LaGrange, Ga.; E. J. Wallis, Western Elec. Co., Atlanta; H. L. Wills, Ga. Ry. & Pr. Co., Atanta; T. F. Wickham, Cen. Ga. Pr. Co., Macon, Ga.; B. L. Willingham, Piedmont Cotton Mills, Atlanta; Ernest Woodruff, Atlanta; E. Y. Wootten, Lockwood-Greene & Co., Atlanta; H. R. Worthington, Fla. Elec. Co., Jacksonville, Fla.; C. M. Young, Col. Pr. Co., Columbus, Ga.

Mississippi Electrical Association Question Box.

Under this heading will appear each month questions and answers to questions from members of the Mississippi Electrical Association. All readers are invited to discuss any question or topic presented. Address all correspondence including questions and answers to Clarence E. Reid, Question Box Editor. Agricultural College, Miss.

Questions Repeated.

QUESTION NO. 2.

A town has a grounded non-metallic telephone system installed, and on the same poles it is desired to run A. C. 2,300 volt 60 cycle wires. Clearance between A. C. wires and 'phone wires to be 2.5 or 3 feet; what interference will be experienced in the 'phone system due to inductance? If a 133 cycle system was installed, would the 'phone service be worse than it would be if 60 cycle current were in the wires?

QUESTION NO. 3.

In addition to sending out 3-phase 2,300 volt, 60 cycle lines, a station wishes to send to near-by consumers, 3-phase, 3-wire, 110-volt circuits, fed from two transformers of not more than 15 kw. each. Is it permissible, or good practice, to set these oil filled transformers, on the floor back of the switchboard, or mount them on a brick wall at the rear of the board, or place them in the boiler room at the rear of the board, beyond this wall, or is it necessary to run the 2,300 volt lines out of the station, to transformers mounted on poles or other outside structure, and then run the 110-volt lines back to the board? These 110 volt lines are controlled by 3-phase carbon break circuit breakers.

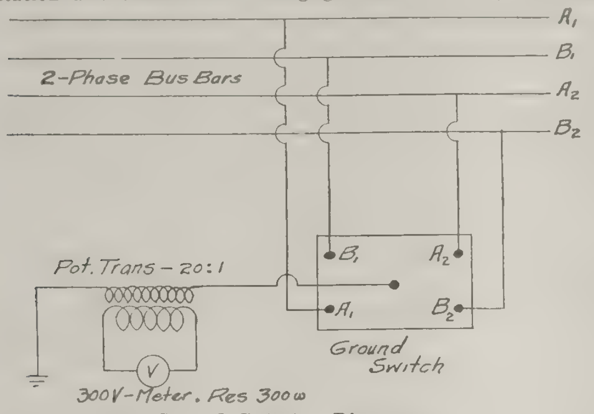
In any of the above situations of the transformers, is it good practice to connect the transformers direct to the 2,300 volt fuses, without oil or other primary switches? The oil switch on the generator is non-automatic. If an automatic switch is not used on primary side of these transformers, are primary fuses necessary or desirable?

QUESTION NO. 5.

The sketch shown here refers to a two-phase plant, using transformer type ground detector. The following readings were noted, with all line switches open, for first set, and second set taken with all line switches closed:

	All lines open	Closed.
When A_1 is selected, voltmeter reads........	61	66.5
When A_2 is selected, voltmeter reads........	61	65.0
Whhn B_1 is selected, voltmeter reads........	61	68.0
When B_2 is selected, voltmeter reads........	61	68.5

When line switches were open, giving the first column of readings the house or station primary circuit was connected where it taps the fuses. Do these readings indicate a condition of station and outside lines being grounded? If so, how seri-



Ground Detector Diagram.

ous are the grounds? If not, what is the explanation of the readings of the voltmeters? Is there naturally and normaly a difference of potential between the ground and any conductor of a high voltage system?

QUESTION NO. 8.

Do members experience trouble with cotton gin loads on account of large motors used and consequent demand on the station at no regular period? ,, nat rates have been found suited for this load?

Answers to Questions.

QUESTION NO. 1.

What is standard practice regarding the use of an air chamber on discharge line boiler feed pumps?

With any cold water pump, it is standard practice to use an air chamber. Therefore when a closed heater is used and cold water pumped to it, the air chamber will be found as a part of the pump. When an open heater is used and the warm water flows to the pump, the air has already been removed and the air chamber is not necessary although in same cases it is found.

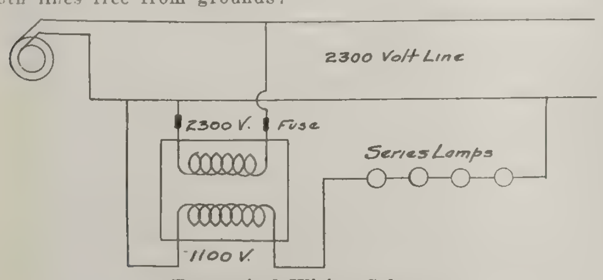
QUESTION NO. 4.

A station wishes to run 2,300 volt, three-phase lines a distance of 120 feet along a vertcal wall, about 20 feet from the floor. Is the use of porcelain insulators good practice? How far apart should the lines be supported? What should be the spacing of the supports of one line? If porcelain insulators are not recommended, what are most used?

For a substantial and permanent job it is probably best to use lead-covered cable in this case. A cheaper and serviceable wiring is secured, however, by use of B and D cleats for 2,300-volt work spacing wires about 8 inches apart and the cleats at a distance of 4½ feet apart.

QUESTION NO. 6.

A plant, to save some line copper, desires to use the above connection. What are the objections, supposing simultaneous grounds should occur on primary and on incandescent circuits, of greater or less serious nature? What objections, supposing both lines free from grounds?



Economical Wiring Scheme.

It seems to the writer that the scheme shown is in its essentials a 3-wire system and should work all right when free from grounds. Such wiring is in operation to the writer's knowledge and no trouble has been heard from it. If simultaneous grounds occur as mentioned a lamp or so may be lost or the fuses blow. If transformer is overfused it may burn up in such a case.

QUESTION NO. 7.

How do member-companies store and care for their reserve supply of transformer oil? When moisture is suspected, how do you test it? When moisture is found in the oil, how do you remove it?

This subject was thoroughly discussed in an article on page 493 of the November issue of SOUTHERN ELECTRICIAN. How to detect and how to remove moisture were points especially covered.

Conduit Construction—Recommendations of National Electric Contractors' Association.

It is evident that the tendency of the times on the part of architects, engineers, inspection departments and municipal authorities is toward the requiring of metallic conduit for the installation of wires in buildings. Recognizing this tendency, the National Electrical Contractors' Association, through its executive committee, has been working on the preparation of reliable data in regard to the proper size of conduit to be used in installing wires and cables. The recommendations of this committee is now available in the form of charts.

The charts show the conduit and conductors in full size, and the prints are made from plates so that there can be no variation in size, and the sheets are mounted on heavy board with an eyelet at the top for convenient hanging. In addition to showing the size conduit needed for such combination of wires, the charts give the actual external diameter of the conduit, and the carrying capacity of the wires shown. The complete set comprises six charts, and give proper sizes of conduit for one, two, three, four and convertible three-wire systems; combinations of duplex wires in sizes number ten, twelve, and fourteen B. & S. Gage; single wire combinations of number 14 B. & S. wire up to ninety wires; combinations of number 16, number 18 B. & S. fixture wires up to one hundred and fifty wires, and combinations of telephone wires up to fifty pairs. This covers practically all of the data required for the installation of wires and conduits, and presents it in a form most convenient for use. The table here shows the data contained on one of these charts for 2-wire systems.

The advantage of a standard system is self-evident from the standpoint of the architect, engineer and contractor, and it is the hope of the National Electrical Contractors' Association that those having to do with the installation of conduits will accept the charts as prepared and write into their specifications that, "the sizes of all conduits shall be the N. E. C. A. standard." The National Electrical Contractors' Association has borne the work and expense of the preparation of these charts and in the interest of standardization is prepared to furnish them at the actual cost of producing them, and will forward a set securely boxed on receipt of $2.25. Orders for them or requests for further information should be sent to H. W. Morton, secretary, 41 Martin Bldg., Utica, N. Y.

New Business Methods and Results.

Representing Interests of Central Station, Electrical Jobbers, Dealers and Contractors.

A Review of Work Done and Plans for Future.

Before laying before our readers the topics to be taken up in this section of SOUTHERN ELECTRICIAN during the next few months, we may profitably devote a little space to a review of the subject-matter which has been treated thus far. Our discussions up to this time have been very largely general in nature, endeavoring to cover, as nearly as possible, the entire field of central station activity. The subjects which we have taken up may be divided into two general classes. First, those relating to the central station itself as an organization, taking up the functions of the different departments, and secondly the relation which the central station bears to the manufacturer, the electrical contractor, its competitors, its customers, the constituted authorities, and to the public at large.

This section devoted to New Business Methods and Results was started in the April, 1912, issue and in that number the relation between the central station, the contractor and the manufacturer was treated. This discussion brought out interesting facts and while there were a number of different opinions expressed, the general feeling of the contributors seemed to be that the field of operation of the parties concerned could be quite definitely defined and that what is needed most just now, is co-operation, or rather a willingness to co-operate, instead of a quibbling over things which are or which should be forever settled. This co-operation is not only desirable, but necessary for the development of the entire electrical industry.

The relation of the central station to its competitors has not so far been treated except in a short editorial regarding isolated plant competition. We intend in this number to present some additional matter on this subject, and trust that it will call for comments from those who are interested.

Another share of our discussions has been devoted to relations with the public and with the customer. First, as regards general matters of public policy, including a consideration of the duties and privileges of a public service corporation in those relations which the name indicates and secondly the general character of the service which is designed and required to keep the favor of the public. The questions of public policy and of good service are capable of considerable expansion, and detailed treatment. For this we must look largely to our readers and contributors, and hope to receive any thoughts which may have any bearing in their minds on these subjects.

The more specific questions of business getting, as might be inferred from the very name and aim of this department have been and will naturally be kept well to the front. So far we have considered wiring campaigns for residence business, summer campaign for irons and other appliances, schemes for Christmas business, and have touched upon the questions of advertising and display as aids to direct solicitation. Some little space has been devoted to a consideration of the internal organization of the central station, particularly as regards the commercial department, having considered in one article its general functions, and in another its organization and methods more in detail.

The commercial side of the rate question has been rather fully treated and was the subject of a number of interesting communications. While there were many individual opinions expressed, there appeared to be an underlying feeling of unanimity in regard to certain basic principles, indicating that opinion on the rate question is becoming somewhat crystallized. It is quite well recognized that the separation of the fixed and variable charges forms the only accurate basis for rate-making, the only difference of opinion being as to how to express these factors simply, yet equitably. The discussion however, seemed to be incomplete in that the technical considerations were more prominent than the commercial, and also in that there was too little interest taken in the controlled flat rate, which is proving itself to be one of the biggest business-getters introduced in the history of electric lighting. Evidently it is a difficult matter to get away from the scientific and technical point of view in dealing with rates.

PLANS FOR THE FUTURE.

During the next few months it is our intention to treat some of the commercial central station subjects somewhat more in detail. For instance, we shall take up specific methods of getting business and the overcoming of competition, to be illustrated with examples from actual experience. The different classes of business, such as residence, commercial, power, signs, etc., will be considered separately. We will also take up in detail the questions of advertising and display. As regards organization we shall endeavor to show the advantages of system as applied to commercial department records, and to give some methods which have been tried and found effective for increasing the efficiency of a selling organization. We will also consider the fields to be worked by the specialist on power, illumination, electric advertising, etc., showing what can be done by making a special effort to secure these classes of business.

Herewith is a tentative schedule for the first six months of 1913, showing the topics assigned for each month. We hope that our readers will study this schedule, enter into the spirit of it and submit ideas or the result of experience. If, on the other hand, information along certain lines of work not set forts is desired, the editors of this department will be glad to know about it, and render every assistance.

January. The relation to competitors and the management of combination gas and electric properties.

February. The nature of contracts, policies in regard to deposits, billing, service charges, extensions, etc.

March. Handling of complaints and delinquencies. Points of contact with the customer.

April. Spring campaigns for current consuming appliances. How to make the summer day-load profitable.

May. The opportunities for a special power engineer in the average central station field, and in the field of a transmission company. Nature of his work, and cases where profitable results have been secured.

June. The field of the illuminating engineer. Nature of his work and the results such men are accomplishing.

Central Station Competitors.

The competitors of a central station in the lighting field, barring those unfortunate cases where there are two or more electric light companies in the same community, are principally oil, gas, gasoline, and acetylene. Of these, gas including both the natural and the artificial, is the only one exploited by a public service corporation and is therefore practically the only organized opposition that the central station has to meet. The use of oil, gasoline or acetylene is altogether an individual matter, the only semblance of any concerted action coming from the manufacturers of gasoline lighting, or acetylene lighting apparatus. Of these factors, we may safely neglect acetylene altogether as only in rare instances does it come into direct competition with electricity. The cost of light as produced from calcium carbide is in nearly all cases greater than that of electric light with tungsten lamps, and the advantages of convenience, safety and cleanliness are all on the side of electric light.

Gasoline, while not a serious competitor in the sense that it has been able to take any large quantity of business from the central station, is nevertheless quite active in some places. The place it does occupy has been secured principally on account of a very low operating cost, for gasoline gas when used with mantles, is by far the cheapest form of light in existence, being only approached by natural gas. There is, however, offsetting this advantage, a considerable disadvantage in the necessity to start the process of vaporization each time the light is required. This renders it unsuitable for any purpose besides lighting stores, halls, or places where the whole equipment can be started and extinguished together. Another very serious objection to the gasoline system is the danger incurred in its careless use. The danger is not particularly in reference to the lamps or generating system, but that which is inseparable from the storing and handling of gasoline. It would seem therefore, that a truthful, candid presentation of the facts should be able to keep competition from this source at a **minimum.**

Oil is not a serious competitor of electricity, since the great advantages of electric light are so manifest that most users of oil quickly discard it when they can get electric service. Electric light, with tungsten lamps, when compared with the larger types of kerosene lamps is chaper than kerosene, so that practically the only objection that can be made by the user of oil, is in reference to the cost of installation.

The gas interests are well organized, and many places are conducting very aggressive campaigns in competition with central stations. It is indeed curious that gas and electric lighting have each been greatly and simultaneously improved in efficiency by the discovery and introduction of new devices such as the incandescent gas mantle, and the metallic filament lamp. Each of these have represented about the same degree of improvement, so that while it was a neck and neck race between the open gas flame and the old carbon lamp, so today it is about even between the tungsten lamp and the latest types of inverted gas mantle lamps. The newer forms of electric light are vastly better than the old gas burners, and vice versa. The Welsbach reflex oilers are just as superior to the old types of electric light.

As the commercial situation now stands, the problem is largely one of salesmanship, as is shown by the fact that in a town where one interest is well organized and the other is not, the business will be found divided just about proportional to the effort put forth to get it. The electric lighting companies in the face of active gas competition are thus required to keep a sufficient force of trained solicitors in the field and take advantage of all the arguments in favor of electric service. As regards the abstract merits of the illuminants, the central station certainly has the better end. The convenience, cleanliness, safety, and coolness of electric light are well known, and unless handicapped by cumbersome rates, these arguments should suffice to get the business. Gas has, if anything, the advantage in the way of cheapness, and has usually a further advantage as a first-comer, since it was customary to pipe buildings, some time before it was the usual thing

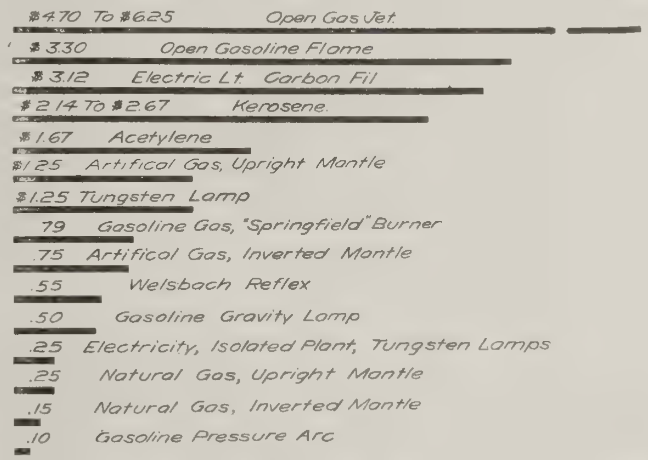


CHART SHOWING COST OF PRODUCING 100 CANDLE POWER FOR 100 HOURS, OR 10,000 CANDLE HOURS—FUEL COST ONLY.

to wire them. Gas has a further advantage that gas mantles are very cheap, while people are yet hardly used to paying for tungsten lamps even though the cost for the smaller units is on a very popular price basis. The comparison yet in the minds of the public generally is really to some extent between the gas mantle and the carbon filament, which is a handicap to electrical development which must be overcome by educational methods. Until such a time the competition between gas and electricity is rendered very keen, because they are so evenly matched. Fig. 1 represents graphically the relative costs of the illuminants that have been considered.

With the centralization of capital, an increasing number of properties are found in which the electric and gas interests are consolidated. This presents a new problem in the handling of new business campaigns, under such conditions. To cease all efforts for new business because of a monopoly would be foolish, and to spend large sums of money in wasteful competition would be equally so. A little study of the field will show that there are large opportunities for business along either line which can not well be taken by the other, and that in order to get the best results and secure all the business possible, each line must be developed systematically and in a measure, independently.

As regards the best organization in such cases, there are a few concerns in which the same solicitor handles both classes of business; there are others in which both are handled from the same office and under the same management, but with different solicitors. The majority, however, appear to have separate departments altogether, with separate heads, but both responsible to a single general manager. This is doubtless much the best plan when it can be adopted, for it leaves each department free to work up the business to the best advantage. The first plan is not good because it encourages the solicitor in assuming an arbitrary attitude. He thinks that it matters little particularly which illuminant he talks up, the customer must have light, and the revenue all comes to one company in the end. The second plan of having both kinds of solicitors in the same department is too apt to create internal friction, and working at cross-purposes. The combination properties are usually found in good sized cities where there is every opportunity to form separate departments, and the fields have less chance to overlap materially to a disadvantage.

The principles discussed here will cover the sale of appliances, electric and gas, and there should be no more confusion about this business than about the sale of the service. The electric division will of course, put out electric irons, while the gas department will just as vigorously try to place gas irons. The fact that different solicitors from the same company work in real competition will of course fool no one, yet it is good for the men. It sets a pace for them, and in effect, as long as care is taken to prevent the friction of wasteful competition, it will stimulate both branches of the business.

Regarding street lights, there is very little real competition. There has been no development in gas lighting which can approach the luminous arc in its effect upon street illumination. We have, it is true, a few gas "white-ways," and others may spring up here and there. Small towns and the outlying sections of cities are often lighted by incandescent gas lamps on low posts, set three or four to the block, and for this purpose they are much better than arc lamps a block or so apart, often defeating their purpose by their very brilliancy. In general, electricity controls street lighting, and we see no evidence of any sweeping change in this respect.

It should be hardly necessary to say anything about the ethics of competition. All competition is more or less wasteful, but under our present economic system it is bound to exist and while it can not be prevented, we can at least use our influence to lessen its abuse. The securing of all business should be by fair means, guarding against taking advantage of competitors, whether by untrue representations, or even in disparaging remarks, though they may be true. It is very doubtful if any real good is ever accomplished by such means. A consideration and application of the Golden Rule in dealings with competitors, together with an assurance to customers of a square deal, will result in a goodly share of the available business.

When rival electric light companies occupy the same field, the action to be taken in regard to new business matters depends entirely upon the circumstances. If a union is possible, it should by all means be effected. Duplication of equipment and distributing system represents a large waste to no purpose. If a union can not be effected, the only plan is to put out a strong soliciting force, and without putting any undue pressure upon the customers of the opponent, scour the town for every non-consumer, at the same time strengthening the position with the public. The opportunity for a merger will soon appear.

In the case of municipal competition the problem is different. Usually it is the fault of the central station that the municipal plant exists. Most plants of this kind are a protest against high rates, poor service, or both, and could have been prevented. However, and fortunately, the average municipal plant is not a howling success. Many of them have failed utterly, many more are just hanging on and extremely few are making money. These remarks are not directed willfuly against municipal ownership in the abstract, yet it is a sad fact, too true, that it seems impossible to get any set of men enough interested in civic matters to manage a public enterprise as efficiently as they would their own business. Whether conditions may change very much in the future, of course, we can not foretell, at present conditions are on the side of the central station. A. G. Rakestraw.

Washington Devereux, Electrical Engineer, Philadelphia Fire Underwriters' Association, On Co-Operation Between Electrical Inspectors, Central Stationsand Contractors.

Editor Southern Electrician:

An article that particularly interests the writer in your November issue is one entitled, "Better Electrical Construction and How to Eliminate the Political Inspector." Well, I know some political inspectors who are mighty good and very capable men. I know some underwriter inspectors of whom I can say the same, and then again I know some of whom I do not care to say anything about. However, having been moving along co-operative lines for more than a year I have had in mind the formation of a society which will carry out the direct principles of Jovianism, namely, co-operation. For the last six or seven years I have been holding meetings of the inspectors of our department every two weeks, on the second and fourth Thursday of the month. The meetings are called for seven thirty, and adjourn about ten thirty p. m. The object is to familiarize the inspectors with the code so that in ruling on jobs there is small liability of an inspector in one section of the city ruling differently from an inspector in another section of the city.

Three months ago I requested the inspectors and the district managers of the Public Service Corporation, which is the Philadelphia Electric Company in this city, to attend our meetings, also the municipal inspectors and the electrical contractors. The contractors were also asked to invite their superintendents and foremen, or any of their mechanics whom they thought would be interested in a meeting whose object was co-operation. At these meetings we talk over the Code and regulations, ask for suggestions, how the underwriters' inspectors can best co-operate with the interests and how the various branches of the electrical industry can co-operate with a view of building up the electrical industry in our territory. These meetings have proved most interesting and instructive. They are called in the offices of the Fire Underwriters' Association, and at the last one we had seventy-five present. A number were unable to attend the meeting, as the room was not large enough, the seating of seventy-five persons being the capacity of our board room, and the Philadelphia Electric Company, through President Joseph B. McCall, has very kindly advised us that they would give us the use of their library on the sixth floor of their building at Tenth and Chestnut streets for future meetings.

It is my belief that in bringing all the electrical interests together and talking over matters once a month, explaining blanks and forms used by the inspection department, how they should be properly filled out and the necessity of properly following instructions in order to facilitate not only office work, but the ultimate result, namely, of having current properly introduced in the building, also the explanation of blanks made for the application of current from Public Service Corporation, and office and inspection practices, the methods of making electrical installations, etc., will be most beneficial to all interested.

A question box is provided and questions between meetings are taken up by a special committee and answered to their satisfaction, and are read at the subsequent meeting. Sections of the National Electric Code are read at the meeting and their meaning explained, as for instance, a contractor or a mechanic will ask under Rule 1-B, "What do you mean by hazardous process?" Then such processes are explained, as for instance, he is told that in saw mills, candy factories, flour mills, or in fact in any establishment where vegetable dust and finely divided particles are floating in the air, such processes are defined as "extra hazardous." Such a paragraph and explanation may take up the greater part of an evening, but the time is surely well spent, and I know that you will agree with me that such work in five years' time will show a marked improvement in methods of installation because a mechanic will not only understand the requirements of the Code as to installation, but he will understand the "why" of the rule, the ultimate result being high-grade efficiency on the part of the mechanic as a result of proper training.

A Device Committee to examine and explain all new devices pertaining to our work and get as much data as possible relating to these devices. A Membership and Attendance Committee, whose duties are obvious, with the addition that they welcome and introduce the members to each other, and promote good fellowship. A Papers and Meetings Committee to arrange for papers, meetings and subjects for discussion. A Library and Reference Committee, to look up all press articles, good books, references, etc., pertaining to our work. A Tabulated Data Committee, to tabulate such data and put same in a handy and concise form for use, such as greatest number of wires in a conduit of a given size, motor leads, etc. It would seem to me that this committee would fill a long-felt want, as there seems to be a difference of opinion about some of the most common things in our work. A Relations Committee to take up with other societies, associations, etc., such practices as we may deem advantageous to the industry. We think we have started something worth while and we call ourselves The Electrical Conference.

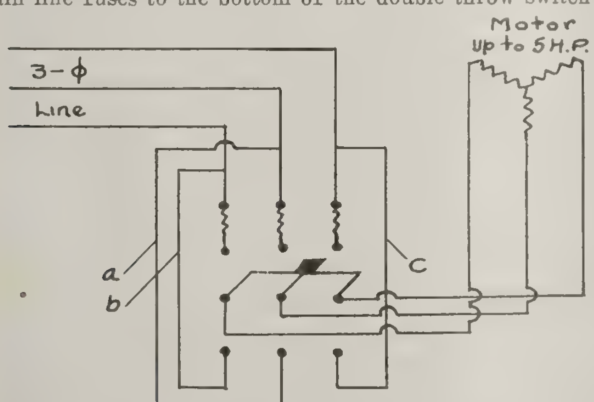
Questions and Answers from Readers.

We invite our readers to make liberal use of this department for the discussion of questions as well as for obtaining information, opinions and experiences from other readers. Answers to questions or letters need not conform to any particular style. All material is properly edited before publishing it. Discussions on the answers to any question or on letters are solicited, however, the editors do not hold themselves responsible for correctness of statements of opinion or fact in discussions. All published matter is paid for. This department is open to all.

Wiring for Starting and Running of Induction Motors.

Editor Southern Electrician:

(342) There has been considerable discussion in the writer's section on the subject of wiring small 3-phase motors. The sketch shown here brings up the points in question. Are the shut taps (a), (b) and (c) from above the main line fuses to the bottom of the double throw switch in



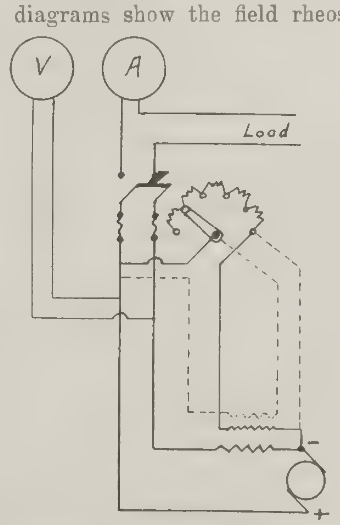
Connections for Starting an Induction Motor.

accordance with the code rules? If not, what are the required changes to comply with the code and the reasons for such changes if required? J. M. S.

Connections to Switchboard for Compound Machine.

Editor Southern Electrician:

(343) The writer shows here the connections for a compound wound generator as are found in electrical books and the catalogs of manufacturers. It is found in some cases that the diagrams show the field rheostat connected



Connections for Compound Wound Generator.

between the field and the line switch and sometimes connected between the field and the armature terminal as shown in the dotted connections of the diagram. I would like to know which connection is preferable and the reasons for or against either connection. Also, it is found that the ammeter is in most cases shown connected in the positive side of the circuit. Is there a reason for this? The writer has thought that this is done so as to protect the instrument from the sudden rush of current through it when the load circuit was closed, that is, the load acts as a brake on the current and the instrument thus stands protected to a certain extent more on the positive than on the negative side. If this reasoning is not correct, the writer will like to know it. M. M. R.

Comparison of Shunt Motor and Watthour Meter Operation.

Editor Southern Electrician:

(344) The commutating type of watthour meter is often compared and referred to as a type of shunt motor. It is well known that the ordinary shunt motor will increase in speed if the field current is decreased. It is also well known that if the field current of a commutating watthour meter be decreased that the disc of the meter will also decrease in speed instead of increase. It would seem, therefore, that the operation of the meter and motor contradict the shunt motor principle. Perhaps some reader can explain this confusion in the next issue. Also please explain why no iron or steel is used in the magnetic circuit of the meter as is the case with the motor. H. B. D.

Cost of Various Types of A. C. Generators.

Editor Southern Electrician:

(345) The different types of alternators of same capacity, that is, the high speed, low speed, belted and direct-connected machines, vary in price. What are the factors entering into this variation in price and what are the combinations of such to give the lowest priced machine and the highest priced one? W. F. Still.

Transformers Siphoning Oil.

Editor Southern Electrician:

(346) The writer is having considerable trouble with transformers siphoning oil at the bushings where the leads come through the case. Even with the insulation stripped off at the bend of the lead there is still some siphoning. If any reader can advise how to overcome this trouble it will be appreciated. A. R. H.

Size of Transformer for Induction Motor.

Editor Southern Electrician:

(347) I would like to request that some one submit for publication in the *Question and Answer* section of SOUTHERN ELECTRICIAN either a formula or a table showing how to determine the most economical size of transformer to use with the different sizes of motors. The table or formula should cover or apply to both single and three-phase motors of sizes from one to 50 horsepower. On 3-phase it is desired to know sizes for use of both two and three transformers. W. C. C.

Type of Lightning Arrester for Short Distances.

Editor Southern Electrician:

(348) Kindly advise through your columns the type of lightning arrester that is now considered the best suited for small plants up to 500 kw. and transmitting a distance not more than 5 miles. The arrester must be suited for operation on circuits of low power factors. M. R. R.

What is a Wattmeter Constant?

Editor Southern Electrician:

(349) I would like some reader to explain what a wattmeter constant is. Where is it found on the meter? Also give reliable method for testing recording wattmeters. Davis B.

Starting a Motor From Three Points. Ans. Ques. No. 330.

Editor Southern Electrician:

In reply to question No. 330 on starting a motor from 3 points, I offer the accompanying diagram. In this sketch, M is a three-phase motor, A and C are double pole, double throw switches, while B is a four pole, double throw switch. Two double pole, double throw switches may be used at B by properly connecting the handles so that the switches can be operated together.

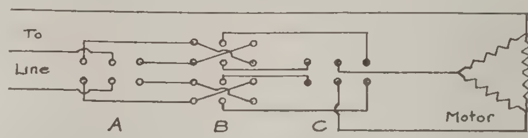


DIAGRAM FOR STARTING A MOTOR FROM 3 POINTS.

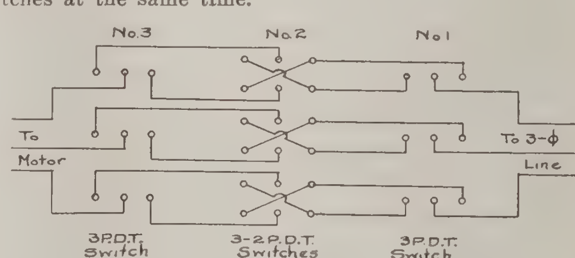
The diagram needs no explanation except to state that the switches must always be left in the closed position either to the right or the left. The operation is as follows: Say, for instance, that all three switches are closed to the left and the motor is not running. It may be started by throwing any one of the switches to the opposite position, and can be stopped from any one of the three points in the same manner.

As these switches only break two sides of the circuit, a three pole switch and fuse block should be placed between this wiring and the line. Fred P. Brien.

Starting a Motor From Three Points. Ans. Ques. No. 330.

Editor Southern Electrician:

In answer to question 330 in the November issue, I wish to submit the following diagram for starting or stopping a three-phase motor from three or more points. Two tripple pole, double throw switches and three double pole, double throw switches are required to start from three points. The double pole, double throw switches should be set in a row and a bar fastened to the handles or the insulating strips across the blades so it will be necessary to work all three switches at the same time.



CONNECTIONS FOR STARTING A MOTOR FROM 3 POINTS.

If the motor is running, it may be stopped at either one of the three switches. If switch No. 1 is opened to stop the motor, it must be closed in the opposite direction so the motor can be started from another point if desired. By referring to the diagram, it will be seen that all switches must be closed in one direction or the other whether the motor is running or not.

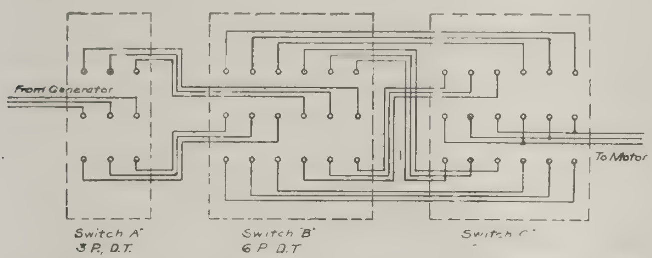
If it is not objectionable to have one wire connected direct to the motor, an arrangement using five double pole, double throw switches can be used, which will cheapen the installation. A. L. Utz.

Starting a Motor From Three Points.

Editor Southern Electrician:

In answer to Question No. 330, in the November issue, the accompanying diagram shows the wiring and connections necessary for the control of a 3-horsepower, 3-phase, 220-volt motor, from any one of three different locations.

The three switches, marked A, B, and C, in the diagram should be located at the points from which it is desired to control the motor. The motor can then be started or stopped by reversing the position of any one switch, regardless of how the other switches are set. In operating with this connection, it is necessary that all switches be closed in one position or the other, and not be left standing open. The choice of switches for any given location should be made with a view to saving wire, since there are twelve wires between Switches B and C, and only six wires between A and B.



WIRING SCHEME FOR STARTING MOTOR FROM THREE POINTS REGARDLESS OF POSITION OF SWITCHES IF CLOSED.

Since a 3-horsepower induction motor may be thrown on the line at full voltage, without damage, no starting devices are necessary. One three pole, double throw knife switch and two six pole double throw knife switches comprise the entire equipment (excepting wire), assuming that the switches are mounted and equipped with terminals on the different contacts. The phase rotation of the currents in the three wires to the motor is the same as in the three wires from the generator for all positions of the switches, hence the direction of rotation of the motor will always be the same. C. S. Stauffer.

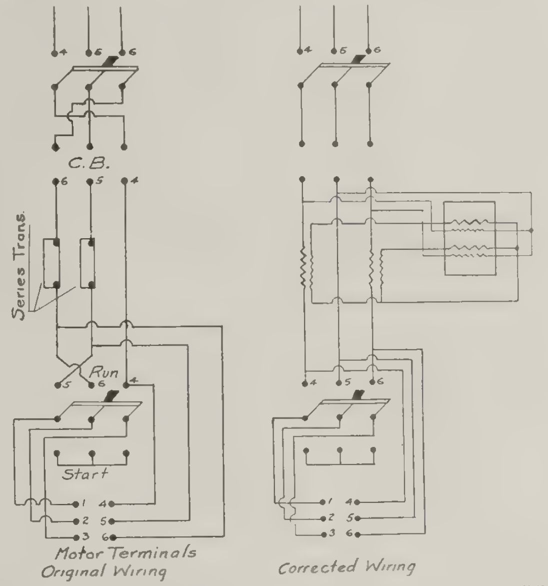
Induction Motor Wiring. Ans. Ques. No. 340.

Editor Southern Electrician:

I have examined the wiring diagram shown with Question 340 of the December issue, and have worked up another diagram which I believe answers the questions by J. G. My diagram is shown by the side of the original diagram so that the changes can be compared. In studying T. G.'s wiring I note that the terminals at the motor are numbered in order from 1 to 6, and that the connections to the line are in the order 4, 5, 6. In tracing out the connections to the line switch it is found that the order of the line wires in the diagram reading from left to right is 4, 6, 5. In view of the fact that the numbering at the motor is probably correct, it is to be supposed that either the connection from the terminals 5 and 6 to the line above the running side of the switch were changed by mistake in making the sketch of connections or that the direction of rotation of the motor has been changed at some time by changing these connections. In the diagrams shown the connections are made assuming that the order of connections at the motor is correct and that the proper connections from the motor will give the right direction of rotation. If these changes are made and the rotation is not correct, changing connections marked 5 and 6 at the motor will give the reverse rotation.

It is a difficult matter to endeavor to explain why the connections as shown by J. G. were made other than to say that the wireman who connected the motor knew little about induction motors and simply made changes in the connection until the motor would operate and in this case he happened to change the phases in one place so that the relation through changes in another made the motor run.

Since the Westinghouse CCL motor is a polyphase type the circuit on which it should be connected would have 220 volts between any two wires. The meter would register the power consumed if the series transformers are connected as shown only when the circuit is balanced as far as load is concerned. It is usual to connect the transformers in the outside lines and take voltage between the middle wire and each outside as is shown in the diagram I have drawn.



ORIGINAL AND CORRECTED WIRING FOR INDUCTION MOTOR.

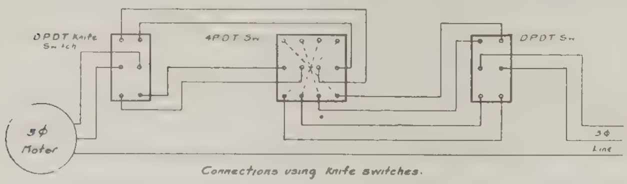
The reason for the wiring at the switch mentioned, that is, the short circuiting of the starting side, is to make possible a star connection of the windings when starting. When running and the switch on its upper terminals, the windings are connected in delta. The star connection makes possible a reduction of current per phase in the proportion of $\sqrt{3}$ to 1 as compared with the current when started with a delta connection. The throwing the windings in star is practically equivalent to a series connection while the delta arrangement compares with the multiple arrangement. This form of starting gives about 75 per cent of full normal torque and is not recommended for motors larger than 5-horsepower. An interesting discussion on this form of starting is given by Mr. W. R. Bowker in his article on page 111, of the March, 1912, issue. This is one of a series on induction motors which it would be well for T. G. to secure. In regard to connecting the wattmeter, it would also be advisable for T. G. to read the articles recently published by Mr. Peck in SOUTHERN ELECTRICIAN. I refer especially to page 191, of the June, 1912, issue, taking up polyphase wattmeter connections. Alex. F. Willis.

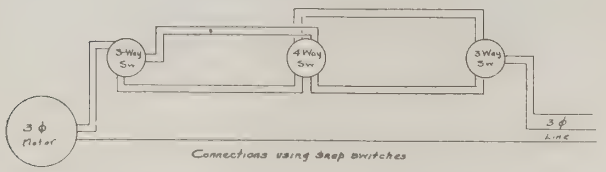
[Mr. Willis is right in regard to the diagram and the order of connections. In the sketch furnished by T. G. with the question, the connections from motor terminals 5 and 6 were made to the middle and left outside wire above the running side of the switch and not from terminal 5 to the left outside and 6 to the middle as shown. This error was made in preparing the drawing.—Ed.]

Operating Motors From 3 Points.. Ans. Ques. No.

Editor Southern Electrician:

The diagram shown here gives the connections for operating a motor from three points. The upper connections show the use of knife switches while the lower shows the





Connections for Starting Motor From 3 Points.

use of snap switches. This latter scheme will probably be best suited for small motors. H. D. Wheeler.

Design of Small Electric Furnace. Ans. Ques. No. 332.

Editor Southern Electrician:

It is quite possible to construct a furnace to be heated electrically according to the requirements given by T. E. B. in the November issue, however since the furnace is small and the temperature high, it is very probable that the electrically heated furnace would not prove satisfactory or economical. I have given in what follows the calculations for the size and amount of resistance wire required:

The heat required to raise and hold the air inside the furnace to 600 degrees can be expressed as follows:

W $\times$ Sp. Ht. $\times$ (T-t) = B. T. U. = Heat in air at 600° F.

5 $\times$ S (T-t) $\div$ Th = B. T. U. = Heat lost by radiation.

3400 B. T. U. = 1 Kw. Hr.

Therefore,

[W $\times$ Sp.Ht. $\times$ (T-t) Th + 5 $\times$ S (T-t)] $\div$ [3.4 $\times$ Th] = watts of electrc energy required to hold the inside temperature of the furnace at the required temperature or 600 degrees. In this equation W equals the weight of air in the furnace to be heated, one cubic foot which at a temperature outside of 62 degrees F is .076 pounds. Sp. Ht. is the specific heat of air in this case at constant pressure or 0.237; t is the temperature inside the furnace or 600° F. In the second part of the formula, the one for radiation, the constant 5 is B. T. U. per sq. ft. per deg. F. difference in temperature per hour; S is the sq. ft. of radiating surface of the furnace chamber in this case a cube whose edge is one foot giving a radiating surface of 6 square feet. T and t as noted above and Th the thickness of the furnace walls taken as 8 inches. Substitute these values in the formula, we have,

[.076 $\times$ .237 (600-62) $\times$ 8 + 5 $\times$ 6 $\times$ (600-62)] $\div$ [3.4 $\times$ 8] = 595 watts required.

Since a 110-volt circuit will be used 595 $\div$ 110 = 5.4 amperes and a wire must be selected with this value as the carrying capacity. Since all the electrical energy supplied the heating unit must be dissipated as heat, it can thus be accounted for electrically as I^2R. Thus I^2R = watts used by heating element. Substituting the values for I and watts required, the resistance of the wire can be found.

$$(5.4)^2R = 595$$
$$R = 20 \text{ ohms.}$$

From a Nichrome wire table, it is found that No. 18 wire at a temperature of 575 has a carrying capacity of 5.9 amperes which is ample for this case. This size of wire has a resistance per 1,000 feet at 575 degrees F of 415 ohms. Therefore, (1,000 $\times$ 20) $\div$ 415 = 48 feet of No. 18 wire required.

In regard to a comparison of heating the furnace by gas and electricity, since no particular gas was referred to, we will assume a gas of 700,000 B. T. U. per 1,000 cubic feet. Since 1 kw. hr. is equivalent to 3,400 B. T. U., then 700,000 $\div$ 3,400 = 206 or the kw. hrs. equal to 1,000 cubic feet of gas from a heating standpoint where all the heat is used to raise the temperature of the surrounding air. It is thus seen at the rate given by J. E. B. for electrical energy, 5 cents per kw. hr. the cost of 206 kw. hrs. is $10.30, while the cost of 1,000 cubic feet of gas is 75 cents, a comparison which is not at all favorable to electrical heating. However, since the furnace takes practically 0.6 kw. per hr., it would cost for an 8-hour day about 25 cents to operate it with absolutely no attention and an assurance that the heat is constant when once set for the proper temperature which in some work may be a consideration of value. Wm. S. White.

Changing Compound to Differential Motor. Ans. Ques. No. 341.

Editor Southern Electrician:

In answer to question No. 341 by Mr. A. C. H. Generally speaking, a cumulative compound motor would not run successfully as a differential motor by simply reversing the series fields, owing to the fact that there are usually so many turns in the series coils that the field would be weakened to such an extent that the motor would have a tendency to increase in speed considerably as the load was increased, and would take an enormous current.

If Mr. A. C. H. has a motor he wishes to change to differential, I would suggest, if it is a multipolar machine, with coils on each pole, that he cut out alternate series coils, and reverse the remainder, or if it is bipolar reverse one and cut out the other. If this should still weaken the field too much, connect a shunt across the terminals of the series coils to carry a portion of the current. The proper proportion for the shunt he can determine by trial.

C. A. Harman.

Tubes for Electrical Work.

Editor Southern Electrician:

In Fig. 1 is shown the form of tube most frequently used in electrical installations, and the accompanying table indicates its properties. These tubes can be obtained in many lengths, from the minimum given in the table, to the maximum. Usually the lengths increase by ½-inch increments for the different sizes. For ordinary interior house wiring, a tube 3½ inches long, ⅝-inch in external diameter and 5-16-inch internal diameter is most frequently used.

When purchasing tubes, the buyer should be careful to see that those that he buys are, as a rule, straight. Crooked tubes are hard to insert in holes bored through timbers, and if an effort is made to force them in, they are usually broken. If the tubes purchased comply with the under-

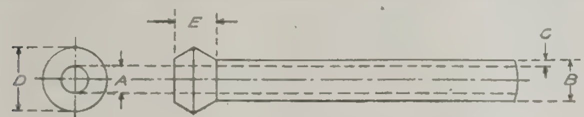


FIG. 1. STANDARD PORCELAIN TUBE.

writers' suggestions, the chances are that they will give satisfaction for ordinary work.

A Diameter of Hole	B External Diameter	C Thickness of Wall	D External Diameter of Head	E Length of Head	Greatest Length Made	Shortest Length Made
5/16	9/16	1/8	13/16	½	24	½
3/8	11/16	5/32	15/16	½	24	½
1/2	13/16	5/32	1 3/16	½	24	1
5/8	15/16	5/32	1 5/16	½	24	1
3/4	1 3/16	7/32	1 11/16	⅝	24	1
1	1 7/16	7/32	1 15/16	⅝	24	1½
1 1/4	1 13/16	9/32	2 5/16	⅝	24	2½
1 1/2	2 3/16	11/32	2 11/16	¾	24	2½
1 3/4	2 9/16	13/32	3 1/16	¾	24	2½
2	2 15/16	15/32	3 7/16	¾	24	2½
2 1/4	3 5/16	17/32	3 13/16	1	24	2½
2 1/2	3 11/16	19/32	4 3/16	1	24	2½

DIMENSIONS OF CODE STANDARD UNGLAZED PORCELAIN TUBES.

All dimensions are in inches. An allowance of one sixty-fourth of an inch for variations in manufacturing is permitted, except in the thickness of the wall.

G. B. SCHMIDT.

Porcelain Cleats for Supporting Electrical Conductors.

Editor Southern Electrician:

Porcelain cleats are used to support electrical conductors in dry locations. Where the conductors are exposed to dampness or to acid fumes, wires must be carried on knobs, because it has been found that the insulation resistance of cleats is too low for safety where dampness exists. Standard porcelain cleats are glazed and in two pieces, as shown in Fig. 1. Wire grooves for two-wire cleats are 2½ inches apart. Cleats for either two-wires or three-wires are commercially obtainable, as indicated in Fig. 1 and in the accompanying table. The three-wire cleats are used for three-wire, 110 and 220-volt systems, and sometimes for three-phase, 220-volt circuits.

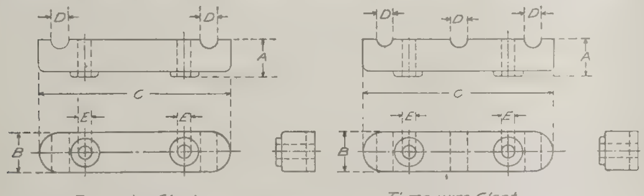


FIG. 1. TWO AND THREE-WIRE PORCELAIN CLEATS.

TABLE 1. APPROXIMATE DIMENSIONS OF TWO AND THREE-WIRE PORCELAIN CLEATS.

All Dimensions in Inches.

Sandard number	No. of wires	For Size Wires	A heig't	B width	C length	D groove	E Diameter screw hole
333	1	18-10	½	½	1 3/16	¼	3/16
* 333½			¼	½	1 3/16		3/16
334	2	18-10	1⅛	⅝	3 3/8	3/16	7/32
335	2	18-8	1⅛	¾	3 3/8	5/16	7/32
336	2	18-10	1⅛	⅝	3 3/8	3/16	7/32
‡ 337	3	See	Note	Bel	ow		
350	2	4-2	1½	¾	3 5/8	1/2	7/32

*No. 333½ has no groove and of itself could not be used as a cleat. It is simply a flat piece of porcelain to be used in combination with No 333; the screw holes of the two corresponding.

‡No. 337 is a three-wide cleat and can be made of the dimensions of Nos. 334, 335 or 336.

The type of cleat illustrated in Fig. 1 is seldom used for conductors larger than No. 14, as it is not particularly strong and is apt to break at the groove if it is used for carrying large, heavy conductors. For supporting larger conductors, single-wire, two-piece cleats, as shown in Fig. 2, are applied. A table of dimensions which were meas-

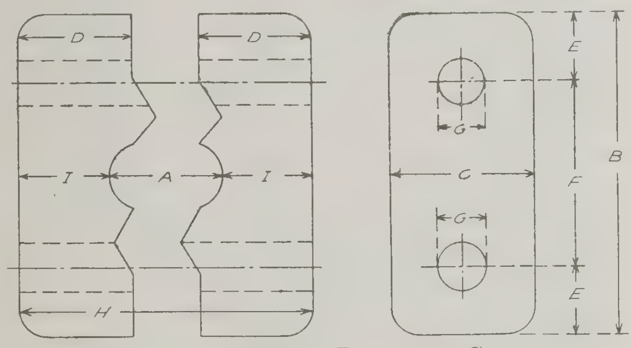


FIG. 2. B. AND D. PORCELAIN CLEAT.

ured from samples under the writer's direction, is given here and indicates the principle measurements. The type of cleat illustrated in Fig. 2 can be held to wood surfaces with round-head wood screws, and very often it can be applied to the members in structural steel buildings by using stove bolts.

B. THURN.

Note:—Nos. 1 to 3 inclusive are regular cleats, (as tabulated) approved for 300 volts, and Nos. 3½ to 4½ regular cleats, (as tabulated) approved up to 550 volts. If cleats Nos. 1 to 3 are desired for service above 300 volts, "Style A" should be specified, in which dimension I is 1 inch in every case.

TABLE 2. DIMENSIONS OF REGULAR STYLE B AND D PORCELAIN CLEATS.

NO.	STD. NO.	SIZE WIRE B. & S.	DIMENSIONS A MIN.	A MAX.	B	C	D	E	F	G	H MIN.	H MAX.	APPROX. PRICE EACH $
1	328	14 to 16	3/16″	3/8″	1 3/4	3/4″	5/8″	5/16″	1 1/8″	1/4″	1 1/4″	1 7/16	.01
1½	329	10 to 2	3/16	7/16	2 1/4	15/16	3/4	15/32	1 5/16	5/16	1 1/2	1 3/4	.016
2		2 to 0	3/8	1/2	2 1/4	1 1/16	13/16	15/32	1 5/16	5/16	1 5/8	1 3/4	.019
2½	330	0 to 3/10	1/2	5/8	2 11/16	1 3/16	1	17/32	1 5/8	5/16	2	2 1/8	.024
3	331	3/0 to 200000CM	1/2	3/4	3 1/8	1 1/4	1 3/16	5/8	1 7/8	3/8	2 3/8	2 5/8	.032
3½	331½	200000CM to 500000CM	3/4	1	3 3/16	1 5/16	1 3/8	5/8	1 15/16	3/8	2 3/4	3	.049
4	322	500000CM to 1000000CM	7/8	1 3/8	3 11/16	1 3/8	1 7/16	11/16	2 5/16	3/8	2 7/8	3 3/8	.065
4½	332½	1000000CM to 1000000CM to	1 3/8	1 15/16	5 3/8	2	1 15/16	7/8	3 5/8	9/16	3 3/4	4 3/16	.164

New Apparatus and Appliances.

The World's Largest Electric Clock.

The largest secondary electric clock in the world has recently been purchased and installed by the Edison Electric Illuminating Company of Boston, Mass. The clock is a part of the electric sign shown in the illustration presented here. It was designed and erected by Betts & Betts of 256 West 55th street, New York City. The sign, clock-dial and hands were furnished by the Federal Sign System (Electric), of New York. Mr. J. H. Betts, president of Betts & Betts, describes the sign and clock mechanism in what follows:

THE WORLD'S LARGEST ELECTRIC CLOCK.

"The sign is supported on a 40-foot by 50-foot framework carrying the word 'Edison' at the top in letters 8 feet high, and the words 'Power' and 'Light' at the bottom in letters 5 feet high. The outside diameter of the clock dial is 34 feet, the height of numerals on the face is 5 feet, the lengths of the minute and hour hands are 18 feet, and 14 feet, respectively, and the decorative and lighting effects are obtained by 6,500 incandescent lamps of many colors. The general design represents mermaids disporting in a fountain surrounding the clock dial. The electric fountains on each side of the clock contains 1,480 lamps which are operated by a 68 circuit high-speed flasher.

"The operating mechanism of this large clock is controlled by a master clock which automatically closes an electric circuit once every minute thus operating a 1-20 horsepower motor which in turn moves the minute hand of the secondary clock through a space on its dial equal to one minute and then the motor is automatically cut out again. The operating mechanism is arranged so that when the master clock requires setting, through a synchronizer, the secondary clock is caused to indicate the same time as the master clock. This feature as well as a self-winding attachment for the master clock are features which have been perfected especially for clock signs of this character."

Steel Taped Cables Versus Conduit System.

Success in present-day engineering is measured not alone by strength and efficiency, for beauty is at last recognized as a most essential element of the accepted design. Bridges and structures heretofore deemed satisfactory, if strong and serviceable, now create a storm of protest if the element of beauty is lacking. Likewise the appearance of street and boulevards is receiving a share of that attention which was formerly devoted to convenience and durability. Only a few years ago, our cities were in a maze of overhead wiring but now the wires have been placed underground in the larger communities; the smaller places, however, have been seriously hampered in their efforts to follow this praiseworthy practice because of the considerable cost of conduits for underground systems.

With the advent of steel taped cable, the way has been cleared for further progress along this line. Briefly, the steel taped cable provides an adequate substitute for the underground conduit system at a much lower cost. Its purpose is not to displace underground conductors in ducts where a permanent, flexible system and provision for suitable future growth is necessary but rather to fill a particular need for which the conduit system is neither adapted nor required. This field includes the smaller cities, suburban districts, parks, private estates and manufacturing plants where local conditions do not justify the expense of a conduit system and where flexibility is unnecessary.

Southern and Western cities are considerably in advance in the installation of such underground systems. Austin, Texas; Galveston, Texas; Lansing, Michigan; Wausau, Wisconsin, and Warren, Ohio, are among those which have used steel taped cable in their ornamental street lighting systems. Kendallville, Indiana, and Henderson, Kentucky, have employed it in connection with the decorative lighting of their public parks. These cities have used a regular

FIG. 1. PARK LIGHTING USING STEEL TAPED CABLE, HENDERSON, KY.

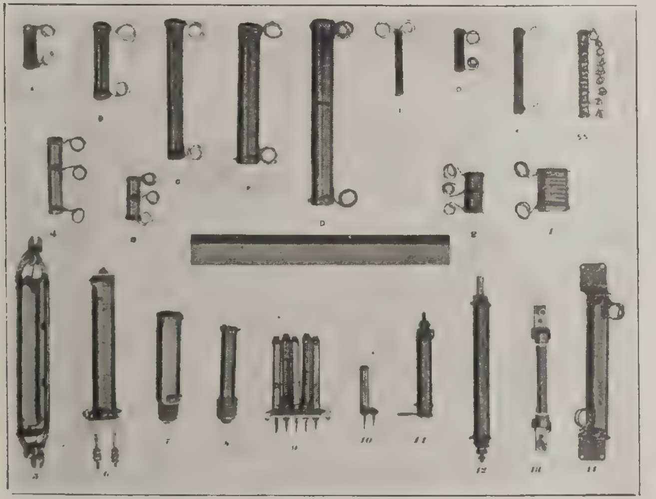
FIG. 2. LAYING STEEL TAPED CABLE IN PARKWAY, KENDALLVILL, IND.

lead-covered cable served with jute and tar over which are two winds of steel tape in reverse directions with still an overall serving of jute and tar as manufactured by the Simplex Electrical Co., of Boston, Mass. Other Southern and Western cities in which steel taped cable has been successfully used are Birmingham, Ala.; Denison, Texas, Manhattan, Kansas; Billings, Montana; Basin, Wyoming, and Casper, Wyoming.

The experience of these cities has shown a material saving in initial cost, due not only to the cost of the cable itself but to the difference in the time and labor of constructing a conduit system and drawing in the regular lead-covered cable in the ducts over the installation of the steel taped cable. While plans and expert superintendence are essential in the construction of a conduit system, the steel taped cable is laid in a narrow shallow trench and the earth replaced. The service record of this ready-made cable-conduit system has been so satisfactory as to give assurance of its complete success in the work for which it has been adopted.

Ward Leonard Enameled Resistance Units.

The accompanying illustration shows the relative sizes, and methods of mounting the various resistance units manufactured by the Ward Leonard Electric Co., of Bronxville, New York, and designed for the requirements of telephone, telegraph, signal work, small rheostats, etc. Each of these units is composed of a porcelain tube wound with a special resistance wire of zero temperature coefficient, the wire being held in place by a covering of vitreous enamel. These units are covered by patents and said to be the only commercial forms of high resistance having a material for which is claimed no temperature co-efficient.



WARD LEONARD ENAMELED RESISTANCE UNITS.

The copper connecting wires or terminal leads consist of round copper braids each composed of a large number of flexible copper wires. Grounding is prevented through the support of the most perfect insulating material. The manufacturers state that the finest wire when properly imbedded in the special enamel used for the resistance units is entirely free from any mechanical strain due to the heating and cooling and is perfectly protected against all oxidation or other chemical depreciation, such as is invariably met with when fine wires are exposed to the air or imbedded in many of the other insulating materials that are often used.

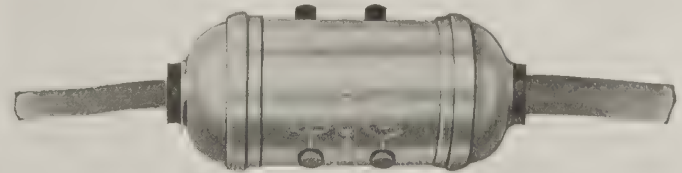
For a radiating capacity of ten amperes or higher, in such sizes the resistive conductor is made of a large number of small wires braided into a wide flat open wire mesh. This braid has a practically zero coefficient and owing to its extreme flexibility, lies close against the tube, thus allowing a very perfect coating of enamel to be applied. With this type there is no spitting of molten metal as is often the case when wires having large ampere carrying capacity burn out. Should a burn-out take place with the resistive conductor described, each small wire will burn out separately and the same result will be found as would be the case with an enclosed type fuse.

The units described here can be mounted in practically any desired manner and through an arrangement in banks any desired capacity can be secured.

New Three Heat Cord Switch for Heating Devices.

There are many electric heating devices now on the market that are designed to operate at several heats. Such devices as electric water urns, chafing dishes, heating pads, frying pans, table stoves, tailor's irons, etc., are advantageously operated at a low heat, medium heat and high heat. For the convenient control of these devices The Cutler-Hammer Mfg. Co., of Milwaukee has augmented its line of feed-through or cord switches by the addition of a three-heat brass shell type as shown in the accompanying illustration. This switch can be placed on the cord in the most convenient location for operation.

There are two push bars each having a light and black button which operate twin mechanisms so arranged that the pushing of one light button gives low heat, while the other, operated alone gives medium heat. The shell is plainly marked so that the operator may know which button to press for low and which, for medium heat. To get high heat both are pushed. The operation is positive and snappy, and one hand only is needed for the manipulation of the push buttons. As can be seen from the illustration two conductor cord is required to connect to the socket



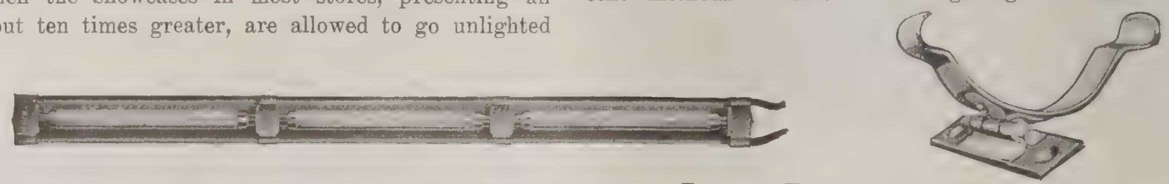
THREE HEAT CORD SWITCH.

or receptacle and three conductor cord is needed to connect the switch to the heating device. The brass shell is finished in polished nickel like the single pole cord switch, No. 7040. The rating of the new three-heat switch, which is known as No. 7044 is 6 amperes, 125 volts, 3 amperes, 250 volts.

Show Case Lighting in Stores.

It is beyond the conception of the illumination engineer why the average central station man will jump at the opportunity afforded for lighting a few feet of show windows when the showcases in most stores, presenting an area about ten times greater, are allowed to go unlighted and neglected. Consider this isolated instance. In a recently completed modern department store of the east there were only 250 feet of show windows to light; while the inferior of the store contained an aggregate of nearly 4,000 lineal feet of cases, an opportunity for the sale of about 16 times as much current. The average store does not have 4,000 feet of showcases, however it does have a sufficiently large number to make a very inviting proposition. Probably the current man would hesitate to believe at first reading that only from the 25 to 45 per cent of the stores of this country use any showcase lighting at all. And, more a large proportion of the percentage is most inadequately lighted, so that additional current could be judiciously used in connection with a properly designed reflector system with a noteworthy increase in display efficiency.

Ordinarily, four 25-watt lamps will suffice to satisfactorily light each eight lineal feet of case. But a very good rule to follow for the proper showcase standard of illumination is approximately double the exterior general illumination. Experience has shown that an intelligent consideration of these two figures will enable any central station solicitor to make recommendations that can be safely relied upon to secure desired results, and assure in many instances much new business in a field which has as yet been only "scratched" on the surface. One of the most recent methods introduced for lighting showcases is the Linolite system of illumination made by the H. W. Johns-Manville Co., New York, which consists of a tubular electric light nearly a foot long with the filament stretched out straight. These lamps complete with reflectors only occupy a space 1½ inches deep by 2½ inches wide and can be easily attached to or detached from the case by means of spring clips. These clips are readily adjusted to the interior of the showcase and firmly support the removable shell in its proper position. An ornamental or plain standpipe or wire conduit is then run down in a corner and through at one end of the case into an outlet box under the base of the case. A single pole flush switch is usually provided for the outlet box so that the lights of each case may be individually controlled when desired.



LINOLITE REFLECTOR FOR SHOWCASE LIGHTING AND DEVICE FOR HOLDING SAME.

Southern Construction News.

This department is maintained for the contractor, dealer, jobber, manufacturer and consulting engineer. The material is obtained from various sources and includes the latest information on new Southern engineering and industrial enterprises. We ask the co-operation of new companies by furnishing authentic information in regard to organization and any undertakings. We also invite all those who desire new machinery or prices on electrical apparatus to make liberal use of this section. No charge is made for the services of this department. Every effort is made to avoid errors in any item, and if such occur, we want to know about them.

ALABAMA.

BIRMINGHAM. The Alabama Interstate Power Co., has recently closed a contract with the Westinghouse Electric & Mfg. Co., for four 1,350 kva. 6,600 volt, 60-cycle vertical generators and thirteen 4,500 kva. single phase transformers to step the voltage up to 110,000 volts, seven 4,500 kva. transformers stepping the 110,000 volts to 13,200 volts for use. This equipment will be used in the hydro-electric development which the company is constructing on the Coosa river.

TUSCALOOSA. The Tuscaloosa Ice & Light Co., is to make an extensive improvement, the cost being approximately $100,000.

FLORIDA.

OCALA. The Florida Power Co., is to install a 1,200 kva. three phase, 60 cycle, 2,200 volt G. E. generator and a S. Morgan Smith water wheel. It is also understood that ornamental street lighting will be installed at this place.

ORLANDO. The city has voted a bond issue of $10,000 for the purchase of electrica lequipment from the Orlando Water & Light Co. The new system will be under the charge of J. L. Minnis.

PENSACOLA. An issue of $40,000 in bonds has been submitted to the voters of Pensacola, $100.000 of which is to be used for an electric light plant and $100 used for connecting railroads.

SHIPLEY. Messrs. Hall and Gotha have applied to the city council for a franchise to install an elelctric light plant. It is understood that an ice plant and cold storage plant will be constructed in connection with this plant.

GEORGIA.

ADAIRSVILLE. The Georgia Railway & Power Co., has been granted a franchise to enter and sell electrical energy in Adairsville.

CANTON. There will be installed in the municipal electric light plant shortly a one 100 H.P. boiler, one 100 kw. 2,300 volt, 60 cycle alternating current generator, and one 150 H.P. automatic engine. Also switchboards and other auxiliary apparatus.

CARROLLTON. It is understood that the Atlanta-Carrollton Railway Co., is one organized to develop the water power of Belle Shoals on North river in Douglas county. The development incudes dam and power house and equipment, and will cost about $50,000 The construction company will be known as the Dog River Power Co.

ROME. A committee has been appointed by the city council to investigate the establishment of a municipal electric light plant.

KENTUCKY.

GLASCOW. It is understood that the Glascow Electric Light & Power Co., has contracted with a New York firm for an entirely new plant.

LAWRENCEBURG. The Lawrenceburg Lighting Co., expects to install two motor generator sets within the next two months. Further information can be secured from P. T. Glidden, general manager.

[illegible]SVILLE. The Kentucky Utilities Co., has purchased the Mount Sterling Water, Light & Ice Co., of Mount Sterling, and the Winchester Railway, Light & Ice Co., of Winchester. Improvements will be made in the Mount Sterling system including transmission lines to take on the industrial load of farmers. An electric railway is also proposed.

MIDDLESBORO. Reports state that a unique power generating plant for coal mine operation is being planned to furnish light and power to the mines of Bell county near Middlesboro. A hydro-electric plant, to cost about a million dollars will be constructed on the Cumberland river and furnish the power.

LOUISIANA.

LAFAYETTE. The Louisiana Traction & Power Co., has been organized with a capital stock of $250,000. The purpose of the organization is to construct interurban electric railways to run from LaFayette to Morgan City, Alexandria and Abbeville. The charter of the company also gives it the right to do electric light and power business. The officers are J. A. Landry, of St. Charles, president; C. O. Morse, of Lake Charles, secretary, and G. J. Landry, of Lake Charles, treasurer.

LAKE CHARLES. It is understood that the Lake Charles Railway, Light & Waterworks Co., is to install motor driven pumps for the waterworks system in the near future.

NORTH CAROLINA.

ANDREWS. It is understood that the municipal electric light plant is to be considerably increased in size so as to accommodate about 350 additional horsepower. One 500 kw. generator with exciter water wheel and governor, switchboard and fixtures are to be installed. The necessary cable insulator supplies are also desired. Further information can be obtained from J. A. Thornton, superintendent.

CHARLOTTE. A hydro-electric plant is to be constructed by the Southern Power Co., at Lookout Shoals on the Catawba river, twelve miles from Statesville. Four units of 400 H.P. each are to be installed and the cost of the plant is about one million dollars. W. S. Lee, of the Southern Power Co., is in charge as chief engineer.

MOUNT OLIVE. It is understood that the municipal electric light plant will make extensions and improvements, including the purchase of a one 100 kva. 2,300 volt, three phase generator direct connected and will construct several miles of transmission lines. The manager, F. L. Oliver, can give other information.

WILMINGTON. A brick substation is to be constructed by the Tide Water Power Co., during the early part of the year and a 500 kw. rotary converter, and two 250 kw. transformers and switchboards, rotaries and transformers are to be installed. The company is also erecting a 264 H.P. B. & W. boiler. Raymond M. Hunt is superintendent, and can give other information.

SOUTH CAROLINA.

SENECA. The Conneross Light & Power Co., recently organized, has purchased the property of the Seneca Light & Power Co., and will complete the development at Taylor's Falls on Conneross creek. A dam will be completed 60 feet high, and two generating units installed, turbine driven, one 600 and one 300 kw. capacity. Four miles of transmission line will be constructed over steel towers to Seneca. S. Morgan Smith turbines will be used, General Electric generators. The plant will cost $565,000. J. E. Sirrine, of Greenville, S. C., is engineer.

TENNESSEE.

EAST CHATTANOOGA. The East Chattanooga Business League is considering the installation of an electric lighting system. If the arrangement is made, the Chattanooga Railway & Light Co., is to install a transformer station and extend the lighting on Chamberlain avenue and Glass street, as well as other streets.

ELIZABETHTOWN. Reports state that the Watauga Power Co is to extend its transmission lines to Jonesboro, Morristown and Greenville, Tenn.

INGLEWOOD. The Eureka Cotton Mills is to install a 50 kw. direct current alternator 2,300 volt, 60 cycle.

SOUTH PITTSBURG. The electric light plant owned by W. C. Houston has been purchased by J. W. Adams, of Chattanooga. The plant will be remodeled and new equipment installed. It is understoo dthat power will later be secured from the Tennessee Power Company's hydro-electric plant at Parksville, Tenn.

WINCHESTER. It is understood that the Kentucky Utilities Co. contemplates the construction of a large power plant at Winchester. The cost of this plant will be approximately $1,000,000 and furnish current to plants in the surrounding towns, including Versailles, Shelbyville, Lawrenceburg, Somerset and Elizabethtown.

BOOK REVIEW.

WIRING DATA. Compiled by F. D. Weber. Published by Underwriters' Equitable Rating Bureau, Portland, Oregon.

The above data has been collected and arranged to be of practical use in the installation of direct and alternating current motors. It takes up those features in connection with which the National Electric Code gives no specific data and gives valuable suggestions and data. It is of such general use by all contractors and others installing electric motors that it would be a valuable addition to the Code, aiding much in its interpretation. Other underwriters' associations should be interested in this data and should follow the example set. The author is to be highly complimented on the brevity and excellent arrangement of the data.

PERSONALS.

WARNER M. SKIFF, for three years assistant manager of the engineering department, National Electric Lamp Association, has been appointed manager of the engineering department of the association to succeed Glenn C. Webster who has assumed the managership of the Tungstolier Works of General Electric Company.

A. M. KLINGMAN, assistant commercial engineer of the National Electric Lamp Association, attended the Birmingham convention of the Alabama Light and Traction Association November 14 and 15 and delivered an excellent paper on street lighting. An abstract of this paper is found elsewhere in these columns.

MR. LOUIS STEINBERGER, president of the Electrose Mfg. Co., of Brooklyn, N. Y., has been awarded a decision for priority in an interference case with Hewlett covering disk strain insulators whose application for patent was assigned to General Electric Co. This decision is of unusual interest since it refers to the most important strain insulators ever invented. The decision is a reversal of the decision of the examiners-in-chief.

S. B. WILLIAMSON since 1908 division engineer of the Pacific division of Panama construction, has resigned his position to enter the service of J. G. White & Co., Ltd., international engineers and contractors of London and New York. Mr. Williamson was called to the canal service by Col. Goethals in May, 1907, as division engineer of the Pacific locks and dams. In his later position he had charge of the construction of the gigantic locks at Pedro Miguel and Hiraflores, involving the placing of vast quantities of concrete, extensive dry excavating and dredging, the construction of terminal docks at the Pacific entrance; and municipal work in Panama City and the Canal Zone south of Culebra. Previous to his work in Panama, Mr. Williamson was engaged in railroad and general construction work in various parts of the United States. He was also in the service of the United States government for some time, and in 1900 was in charge of the fortification work at Newport, R. I. In his new field of work, with J. G. White & Co., Ltd., he will be associated with their London office in the capacity of principal assistant engineer, directing construction in all parts of the world excepting the United States and its possessions.

MR. PERCIVAL STERN, who for some years has acted as general manager for the Interstate Electric Company of New Orleans, has recently acquired by purchase the other holdings of the company and now personally controls the business. This is one of the largest deals which has recently taken place in the Southern supply field, as the Interstate is one of the largest companies.

Mr. Stern is a well-known supply man in the South, being born in Amite City, La. He was educated at the Tulane High School and graduated from the high school in 1895 and Tulane University, electrical department, in the year 1899 with class honors. After leaving college he worked as an electrical wireman some months, then formed partnership with another college boy, opening a small construction shop, under the name of Stern & Marks, in the year 1900. This concern was successful and in 1903 Stern & Marks was absorbed in a consolidation of several other companies to form the present Interstate Electrical Company, Ltd., at which time Mr. Stern was appointed general manager, which position he has held up to the present time. After a year in business it was decided to abandon the construction work and enter the supply field entirely.

Their activity in this line has been remarkably successful, having built up a large supply business in the South, in addition to an enormous export business. Particuar attention is now being paid to the export business on account of the Panama canal. It is felt that this will give an added interest to business in this section.

A. M. DELVALLE, Southern representative for the Garratt-Callahan Co., of San Francisco an dChicago, manufacturers and distributors of the Magic brand of boiler preservatives, is to be placed in charge of an office of the company soon to be established in the South and probably at Savannah or Jacksonville. The establishing of this office has been the result of increased sales in the States of Florida, Georgia and the Carolinas. Mr. Delvalle is well fitted for this new charge, since he is thoroughly familiar with the field and its requirements, having been an engineer in various capacities for the past 17 years. His product, "Magic," was formerly handled by the H. W. Johns-Manville Co., and is not, as sometimes supposed, a boiler compound. It acts on the iron and not on the water and is therefore a boiler preservative.

THE BINFORD ELECTRIC CO., INC., has recently organized and opened business at Richmond, Va., as jobbers of electrical apparatus and supplies. The company has secured commodious ware-rooms embracing 20,000 square feet of floor space, located at Nos. 1322-1324 E. Main street, in the heart of the jobbing center of the city. The stock has been discriminately selected to fit the demands of the Southern trade, and every effort will be expended to promptly and efficiently fill all orders entrusted to the company.

Mr. Julien Binford, president and treasurer of the firm, has had a long and practical experience in the electrical business, covering the contracting, retailing, manufacturing and jobbing fields for a period of over eighteen years. He takes this occasion to thank old friends for their many courtesies and patronage while secretary of the Tower-Binford Electric and Mfg. Co., of Richmond, and soliciting a share of future business for his new company.

FORT WAYNE ELECTRIC WORKS, Fort Wayne, Ind., has moved its Cincinnati office to 704-5 Provident Bank building. There has recently circulated unfortunate false rumors to the effect that the commercial organization of the Fort Wayne Electric Works was to lose its identity as such and become a part of the sales organization of the General Electric Co. The management advises that such rumors have no foundation and that no changes are to be made in the sales organization that will in any way affect relations with customers. The same relations which have heretofore existed between the Fort Wayne Electric Works and the General Electric Co., will continue to exist. The only basis for the false rumors is the moving of the Cincinnati office of the Fort Wayne Electric Works into the same building with the General Electric district offices, this change being caused by a fire which partially destroyed the Union Trust building, in which the offices have been located in Cincinnati.

Electrical Devices Recently Approved.

The devices and materials appearing in this section each month, having recently been examined under the specifications given in the National Electrical Code and working in practice, are approved by the Underwriters Laboratories, Incorporated. The information in this section supplements the list published in April and October by the National Board of Fire Underwriters, and is for the convenience of engineers and electrical contractors who desire to ascertain the names of manufacturers up to date whose devices have been examined and approved.

THESE DEVICES SATISFY THE REQUIREMENTS OF THE SOUTHEASTERN UNDERWRITERS ASSOCIATION, AND HAVE BEEN APPROVED BY THE ELECTRICAL DEPARTMENT, A. M. SCHOEN, CHIEF ENGINEER.

CABLES, ARMORED.

PRATT-CHUCK CO., Frankfort, N. Y., Single and double strips, No. 14 B & S gauge, single or multiple conductors. Approved November 15, 1912.

CONDUIT BOXES, COVERS.

PASS AND SEYMOUR, INC., Solvay, N. Y. "P and S" Conduit Box Cover. For three and four inch round conduit boxes. Approved November 15, 1912.

FUSES, PLUG.

CHICAGO FUSE MFG. CO., 1014 Congress street, Chicago, Ill. Edison plug fuses, 3 to 30 A., 125 V. Approved November 11, 1912.

PAISTE COMPANY, H. T., 32nd and Arch streets, Philadelphia, Pa. Paiste "Fusette"; Edison plug fuses 6-30 A., 125 V. Fuses consist of a casing carrying a cap and screw shell and a renewable portion of porcelain in which is carried the fuse element. Approved November 1, 1912.

GROUND CLAMPS.

BENJAMIN ELECTRIC MFG. CO., of Canada, Ltd., 11-17 Charlotte street, Toronto, Ont., Canada. These devices consist of straps of tinned copper provided with suitably spaced holes and with bolts for clamping to pipes of different sizes. Sizes for ½ to 3 inch pipe. Approved October 11, 1912.

INSULATING MATERIALS.

NORTHERN INDUSTRIAL CHEMICAL COMPANY, 68 Northampton street, Boston, Mass. "Roxite," molded insulating material. A molded insulating non-combustible compound of good dielectric and mechanical strength, unaffected by oils or acids and very slightly absorptive of moisture. Approved November 11, 1912.

PANELBOARDS.

ELECTRIC MFG. CO., 926 Lafayette street, New Orleans, La. 125 and 250 V., 2 and 3 wire boards equipped with knife switches and terminals for cartridge enclosed fuses. Also 2 3-wire metering panel, 125-250 volt when mounted in suitable slate-lined cabinets. Approved November 21, 1912.

WURDACK ELECTRIC CO., WM., 17-19 N. 11th street, St. Louis, Mo. Two and 3-wire panelboards, 125, 125-250 and 250 volts, with or without main line knife switch and fuses. All standard types, branch circuits with open link. Edison plug or cartridge enclosed fuses with or without knife or snap switches. Approved November 26, 1912.

RECEPTACLES, STANDARD.

APPLETON ELECTRIC CO., 212-214 N. Jefferson street, Chicago, Ill. Keyless erceptacles for ½, ¾ and 1 inch rectangular unilets; 660 w., 250 v. with and without shadeholder groove. Approved November 11, 1912.

FREEMAN ELECTRIC CO., E. H., Trenton, N. J. Wall sockets, brass shell, key and keyless; porcelain shell, key and keyless. Sign receptacles. Conduit box type, cleat type and molding type. Approved November 4, 1912.

PAISTE CO., H. T., 32nd and Arch streets, Philadelphia, Pa. "Paiste" 660 w., 250 v., sign, cleat, concealed, molding, conduit box and conduit receptacles. Approved October 21, 1912.

PASS AND SEYMOUR, INC., Solvay, N. Y. "P and S" wall sockets, brass shells, key, keyless, conduit box, and pull. "P and S" wall sockets, porcelain shell, key and keyless. Brass shell types with "Shurlock" attachment. Approved October 2, 1912.

SIGNS, ELECTRIC.

BABCOCK & STORM, Chicago, Ill. Standard requirements Card issued October 31, 1912.

SWITCHES, PENDENT SNAPS.

KNOWLES, C. S., 7 Arch street, Boston, Mass. Have standard requirements. Approved October 4, 1912.

GORDON ELECTRIC MFG. CO., 403 Masonic Temple, Chicago, Ill. Standard requirements. Approved October 14, 1912.

TRANSFORMERS.

MALONEY ELECTRIC CO., St. Louis, Mo. Air-cooled transformers for indoor or outdoor use for 110 and 220-volt primary, giving 11 or 22 volts secondary. Approved November 15, 1912.

VICTOR ELECTRIC CO., Jackson Boulevard and Robey street, Chicago, Ill. Bell-ringing transformers. Approved for ringing bells October 25, 1912.

CONDUIT BOXES.

APPLETON ELECTRIC CO., 212-214 N. Jefferson street, Chicago, Ill. Pressed steel outlet boxes, sherardized or enamel finish for use with flexible tubing. Covers of steel for above boxes with or without porcelain bushings. Meter connection boxes. Approved December 4, 1912.

SWITCH BOXES.

KUSEL TELEPHONE AND ELECTRIC SUPPLY CO., St. Louis, Mo. Single and two gong for old and new work. Approved December 14, 1912.

TUBING, FLEXIBLE.

CONDUIT COMPANY, 126 Don Esplanade, Toronto, Canada. Marking: Blue thread wound spirally on the exterior of the lining. Approved November 26, 1912.

WIRES, WEATHERPROOF.

WACLARK WIRE COMPANY, Boyway avenue and S. Front street, Elizabeth, N. J. Tag on coil to read: N. E. Code Standard. Approved December 14, 1912.

SOUTHERN ELECTRICIAN

PUBLISHED MONTHLY

Vol. 45. FEBRUARY, 1913 No. 2

PUBLICATION OFFICE
DALTON, GA.

EDITORIAL and ADVERTISING DEPARTMENTS
GRANT BUILDING ATLANTA, GA.

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SUBSCRIPTION RATES

Domestic..$1.00 For Two Years
Canada..$1.00 Per Year
Foreign...$1.50 Per Year

Complaints of failure to receive SOUTHERN ELECTRICIAN regularly or of any errors of any nature, should be promptly made to the Atlanta office.

Advertising copy or change orders for standing advertisements must reach the Atlanta office by the 5th of the month preceding the month of publication.

Entered at Dalton, Ga., Postoffice as Second-class Matter.

CONTENTS.

Electrical Engineering—A Name With a Meaning.

The April issue of this publication will appear under the name ELECTRICAL ENGINEERING, representing the consolidation of *Southern Electrician* and the *Electrical Age*. As will be pointed out in detail in that number, every field of industrial activity has been strongly influenced in a constructive way by the application of electricity in one or all of its forms as light, power and heat. Further, industries have been created to produce and apply this form of energy and thus aid in the promotion of industrial progress. The activity connected with creating the means for the production, the activity in connection with the production and the application of electrical power, has been characterized as a distinct field of endeavor, requiring special training, and is now generally recognized in the engineering world as the field of electrical engineering.

The purpose of this publication has been since its inception to serve the interests in this very field and its editorial policy will therefore in no way be changed. The modification of the name is one which we believe in keeping with the growth mentioned and will more closely associate our publication with the work it is endeavoring to do. An indication is further made through the name, of its purpose as a technical journal in regard to the construction, application and operation of electrical apparatus and again through the name a standpoint is furnished from which it serves the interests of the central station, the consulting, constructing, contracting, illuminating and operating electrical engineer and architect. We invite constructive criticism in regard to this step taken on the part of this publication.

A Fault In Display Street Lighting.

The success of the quartz lamp street lighting installation recently introduced by a group of Chicago business men on a portion of Randolph street hints at a possible reaction from the too common low mounting of street lamps. Formerly, when the commercial value of some special illumination in front of business buildings was first demonstrated, it often took the form of outline lighting. However ineffective this lighting may have been as a means of brightening the locality, it certainly had the decided advantage of pointing out the height and expanse of the buildings thus illuminated in outline. On the other hand, the great variations in the size and contour of the buildings adjoining often spoiled that element of harmony which the illumination of a business block should show if it is to reflect the cooperation of the merchants.

Our attention has been called to the uniformity now so strongly present in the curb-lighting method so largely in use, by Albert Scheible, a consulting engineer of Chicago. The criticism is a good one, for indeed in one respect uniformity can be overdone since it tends to give the same effect to business streets of varying degrees of importance. This is largely due to the fact that the lamp-posts, whether equipped with tungsten or arc lamps, throw a comparatively negligible amount of light upon any part of building fronts above the second story. Where the store buildings are not tall and where many of them are so old as to reflect the days of outgrown business methods, this darkening of the upper portions may be a decided advantage; but for streets lined with modern buildings of any considerable height, the curb-lighting system does not do justice to these structures. If any one doubts this, let him compare some of the illustrations which have appeared in these columns from time to time, showing the effect produced at night by the post-lighting systems used in different cities, or even in different sections of one and the same city. In many cases, it will be evident from the cuts (in which the camera has faithfully reproduced the nocturnal appearance of the streets) that it is the greater width of the streets and the more modern array of the stores on the main floor of the buildings that distinguishes the downtown business street from the outlying one at night. Yet the superiority in size and architectural beauty of the buildings on the more prominent streets is part of what makes the latter so attractive by day. Why should this be partly obscured after dusk?

Some may hold that the plan adopted on Randolph street has gone too far to the other extreme, since it approaches a general daylight effect without giving that distinctive touch of the festival element which the regular rows of curb-lights, mounted upon artistic posts, carry with them. However, this method lights up entire building fronts, thereby enabling the merchants to show the size and beauty of the buildings which they occupy and of which they may rightly be just as proud by night as by day. A part of the display effect commonly produced by the post systems may be missing; yet where the buildings are tall, there is fortunately lacking that curious effect which has aptly been described as "tunneling through the dark canyons of a city street." In such cases it may be that a combination of the two methods—or of outline and post lighting systems—might be superior to any of the plans heretofore used singly. At any rate, the extent to which lamps mounted high above the walks can display the entire building fronts, instead of shrouding the upper half of the same in darkness, deserves to be considered and may point the way to a still more effective lighting of business thoroughfares.

Words of Serious Import.

In a recent issue of the *New York Commercial* the head of a large and influential public service corporation, a man who has spent all his life in the upbuilding of the worthy organization he now heads, and one who, with a very few others, is responsible for the fathering of the operating and manufacturing phases of the industry in its early days, sounds a word of warning in regard to the present program of public service regulation by the uninformed and professional politician.

In what follows we quote Mr. H. M. Byllesby on what he aptly terms the great problem of the public service corporation: "In the period of the earlier development of public service enterprises, great risks were incurred, huge sums were lost and huge sums of money or its equivalent in substantial income earning property have been achieved. Probably, viewing the past and considering both the failures and successes of such enterprises, the capital invested has received a smaller total profit on its total amount than in the average of mercantile, commercial, manufacturing or trading enterprises. The business today, as regards the various physical elements entering into it, the machinery used, the motive power and the general development of the art is wholly beyond the experimental stage. However, in nearly every direction, opportunities still present themselves and there is a crying demand for further extension of service of such corporations. While, from the now somewhat extensive experience and history of the art, it is less difficult than in the past to forecast the probable monetary outcome of such extensions, enlargements or new developments, there still exist many cases where the returns to be achieved are still more or less problematical and in some cases absolutely problematical as to the dates at which returns will be reached.

"Today throughout the country the unmistakable tendency by Interstate Commerce Commissions, Public Utility Commissions, and by the law making and law administering bodies to hamper and curtail and paternalize the conduct of all these corporations to a point which is rapidly destroying the enterprise of the individual officers and employes of such corporations, is putting a period to the further investment of capital for the extension and enlargement of such enterprises. The result of this policy, if carried along the lines of its present extreme tendencies, will be to simply stop the further energetic development of these enterprises; to destroy the individual initiative of these corporations and this policy, if persisted in along the program of the political agitators of the present time, leads inevitably and logically to Federal and municipal ownership.

"A new situation and new conditions are now confronting the public and these corporations. It is a time for the underlying common sense of our people to take these questions out of the hands of the muck-raker and professional politician and put them before the great tribunal of common sense and love of justice of the American people. Our country has reached a point of intelligence and development where it should recognize, and at some time will recognize, that these questions are of such deep and far-reaching importance that they should be placed in the hands of entirely non-political tribunals, fair-minded, experienced and candid, and who will carefully weigh all the questions involved; with a proper attention to the economic questions involved and with a full realization of the obligations of common honesty resting upon all of us to each other, to the investor, to the wage earner, and to the communities concerned.

"Unless this course is pursued, the present program leads inevitably to paternalism and federal and municipal ownership. It is unnecessary to point out the perils to our beloved country which would follow the placing in the hands of a political party or of the government, of the enormous patronage resulting from federal and governmental ownership of this huge fabric of public service corporations. The public does not desire this; the investor does not desire it, and common sense abhors such a policy. The economic history of civilization teaches beyond the possibility of a doubt that the best results to the state and its citizens are reached by wise and prudent encouragement of individual enterprise and thrift, accomplished by allowing suitable rewards to follow successful enterprises.

"The public service enterprises of the United States of America have been one of the greatest factors in the development of this country. There are vast sections of country which require the services of such companies; existing and already served communities require continual extensions to the operations of such corporations. All this requires many millions of dollars annually.

"If the laws and various commissions dealing with these subjects approach them with a desire to encourage enterprise and not to throttle it; if rewards are allowed to follow the energetic development and the hazards of these corporations and if these laws and commissions recognize that their object is two-fold—first to protect the public and the state against selfishness, and equally on the other hand, to protect the capital and the brains and the enterprise of these corporations against unfair restrictions and the embarrassments of paternalism, these corporations can continue serving the public and under terms and conditions which will be far more satisfactory to them than the uncertainties and hazards of the past, and at the same time, due to the removal of these uncertainties and hazards, the public and the state will be served with even a better service and under more favorable conditions of charge than in the past.

"Very nearly the entire water power development industry in this country is held up at the present moment awaiting the settlement of the question dealing with water power sites by the various governing bodies. It should not be a difficult matter, and it is not a difficult matter to formulate rules and regulations which, while amply safeguarding the state and the citizens, will also enable these potential water powers to be turned to useful account in the development of the country and the conserving of the fuel supply."

A Comment on State Ownership of Waterpowers.

It is and always has been one of the aims of a successful publication to act as a mouthpiece for its readers when they have something worth while to say. This feature in the policy of this publication is considered vital to its usefulness as a technical journal and we take this opportunity to extend a broadcast invitation to all electrical engineers and others interested in the different phases of the electrical industry to take advantage of this service SOUTHERN ELECTRICIAN stands ready to render.

We have received an interesting letter from a reader who is connected with a Southern public utility organization, in which reference is made to the paragraph of Prof. Switzer's remarks on the Progress of the Hydro-Electric Industry, page 3, of the January issue, beginning, "Beyond state regulation and control of waterpowers there remains but one step, etc." The reference is as follows: "The article by Prof. Switzer suggests the desirability of the state regulation of waterpower companies and says further, that beyond state regulation there remains but one step and that sooner or later this step will also be taken. The step to which he refers is state ownership. Is it not possible that there is still one more step beyond that, namely, government ownership? And is it not possible that the views expressed by President Taft on government ownership as published in the October Century and quoted in the magazine entitled,*Concerning Municipal Ownership* are correct? I would suggest giving readers of SOUTHERN ELECTRICIAN an oportunity to decide this question themselves by publishing the excerpt from the article mentioned as it appeared in the January issue, pages 16 and 17, of *Concerning Municipal Ownership.*"

The excerpt mentioned follows, which it is to be noted, represents President Taft's views as reported by the chairman of the Republican National Committee:

"That form of socialism popularly known as state socialism, which would transfer to the government the conduct of great industrial enterprises, must be doomed to failure. The effort to procure, through broader federal employment, even an approximate equalization of wages, would inevitably result in over-paying the inefficient and the moderately efficient, and that means, as the president said in his letter of acceptance, 'the appropriation of what belongs to one man to another.' If, as the president believes, experience has proved, economical operation of industries by the government is an impossibility, the government, in attempting to conduct certain industries, would be compelled to insure to itself an absolute monopoly because it could not compete with private enterprises. This in turn would mean either operation at a serious loss to the government or a material enhancement of the prices of the products. Either the consumer would be compelled to defray the increased cost of production, increasing his cost of living or the deficit would have to be made good from the public revenues, and they, in turn, replenished by increased taxation. In either case it would mean 'the appropriation of what belongs to one man to another.' When we reflect that over $12,600,000,000 is invested in manufacturing, over $16,600,000,000 in railways, $600,000,000 in telegraph and telephone lines, in this country, it is easy to appreciate how great would be the financial disaster should the government undertake to conduct only these four lines of industry and do so at a loss. Suppose, for instance, that the government 'took over' these four industries and the first year 'paid a 5 per cent loss,' to employ the commercial expression. That would amount to a loss of virtually $1,500,000,000, or nearly $500,000,000 more than the entire national debt. When Uncle Sam is conducting his present business wisely and as economically as possible, he manages to take in about $50,000,000 more than he pays out. Of course he sometimes falls far short of this and has a deficit at the end of the year, as he did in the fiscal years 1908 and 1909, but even if we assume, for the sake of argument, that he can collect every year $50,000,000 more than his expenses, it would take him thirty years to pay off the loss incurred in one year by his little experiment in state socialism. And Uncle Sam has never conducted his business in such a way as to warrant an experiment which might easily prove so disastrous.

"Now, to go back to the problem of securing the industries and the capital which the socialists maintain the government should acquire and control. The socialist program calls for collective, or governmental, ownership of railways, telegraph and telephone lines, farm and city lands, manufactures and banks and banking capital; that these industries and properties in the United States represent a capital of over $70,000,000,000; that if, according to the program of the Fabians, these were acquired by purchase, the government would incur a debt of $70,000,000,000, on which the interest at 3 per cent would amount to $2,100,000,000 a year. It is shown that the interest on all the public debt of the world amounts to only $1,550,000,000. Now, is it conceivable that wholly irrespective of its ability to manage these properties once it had acquired them, any government or people could incur such an enormous debt, or, having incurred it, could hope to pay the interest thereon? Is it possible to escape the conclusion that the ultimate aim of socialism, whether it be repudiated by the Fabian idealist or acknowledged by the franker and probably more practical, communist, is confiscation, seizure without remuneration, 'the appropriation of what belongs to one man to another?' The practical exigencies of an impractical system can lead to no other goal."

The above quoted remarks, as already stated, were taken from the article appearing in *Concerning Municipal Ownership.* In referring to the original article appearing in the October *Century,* the wind-up of a five-page article on, Socialism and Its Menace, is through a paragraph entitled, "Provision for Future Betterment." We believe it is only fair to the author of the article in our January issue that this paragraph be added and its interpretation considered with the remarks that have gone before. We quote in part, as follows:

"Further acquirement of steams and water-powers has been effectually checked. To this end President Taft has withdrawn from entry—that is, from passing into private ownership—1,800,000 acres of land. The creation or extension of the coal monopoly has been prevented by the withdrawal of 68,000,000 acres of coal lands and the insistence that these and all other mineral lands shall only be leased, not sold. So, too, will phosphate lands, oil lands, forest lands, and the other resources which in private ownership would contribute to the upbuilding of monopolies and the defeat of economic justice; the president has insisted that title thereto shall remain in the government."

The Rehabilitation of Augusta-Aiken Railway & Electric Corporation's System

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN)

BY E. C. DEAL, GENERAL MANAGER AUGUSTA-AIKEN RAILWAY AND ELECTRIC CORPORATION.

A Description of Complete Equipment of Generating Station and Substations, Methods of Switching and Transmission Underground Construction.

DURING the year 1911-1912, the Augusta-Aiken Railway and Electric Corporation made extensive improvements in its system, these improvements involving rearrangement of its lines and method of distribution as well as the installation of additional station capacity. Before the additional facilities were available, the equipment of the old system was worked to its full capacity. A general description of the old plants and the available capacity are of interest and will be taken up here. The original layout included two plants in Augusta practically side by side, one being near Clearwater, S. C., about eight miles Augusta, and with a sub-station about nineteen miles from Augusta and five miles from Aiken, S. C.

FIG. 1. NEW AUGUSTA STATION (WEST PLANT) SHOWING CONDENSER AT LEFT AND COAL TRESTLE AT RIGHT.

EAST AND WEST PLANTS.

These two plants are located just above Fifteenth street on the north side of the Augusta canal. The west plant has two 400 kw., 2,300-volt, 2-phase, 60-cycle vertical water wheel driven generators, and one General Electric double current generator—16 pole, 450 rpm, 400 kw, 600 volts, D.C. 375 volts, A.C., 2-phase, 60 cycles. This latter machine was used as a rotary converter started from the D. C. end and connected through two transformers which stepped the voltage to correspond to the bus potential. This machine is also used for railway purposes for peak loads and at times of high water when the main railway generator has a reduced output. The main railway unit is a 675 kw. 550-volt, 188 rpm. Bullock generator, whose armature shaft extensions are provided with magnetic clutches on each end, and is in line with, and constitutes part of a horizontal jack shaft line down the full length of station, driven on west end by a pair of twin 45-inch, 500 hp. (each) Stilwell-Bierce-Smith-Vale water turbines, and on east end by a vertical marine type Corliss engine of 650-hp. To this line shaft is also belted a 2-phase, 2,300-volt, 250 kw. 600 rpm. generator.

The east plant has a 400 kw. double current generator, a duplicate of that used in the west plant, this machine being belted to a water wheel which also drives a small 75 kw. 2-phase, 2,200 volt, Westinghouse generator. There is also a Dyer 500-hp. corliss engine, connected to a General Electric D.C. generator which was used for railway purposes.

The east and west plants were operated from switchboards located in the west plant. All water turbines have Lombard governors. Exciters on vertical A. C. generators are belt driven from the vertical shafts through a horizontal countershaft connection. The 250 kw. Bullock generator has a direct connected exciter. It can be seen that all the A.C. current available was from the power supplied by the canal which was Augusta's only power source. The direct current supply was also dependent to a great extent on the water supply, for the rotary converter could not be used without alternating current and the supply was limited to the engine output. The water supply, too, has been uncertain for in times of low water the railway company was the first to have its supply cut off, as it is the youngest consumer. In times of high water all wheels lose their capacity from loss of head and in many cases the water has risen until the main railway generator was partially submerged. As floods have been of frequent occurrence, the power plant was always in danger. This ever-present danger and the full capacity load which was growing rapidly was the cause for the extensive improvements that have been made.

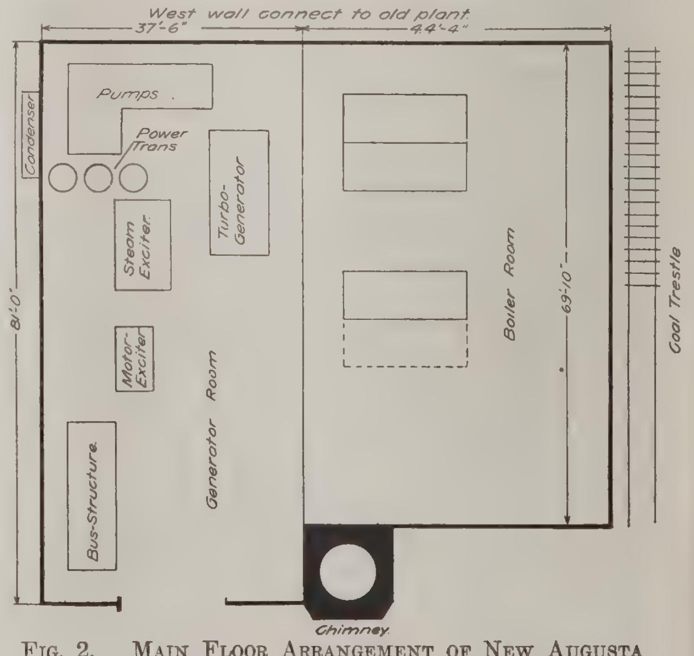


FIG. 2. MAIN FLOOR ARRANGEMENT OF NEW AUGUSTA STATION (WEST PLANT).

CLEARWATER STATION.

This station was known as the Augusta and Aiken Power House and formed an independent generating station. It had two General Electric 300 kw.—550 volts, 150 rpm. generators, each coupled to a Clark engine. The generators fed the bus from which feeders went toward Augusta and toward Aiken. The Augusta feeder fed back as far as North Augusta, where the city's direct current supply ended at the section breaker. From the bus, a 200 kw., 25 cycle, 3-phase, rotary converter was run inverted, feeding through three transformers at 13,200 volts and by transmission to the Aiken substation eleven miles distant.

AIKEN SUBSTATION.

This station contained one 200 kw. 25-cycle, 3-phase, 550-volt, rotary converter fed from three stepdown transformers which were fed at 13,200 volts from the Augusta and Aiken power house. Both step up and step down transformers were connected Y to Y.

ADDITIONAL DEVELOPMENTS.

In the scheme for additional power, a new power house has been erected as an extension at the east end of the west plant. The new plant with its generating apparatus is of 2,500 kw. capacity and in times of high water will carry the total load. The arrangement is such that the new station can carry the city load in parallel with the west plant. Step up transformers in the new station raise the voltage to 13,200 volts which is transmitted to the Augusta and Aiken power house over a new transmission line. At this point a 500 kw. motor generator set is installed with necessary transformers and switchboard. The old transmission line from the Augusta and Aiken power house to the Aiken substation is used between these two stations and a 200 kw. motor generator set is installed at this station. With the new arrangement the Augusta and Aiken power house becomes a substation except in the times of emergency. If the new transmission line from Augusta to the Augusta and Aiken power house should fail, the old apparatus could be used and the Augusta and Aiken division run in the old way. If the set at the Augusta and Aiken power house fails, the Aiken substation need not be interrupted and the old engine units can be run on the bus at the Augusta and Aiken power house. Should the set at the Aiken substation fail the inverted rotary at the Augusta and Aiken power house can be run from the D.C. bus as before and power at 13,200 volts, 25-cycles sent to the Aiken substation. The diagram, Fig. 5, shows the arrangement for operating the interurban division.

FIG. 3. BUS STRUCTURE AND SWITCHBOARD GALLERY, AUGUSTA STATION (WEST PLANT).

NEW GENERATING STATION.

The new generating station is of brick with a steel frame work. The main floor is built above the highest water recorded so that one trouble in the old plant has been eliminated. The main floor contains the boilers and the turbine units with exciters as well as the 2,300 volt bus structure and oil switches. The switchboard is on a gallery together with the lightning arresters. All switches are of the remote control type. The layout of the station is shown in Fig. 2.

FIG. 4. INTERIOR OF NEW AUGUSTA STATION (WEST PLANT) SHOWING TURBINE, EXCITERS AND TRANSFORMERS.

MAIN STATION.

The main station is located at the east end of the west plant and joins the old plant. The building is divided north and south into a boiler room and generator room. On the boiler side of the building is a coal trestle used for unloading the coal at the boiler room entrance. On this side of the building a provision is also made for extension and the alternate courses of brick in the wall are set back for bonding future work. The feed water pumps are located at the west end of the generator room while the condenser is located at the south side of the building next to the canal. There is a bank of three 400 horsepower Casey-Hedges boilers working at 150 pounds gauge pressure. These boilers have been tested with full load on the turbine with satisfactory results.

The turbine unit is a 2,500 kw. continuous rating Curtis horizontal, operating condensing at 150 pounds gauge pressure and 28 inches of vacuum. The condenser when supplied with sufficient water at 70° F. is guaranteed to produce 28 inches of vacuum when condensing 50,000 pounds of steam per hour. No circulating or vacuum pump is required. The circulating water is supplied from the canal and is siphoned through the condenser to a sewer at a lower level. To start the water siphoning through the condenser, a by-pass is arranged so that the water will flow through to the tail pipe by gravity, thus creating a vacuum in the condenser, which draws the water over when the by-pass is closed and the water siphons continuously, until interrupted.

The turbo generator is a two-phase, 2,300 volts 60-cycle machine operating at 1,800 rpm. The two phase requirement corresponds with the old equipment and the new station is operated in parallel with the west plant. The exciter capacity consists of a 75 kw. 125 volt turbine driven compound wound generator and a motor driven 50 kw. 125 volt compound wound generator. The motor is a 2,300 volt 60 cycle, 2 phase, machine operated from the bus with a remote controlled oil switch with starting compensator and no voltage release. All leads from the machine are brought under the floor to the bus-structure. Lead covered cable is used from the machine to this structure for safety from water as well as better insulation. These leads are run in fiber conduit hung in brackets under the main floor.

The oil switches are mounted on this structure, which consists of a steel frame work concrete slab. The oil switches are mounted on the steel frame with the axis of the operating rods parallel to the 2,300 volt busses. The arrangement makes a convenient arrangement for connection from the oil switches to the busses above and also for the leads from the switches to the power transformers and outgoing feeds as well as the buss tie. The whole steel framework is covered by a concrete slab which supports the 2,300 volt busses. Each bus is separated from those adjacent by a slate partition. The porcelain bushings that allow the leads to pass through the concrete slab from the switches to the bus are used as supports for the bus and have the bus clamps as caps for the bushings. All current transformers and potential transformers are mounted on the bus structure with the secondary leads running to the switchboard mounted in the gallery above.

SWITCHBOARD.

The switchboard is mounted on the gallery, which extends along the south side of the building above the bus structure and the power transformers as shown in the illustration. This board consists of a Thirrill regulator panel, exciter panels, generator panels, one spare panel, 2-phase feeder panels and transformer and bus tie panels. The two exciters have a common negative brought to one side of the main generator field switch, the positive leads being brought through breakers to the positive bus. These breakers are operated by a trip from reverse current relays.

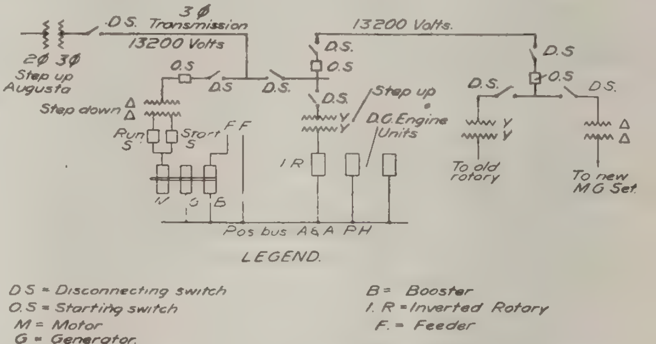


FIG. 5. TRANSMISSION SYSTEM AND LAYOUT OF INTERURBAN DIVISION.

The generator oil switch, transformer switch and feeder switches are operated by solenoids controlled at the switchboard. All switches except the main generator switch have overload relays for tripping. The generator switch has the same arrangement for solenoid-operation from the exciter bus except that the overload relays show a red signal lamp and a bell alarm rings. This leaves the operation of the oil switch to be taken care of by the operator and gives the feeder switches time to open. All oil switches have disconnecting switches on both sides. These disconnecting switches are mounted on the switch structure.

The generator panel contains an indicating wattmeter, a watt-hour meter, a P. F. meter and also an ammeter which will read either phase. Besides these there is the synchronizing plug with synchronizing lamps and red signal lamps for overload. The turbine governor motor control switch for speed regulation is mounted on this panel.

The feeder panels have ammeters for each phase and the transformer panel also contains an integrating wattmeter which reads the power to the interurban division. All panels have switch control handles with red and green indicating lamps. These control handles are detachable and the operating drum can be locked in the closed or open position of the switch so that after the handles are removed, the switch can not be operated from the board except by the operator who locked it into its position. A swinging bracket at the left of the board next to the Tirrill regulator panel contains the synchroscope, a frequency meter and three voltmeters. These voltmeters read the generator voltage, bus voltage and voltage on the west plant side of the bus tie switch. These are necessary for synchronizing. All synchronizing is done between incoming machine and bus.

Both exciters are designed for and operated with a Tirrill regulator. The outgoing 2-phase, 2,300-volt feeders pass from the feeder switches under the gallery to the south wall. From this point the leads come through the gallery floor to the outlet in the south wall near the roof. The 2,300-volt choke coils are mounted under the gallery after the outgoing feeders leave the oil switches. The 2-phase feeders have 2300 volt aluminum lightning arresters mounted in the gallery.

The interurban division of the railway is fed from two 500 kw. transformers which are connected 2-phase, 3-phase stepping up to 13,200 volts for transmission. A third transformer is used as a spare for emergency. The transformer panel controls the oil switch on the low tension side of the transformer. The 3-phase, 13,200 volt lines pass through the gallery floor to the choke coils, and then up through the roof to the north side to the pole line. The outgoing line from the station has disconnecting switches in the high tension side and 13,200-volt aluminum lightning arresters mounted in the gallery. These arresters have four tanks for the ungrounded system.

THE TRANSMISSION LINE.

From the step-up transformers for the power supply to the interurban division, the high tension, 3-phase line passes through disconnecting switches and choke coils to the south side of the roof. The line passes back over the roof to the north side of the building where the pole line begins. The 13,200-volt line passes across a part of the city in order to reach the North Augusta bridge. Through the city the line is carried on poles 60 to 70 feet high. The line is carried across the Savannah river on bracket arm extensions from the North Augusta bridge. The poles used on the transmission line are chestnut second growths. The wires are carried on 2 piece porcelain Locke insulators No. 408 A, the three insulators being on a single cross arm and spaced two feet apart.

The transmission line has electrolytic lightning arrestors at the main station mounted in the gallery. At each substation the arrestors are mounted outside the buildings and are the four-tank type for underground systems. At the Clearwater substation there are two sets of arrestors—one on the incoming line to the Aiken substation. As shown on the switching layout, the line between Clearwater and Aiken can be operated from the old apparatus, while the line from Augusta is operated from the new power supply. As the old transformers are connected star with ungrounded neutral, the new arrestors are satisfactory. Referring to the sketch it can be seen that, should the transmission line fail between Augusta and the Augusta and Aiken power house, the old engine units can be operated and the inverted rotary used to send power to the Aiken sub station where the switching arrangement allows for the operation of the old apparatus. In case of failure of the old apparatus at the Aiken substation the old 25 cycle apparatus can be run from the inverted rotary at the Augusta and Aiken power house. This inverted rotary can be run from the bus at this power house, the present schedule and demand being such that the 500 kw. set has capacity enough to carry the whole interurban division.

SUBSTATIONS.

As the two sets installed, one in each substation, are similar in voltage and switching arrangement, a description of one will be satisfactory. The capacity of the Aiken set is 300 kw with 2 boosters while the Clearwater (A and A P. H.) set is a 500 kw set with one booster. The boosters are series wound for 200 volts boost. The

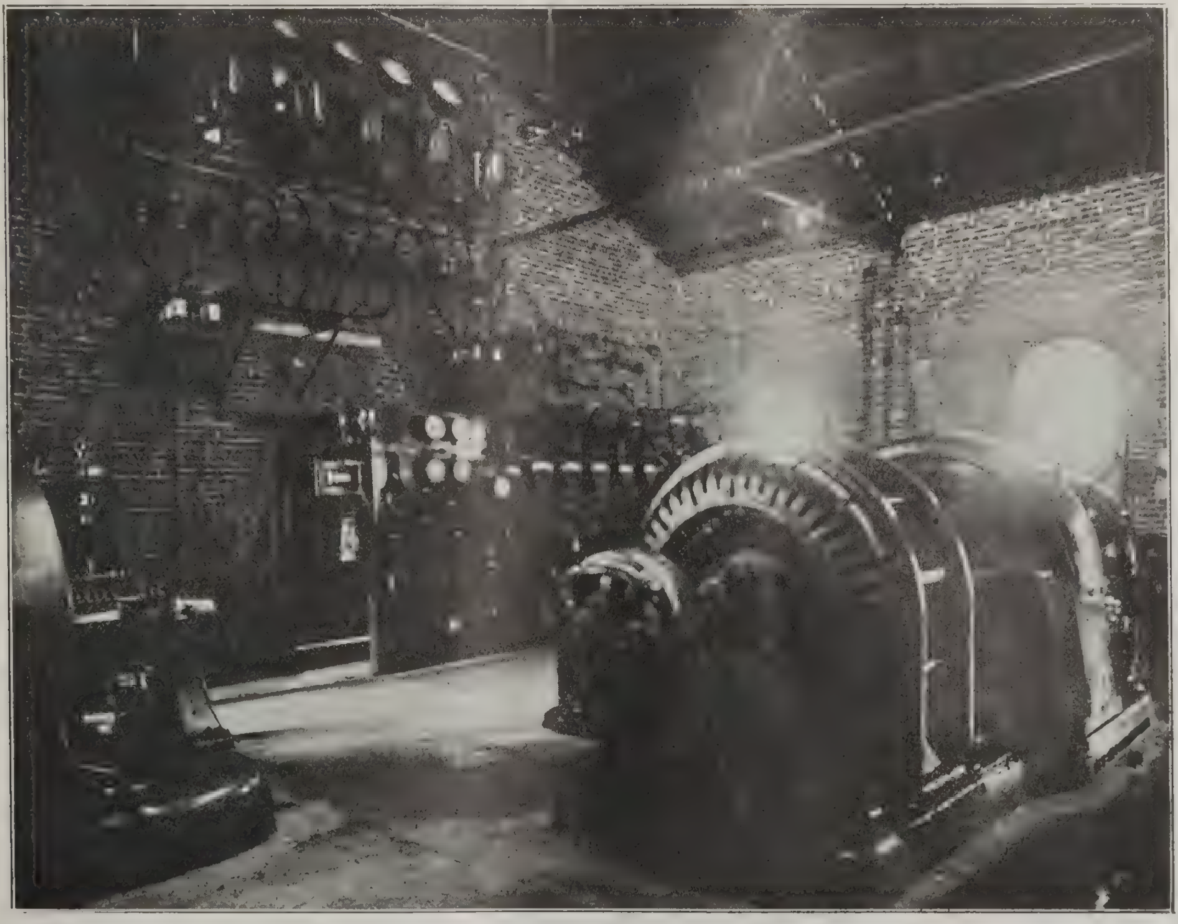


Fig. 6. Interior of Clearwater Sub-Station.

Clearwater booster is connected in the Augusta feeder to boost 250 volts with 400 amps. in the feeder. This feeder pulls the heavy interurban cars over the heavy grade encountered after leaving Augusta, a grade of about 350 feet in one mile.

The Aiken set consists of a 450 hp, 2,300 volt, 10 pole synchronous motor with a 300 kw, 550-600 volt, compound wound interpole generator. There are two 50 kw series boosters each wound for 200 amperes with 250 volts boost and a maximum boost of 300 volts at 300 amperes. The base for this set is in two parts while the total shaft is in four parts coupled together. The 125 volt exciter for the synchronous motor is mounted on the shaft extension at the motor end. The overall dimension of this shaft is over 23 feet. The set has the usual 50 per cent overload guarantees that go with railway apparatus.

The motor panel in addition to synchronizing lamps has a starting and running switch. The starting switch is connected to 1150 volt tap from the transformers, by means of which the set is brought up to speed after which the running switch is thrown in. The field is then put on the motor by which it is pulled into synchronism. The panel also contains in addition to indicating wattmeter, watthour meter and ammeters, a power factor meter. The exciter and motor field rheostate are operated from the motor panel. The two oil switches have a mechanical interlock which prevents the closing of the running switch before the starting switch is opened. There is no automatic trip on the starting switch but the running switch is supplied with an overload release.

The generator panel contains an ammeter and overload trip circuit breaker and line switch. In addition there is a starting switch for starting the set from the A. C. end for synchronizing. The D C and A C voltmeters are mounted on a swinging bracket at the end of the board.

The D. C. bus is connected to three feeders—one feeding the line adjacent to the substation, and the other two feeders going in opposite directions to the section farthest from the station. These two feeders are connected through switches by means of which the boosters can be thrown into circuit on the feeders operated direct from the bus. These two feeders have breakers with no voltage release trip. The booster panel switch connections are shown on the accompanying diagram, Fig. 9.

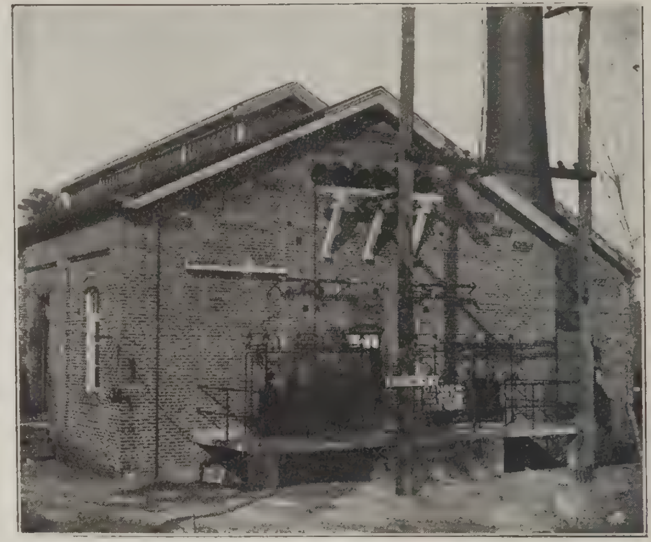


Fig. 7. Clearwater Sub-Station Showing 13,200-Volt Underground Lightning Arresters.

UNDERGROUND SYSTEM.

As stated above, the distribution in Augusta is 2300 volts, 2-phase. The underground system covers Eighth and Ninth streets between Reynolds and Walker and also Broad street from Thirteenth to Fifth. In laying out this system both phases of the 2300 volt feeders were run the length of Broad from Thirteenth to Fifth streets with one phase feeding out Ninth street. As the two phase motors are few, the section where both secondary phases were required was between Broad and Ellis on Eighth. At these points it was necessary to have both secondary phases. However with this exception one phase feeds the north side of Broad and the other feeds the south side—

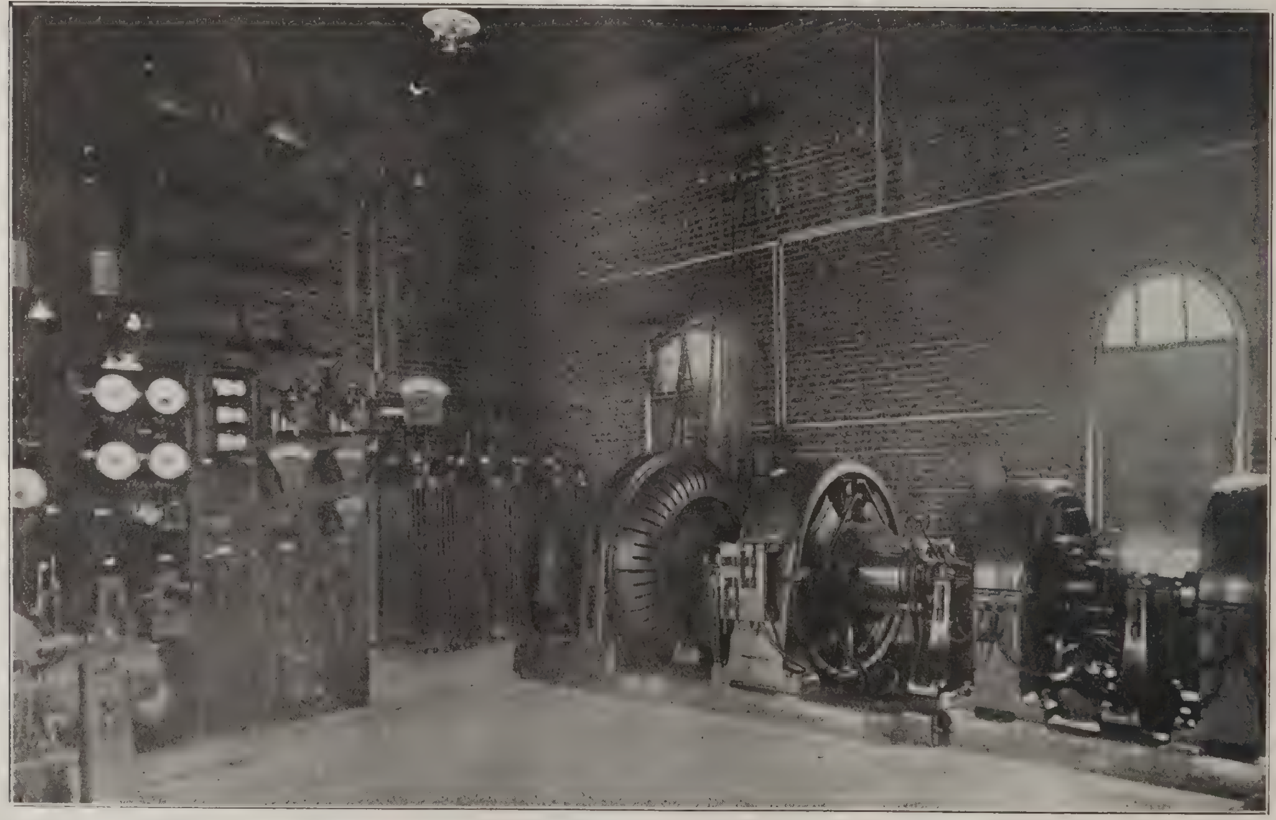


Fig. 8. Interior of Aiken Sub-Station No. 2, Showing Synchronous Motor With Three Constant Current Generators on One Shaft.

one phase taking the Ninth street circuit and one the eighth street circuit. This method gives an almost balanced load. The motor load of any consequence has been taken care of on separate 2-phase secondaries at 230 volts.

The lights are fed from secondary net works, each being supplied from a bank of three transformers. The transformers are 3-wire, 115-230 volts with neutral tied in solid to the main and each outside leg carried through a fuse box of the underground type, these boxes being two pole. The transformer primary leads are fused through single pole subway 2500 volt fuse boxes.

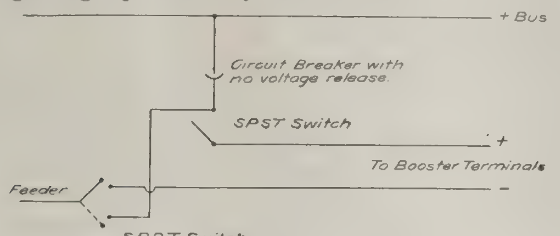


FIG. 9. BOOSTER SWITCH CONNECTIONS.

The house services are taken from 3-pole switch and fuse service boxes at the side of the houses. The leads from the secondary mains are brought to the service switches through pipes, lead covered cable being used to the service switches which are mounted to a height of seven feet above the sidewalk. Each service box is used for three or four services depending on the load. These cut-ins from the boxes are a balanced load on the 3-wire network. The neutral wire used is the same size as the two outside wires.

The secondary net works fed from a bank of three transformers has its primary phases sectionalized at a junction box so that trouble on a primary would affect only one secondary net work. The junction boxes are located at the center of load for the system and from these boxes all primary sections radiate. Each junction box has fuses for each individual primary section.

The primary phases and 500 volt D. C. main are brought underground at Thirteenth and Broad. At this point there are oil switches and lightning arrestors, these are the main supply switches. At Fifth and Broad streets the underground system is connected to another set of overhead feeders with oil switches and lightning arrestors. This connection is to be used only in case of failure between the junction boxes and the regular operating switches and is an emergency connection.

In putting in the underground system in Augusta many difficulties were met due to the low level of the street in relation to the river and consequently in relation to the services. The soil was of varying composition in different sections and quicksand was found so that many man holes were extra expensive on account of the necessary work and the concrete required to get a foundation. Obstructions at corners caused manholes to be odd shapes which made construction cost high. On Broad the paving is laid over a six inch concrete bed. This involved an excessive construction expense. Floods during the construction caused extra expense and this element was a menace at all times and required that all electrical apparatus and fuse boxes should be moisture proof even under water pressure.

TRENCH CONSTRUCTION.

Main trenches were run on both sides of Broad street from Thirteenth to Fifth, and on one side only of Eighth and Ninth sthreets. Manholes were located at each intersecting street and, on Broad street where blocks were very long, a small manhole or pull hole was located between blocks. At points where services were to be taken from the mains, handholes were placed. All ducts entered the manholes and pull holes, but the top ducts only enter the hand holes. These top ducts are used for secondary mains while lower ducts are used for primary lines. The ducts were of vitrified clay laid in sections of 3, 4, 6, 8, 9 or 12 depending on the location. The ducts were laid on a 3-inch concrete bed with 3 inches of concrete on top and sides, the top of ducts here being 30 inches below street level. At each corner duct lines are run between manholes for necessary lateral cable connections. On Broad street the duct lines on the south side of the street are few in number due to the fact that primary lines are carried through the other duct line on the opposite side, lateral connections being made to transformers on the south side.

As stated above the manhole covers through which transformers had to pass are 30x30 inches so that transformers have to meet this requirement. Due to excessive rains and flood water, the man holes are flooded at times but the entire system has passed satisfactorily through a flood during which the surface of Broad street was under one foot of water.

WORK ON RAILWAY LINES.

Considerable work has been done in re-timbering, bonding and improving the roadway of the interurban division, and also is lowering the tracks to compare to the new street grade on Central avenue in the city. An extension of the city belt line from Broad street through Fifth and Hale streets, connecting with the old line on Third street, thus forming a belt line in the lower section of the city. Seventy-pound rails were used in this extension.

STREET LIGHTING.

With the view of beautifying Broad street, Augusta's most prominent business street, the company installed ornamental iron posts from Fifth to Thirteenth W., the section of this street in which the wires were placed underground. These posts carry the railway trolley and feed wires and alternating poles are equipped with two Adams-Bagnall Electric Company's 6½ ampere, 70-volt flaming arc lamps. "White Way" posts have been installed along Ninth street and also around the two blocks opposite the Union Station. Adams-Bagnall Electric Company's Tuxalabra posts No. 33 and 35 were used, equipped with 100 watt Mazda lamps.

The system of the Augusta-Aiken Railway and Electric Corporation is now as complete in all details as any other system in the south and it is in a position to handle the fast growing demand for some years to come. The engineering work in connection with the rehabilitation was done by J. G. White & Company.

The first electric railroad in the Canal Zone at Panama is building. The new road is to run between Panama City and La Boca.

There are 750 miles of telephone wire in the New Hudson terminal office building in New York.

In the electric furnace gold boils at 2,400 degrees centigrade. By this thermometer water boils at 100 degrees.

The first large electric smelting plant is being successfully operated at Saulte Ste. Marie, Canada.

Alternating Current Engineering.

Contributed Exclusively to Southern Electrician

BY WILLIAM R. BOWKER.

The Installing and Wiring of Alternating Current Motors.

UP to this point in this article, little information has been given on installation methods. In what fellows the writer has formulated some of the important methods of installing induction motors and gives data on proper wiring, sizes, etc. It may be of interest to state at this point that after discussing synchronous motors in the section following this one, generators will be taken up, this subject being followed by a careful discussion of the engineering considerations in the transmission of power.

The use of polyphase motors in combination with transformers is important, for in practical service where current is generated and transmitted at high voltages, it of necessity has to be transformed down to a voltage practically suitable for polyphase induction motors. While with a non-inductive load, such as incandescent lamps, the regulation of transformers is within 3 per cent. With an inductive load such as induction motors, the drop in potential between no load and full load increases to about 5 per cent. If the motor load is large and fluctuating, and close lamp regulation is important, it is desirable to use separate transformers for the motors.

For the operation of induction motors on three-phase systems either two or three transformers may be utilized. Wherever a suitable size of transformer is available, however, three transformers are preferable, since in this case each transformer acts as a reserve to the two others, thus providing for the operation of the motor, in the event of one transformer becoming disabled. For the larger motors, the capacity of the transformers in kilowatts should equal the output of the motors in horse power. Thus a 50 horsepower motor requires a transformer of 50 kilowatt capacity. This ratio of transformer capacity and motor output is determined by the allowance that has to be made for power factor and efficiency.

The table given here shows the approximate transformer capacity that should be used with three-phase and two-phase motors.

TRANSFORMERS FOR DIFFERENT HP. MOTORS.

Output of Motor in Horsepower	Three Phase 2 Transformers	Three Phase 3 Transformers	Two Phase 2 Transformers
1	.6 Kilowatts	.5 K. W.	.6 K. W.
2	1 " "	.75 "	1 "
3	2 " "	1 "	1.5 "
5	3 " "	2 "	3 "
7½	4 " "	2.5 "	4 "
10	5 " "	3.5 "	5 "
15	7.5 " "	5 "	7.5 "
20	10 " "	7.5 "	10 "
30	15 " "	10 "	15 "
50	25 " "	15 "	25 "
75		25 "	35 "
100		30 "	45 "

The power factor of standard commercial induction motors at full load varies from 0.75 to 0.92 depending upon the size and frequency of the motor, while the efficiencies range from 80 to 92 per cent. The product of the actual efficiency and power factor gives the apparent efficiency, and it is this latter quantity that determines the capacity of the generators and transformers required for supplying energy to induction motors.

For motors of sizes above 5 horsepower the apparent efficiencies are 75 per cent and above, and for motors of less output than 5 horsepower the apparent efficiencies will be slightly less. For this reason, the smaller sized motors should be supplied with larger transformer capacity, especially if as is desirable, they are expected to run most of the time near full load or even at slight overloads.

The three transformers with their primaries connected to the generator supply circuit and their secondaries to the induction motor in a three-phase system is shown in Fig. 84, the three primaries and likewise the secondaries being connected in closed delta. The connections of two transformers for supplying an induction motor on a three-phase circuit is shown in Fig. 85. As one of the transformers in Fig. 84 is not utilized in this arrangement, the two transformers are made correspondingly larger, so as to equal the capacity of the three transformer combination, and are connected "open delta."

The copper required in any three-wire, three-phase circuit for a given power and loss is 75 per cent of that necessary with the two-wire, single-phase or four-wire, two-phase system having the same voltage between the lines. The connections of three transformers for a low tension distribution by the four-wire, three-phase system are shown in Fig. 86, the three transformers having their primaries joined in delta and their secondaries in star or Y connection. The three upper lines are the three main three-phase lines and the lowest line is their common neutral. The difference of

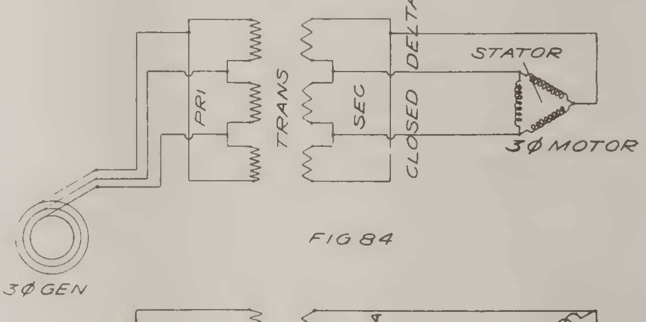
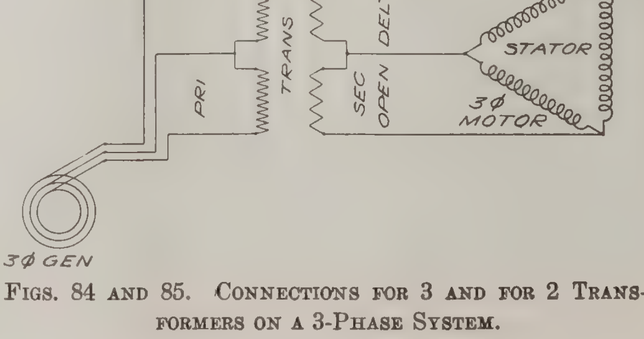


FIG 84



Figs. 84 and 85. Connections for 3 and for 2 Transformers on a 3-Phase System.

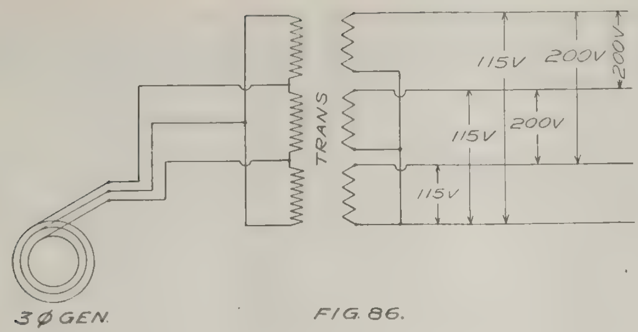


FIG. 86.

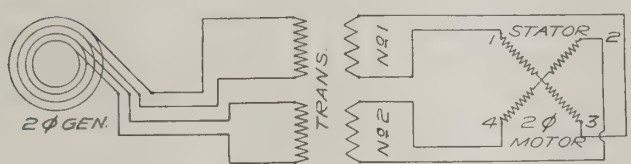


FIG. 87.

Figs. 86 and 87. Connections for 3 and for 2 Transformers for a 4-Wire, 3-Phase and 2-Phase System.

potential between the main conductors is 200 volts, while that between either of them and the neutral is 115 volts. Two hundred volt motors are connected across the mains, while 115 volt lamps are connected between the mains and the neutral.

The neutral is in principle similar to the neutral wire in a three-wire, direct current system, and carries current only when the lamp load is out of balance. The potential between the main conductors should be used in calculating, and the section of the neutral wire should be in the proportion, to each of the main conductors, that the lighting load is to the total load. When lights only are used, the neutral should be of the same size as the main conductors.

The copper required in a four-wire, three-phase system of secondary distribution to transmit a given power at a given loss, is approximately 33.3 per cent as compared with a two-wire, single-phase system, or a four-wire, two-phase system having the same voltage across the lamps. The connections of two transformers for supplying current to motors on the four-wire, two-phase system is shown in Fig. 87, the leads from one transformer being connected to terminals 1 and 3, and the leads from transformer 2 to terminals 2 and 4 of the motor. This system is practically equivalent to two separate single-phase circuits; one half the power being transmitted over each circuit when the load is balanced. The copper required as compared with the three-phase, three-wire system to transmit a given power with a given loss and voltage between the lines is 133.3 per cent; that is, the same as with a single phase system.

Each lead for a three-phase motor should be 58 per cent of the cross-section of each wire of the single-phase system; based on the same apparent kilowatt capacity and voltage. The drop of voltage in lines supplying motors alone, is due to inductance as well as resistance.

In Fig. 88 is also represented the arrangement of the essential apparatus and outline of connections necessary to transform high voltage current down to the motor voltage, say of 110, 220 or 440; from a three-phase supply through the intermediary of two transformers to a four-wire two-phase motor circuit with fuses and starting com-

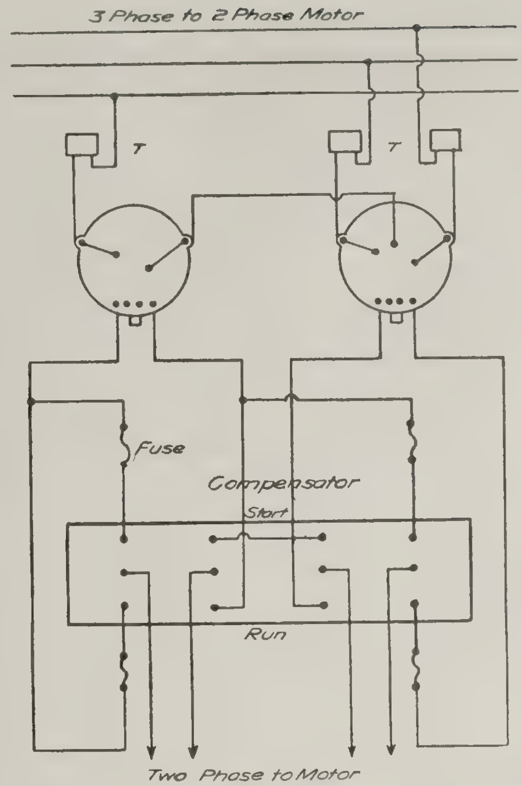


Fig. 88. Arrangements of Apparatus for Securing 4-Wire, 2-Phase Connections From a Three-Phase System Through Two Transformers.

pensator connected in the stator circuit ofthetwo-phase motor, the rotor being of the short circuited squirrel cage type.

Before leaving the important subject of induction motors, the practical information embodied in the following tables is desirable and will no doubt be of service. Table I refers to 220 volt three-phase motors; the first column of which gives the output of the motors in horsepower, the second column gives the least size wire to be used when installing. For instance if installing a 5 horsepower squirrel cage type of motor with compensator, the least size of wire to be used between the entrance service and compensator fuses would be a No. 6. Referring to column 2, for a 25 horsepower motor, the wire sizes are given in circular miles, as 250 c.m. and 300 c.m.

Table 1. Wire Sizes for 220 Volt, 3-Phase Motors From Line to Motor.

NOTE:—This table gives minimum wire sizes for alternating current (A. C.) motors and no wire smaller than prescribed will be approved.

220 VOLT THREE-PHASE MOTORS.

H.P.	To Comp. Fuse	Without Comp.	Comp. To Motor
1	No. 12	No. 12	No. 12
2	10	8	12
3	8	6	12
4	8	4	10
5	6	4	8
7½	4		6
10	2		6
12½	0		4
15	2/0		4
20	4/0		2
25	250-M		2
30	300-M		1/0
35	400-M		1/0
40	500-M		3/0
50	800-M		250-M
75	1250-M		400-M
100	2500-M		650-M

Where several motors are on the same set of mains, or feeds, the aggregate of the "circular millage" called for in the table shall be installed. The above table applies to "squirrel cage induction motors." Motors provided with "armature resistance" to start at full load current, use wire size indicated in last column.

As a general rule practical service requirements do not demand a compensator or starting resistance for motors up to 5 horsepower, and column 3 gives the sizes of wire to be used under such circumstances. Column 4 gives the sizes of wires to be used in the leads between the compensator and the motor terminals connected to the stator windings of the squirrel cage type of induction motor and secondly are also the sizes from the service direct to the stator terminals, when the rotor is of the coil wound type with slip rings and starting rheostat.

Table 2. Wire Sizes for 440-Volt, 3-Phase Motors From Line to Motor.

440 VOLT THREE-PHASE MOTORS.

H.P.	To Comp. Fuse	Without Comp.	Comp. To Motor
1	No. 12	No. 12	No. 12
2	12	12	12
3	12	8	12
4	12	8	12
5	10	6	12
7½	8		12
10	6		10
12½	4		8
15	4		8
20	3		[illegible]
25	2		6
30	1/0		6
35	2/0		4
40	2/0		4
50	4/0		2
75	350-M		1/0
100	500-M		3/0
150	550-M		3/0

Table No. 2 has reference to 440 volt, three-phase motors, the explanation given with Table I being applicable in this instance. The sizes of wires to be used in the leads between the service wires and motor in the case of 110, 220, and 440 volt single-phase motors of from ¼ to 15 horsepower output are given in Table 3.

Table 3. Wire Sizes for Single-Phase Motors From Line to Motor.

SINGLE-PHASE MOTORS.

H. P.	110 volts	220 volts	440 volts
¼	No. 12	No. 12	No. 12
½	10	12	12
1	8	12	12
2	4	10	12
3		8	12
4		6	10
5		4	10
7½		2	6
10		1	4
15		2/0	

Table 4 gives the least size of wire to be used for various lengths when a supply service is run between the transformer secondary terminals or other source of supply and the service entrance to the place where the motor is installed, so as to keep the voltage drop between those two points within the practical limits of about three per cent, this table being for a 220 volt single-phase power supply. Referring to the tabulated information, and looking along the first horizontal line of squares, we find 20 feet, 30, 40 up to 160 feet. This has reference tothe distance or span in feet between the supply source terminals and the service entrance or length of service lines. The first vertical column has reference to the horsepower of the motor to be installed, the second column to the amperes, given only in approximate figures, increasing in the numerical order of five.

Table 4. Smallest Size of Wire for Various Distances from Transformers to 220-Volt Single Phase Motors—3 Per Cent Loss Allowed.

220 Volt. Single Phase.													
HP	Amp	Ft. 20	30	40	50	60	70	80	90	100	120	140	160
	5												10
1	10												10
2	15										10	8	8
3	20									10	8	8	8
5	25								10	8	8	8	8
	30							10	8	8	8	6	6
7½	35						10	8	8	8	6	6	6
	40					10	8	8	8	6	6	6	4
10	45				10	8	8	8	6	6	6	4	4
	50				10	8	8	6	6	6	4	4	4
15	60			10	8	8	6	6	6	4	4	4	2
	70		10	8	8	8	6	6	4	4	4	2	2
20	80	10	8	8	8	6	6	6	4	4	4	2	2
25	90	10	8	6	6	4	4	4	2	2	2	2	1/0
	100	10	8	6	6	4	4	2	2	2	1/0	1/0	1/0

READING TABLE 4.

The following explanation of the table will give a clear understanding of how to read it. Take the 5 amperes in vertical column 2, all are blank spaces horizontally until the 160 foot span is reached, which shows that a wire of No. 10 gauge size has to be used. The table shows that no matter whether the service wire is 20 feet or any other length up to 160 feet run, a No. 10 wire is necessary, for in practice no wire of a less size than this is advisable.

Table 5. Smallest Size of Wire for Various Distances from Transformers to 220-Volt, 3-Phase Motors, With 3 Per Cent Loss.

220 Volts – 3 PHASE																
HP	Amp	Ft. 20	30	40	50	60	70	80	90	100	110	120	130	140	150	160
1	37															10
2	6.6															10
3	93															10
5	15											10	8	8	8	8
7½	22								10	8	8	8	6	6	6	6
10	25								10	8	8	8	6	6	6	6
15	38					10	8	8	8	6	6	6	6	4	4	4
20	51				10	8	8	8	6	6	6	4	4	4	4	4
30	77		10	8	8	6	6	4	4	4	2	2	2	2	2	2
40	107		8	6	6	6	4	4	4	2	2	2	1/0	1/0	1/0	1/0
50	118	6	6	6	4	4	4	4	2	2	2	2	1/0	1/0	1/0	1/0

Suppose it is necessary to know what size of copper wire to install for service supply lines for a 25 horsepower motor where the distance is 100 feet. Looking along the horizontal squares in a line with the 25, we arrive at the one that is in the same vertical column with 100 feet at the top; and find that a No. 2 gauge will carry the current at a voltage of 220, with only a 3 per cent drop of voltage in the 100 feet span. The same sized wire would also be used if the distance were anywhere between 90 and 140 feet.

Table No. 5 gives the same information as No. 4 in reference to a 220 volt three-phase supply service with a 3 per cent drop loss.

Table No. 6 gives the currents required for induction motors of various output, at voltages of 110, 220 and 500.

Table 6. Currents Required by Induction Motors of Various Sizes and Voltages.

Current Required by Motors.									
	Alternating Current Motors								
Horse Power	Single-Phase			2-Phase (4-Wire)			3-Phase (3-Wire)		
	110 V	220 V	500 V	110 V	220 V	500 V	110 V	220 V	500 V
1	14	7	3.1	6.4	3.2	1.4	7.4	3.7	1.6
2	24	12	5.3	11	5.5	2.5	13	6.5	2.9
3	34	17	7.5	16	8.0	3.5	19	9.5	4.1
5	52	26	11	26	13	5.7	30	15	6.4
7½	74	37	16	38	19	8.1	44	22	9.3
10	94	47	21	44	22	10	50	25	12
15				66	33	15	76	38	17
20				88	44	19	102	51	22
30				134	67	29	154	77	33
40				178	89	39	204	107	45
50				204	102	45	236	118	52
75				308	154	68	356	178	77
100				408	204	90	472	236	104
150				616	308	135	710	355	156
200				818	409	180	940	470	208

Balancing Loads on Three-Phase Circuits

(*Contributed Exclusively to* Southern Electrician)
BY H. P. WOOD, PROF. ELECTRICAL ENGINEERING, GEORGIA SCHOOL TECHNOLOGY.

In the plants of many small cities and in isolated plants three-phase generators are often used to furnish power to mixed systems with single-phase loads of incandescent lamps, street arcs and induction motors of small size. In such cases due consideration is not always given to the phase relations of the single-phase loads. It is an interesting fact that the proper connection of two single-phase loads to a three-phase circuit will give exactly balanced conditions when the currents of the two loads are equal and one differs 60 degrees in phase from the other. If no test is made the chances of getting the connection right or wrong are equal.

A specific instance of the application of this principle is found when a single-phase induction motor of the self-starting type, which takes 30 amperes at 110 volts and 72 per cent power factor, is connected to one pair of wires of a three-phase system and incandescent lamps taking 30 amperes are connected to another pair of wires. The currents are 30, 59 and 30 amperes. When the loads are reversed the currents become 30, 35 and 30 amperes, respectively.

In explanation of this, suppose that we have two circuits connected to a three-phase generator as shown in Fig. 1. If the power factor of one circuit is unity and of the other 50 per cent, and the current Ia'a equals the current Ic'c, the current Ib'b will be twice as great if the pressure Eab happens to be ahead of the pressure Ebc by 120 degrees. This condition is shown in Figure 2. The three

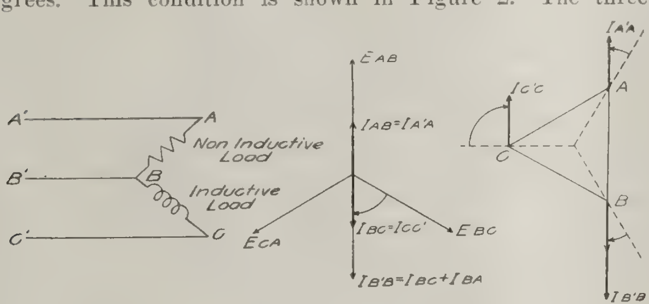


Fig 1 Fig 2

Figs. 1 and 2. *Inductive and Non-Inductive Loads on a 3-Phase Circuit with Vector Relations, for Unbalanced Conditions.*

pressures, Eab, Ebc and Eca are drawn from a common point at angles of 120 degrees, so that Eab is 120 degrees ahead of Ebc in a counter clockwise direction. The current Iab is drawn in phase with the pressure Eab since it flows through a circuit of unity power factor such as an incandescent lamp load. The current Ia'a is of course equal to the current Iab and its vector coincides. The current Ibc is drawn 60 degrees behind the voltage Ebc as we are assuming a lagging load of 50 per cent power factor for this phase. The current Ic'c equals Icb or equals minus Ibc. The current Ib'b equals Iba plus Ibc and is found by reversing the vector Iab and adding Ibc. With reference to the star voltages from the imaginary neutral point, Ia'a is ahead 30 degrees, Ib'b is behind 30 degrees and Ic'c is behind 30 degrees.

When the phase rotation is reversed (Fig. 3), the pressure Eab is behind the pressure Ebc by 120 degrees and the currents in the three line wires are equal and the loads are exactly balanced. As before, the current Iab is drawn in phase with the pressure Eab and the current Ibc is drawn 60 degrees behind the pressure Ebc. The current Ia'a equals the current Iab and coincides with it in phase. The current Ic'c equals Icb, that is Ic'c equals minus Ibc, and is drawn in reverse direction and coincides in phase with the pressure Eca. The current Ib'b equals Ibc plus Iba by vector addition, and coincides in phase with the pressure Ebc. With reference to the star voltages each of these line currents lags 30 degrees and the three-phase system is balanced. The power factor is the cosine of 30 degrees or 86.6 per cent.

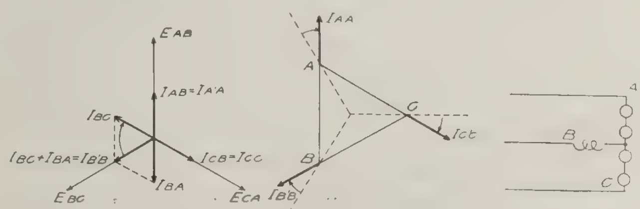


Fig. 3 Fig 4

Fig. 3. Vector Relations for Balanced Conditions.
Fig. 4. Scheme for Connecting Load Properly.

In the latter case the I^2R losses in the respective wires are equal and for the three wires equal 3 I^2R where R is the resistance of one wire. In the former case the losses in the wires A, B and C, are I^2R, 4 I^2R and I^2R, or 6 I^2R for the three wires, giving exactly twice the line loss as in the second case. The voltage drops may be taken roughly as of the same order and from every point of view the connections of the loads so that Eab is behind Ebc by 120 degrees is preferable.

Single phase loads of low power factor may be street arc lamps fed from constant current transformers or single-phase induction motors. In some cases mills which purchase power from central stations are required by the terms of their contracts to maintain balanced three-phase loads. When electric lights and polyphase induction motors are installed, this means that the lights must be wired to all phases. An alternative scheme suggested by a consideration of these facts is to have the lights wired to one phase and run a single phase induction motor on another proper phase to maintain balance. Or an amply large three-phase motor might have the wire A wholly or partially disconnected as the lighting load is thrown on, so that it runs on the wires BC as a single-phase load. Such a scheme might not prove as wasteful of motor capacity as it seems, for if lights are thrown on one phase the resultant lowering of voltage tends to make that phase winding of each induction motor draw less power from the line or even act as a generator, with resultant lowering of efficiency.

Of course the surest method for ascertaining if the proper connections are made is to measure the currents in the three wires after the loads are connected, but the following method for determining the phase rotation before the loads are connected may be of interest. If for instance, 4 lamps are connected in series across the wires AC of a 220-volt three-phase circuit, they will be equally bright. If we connect a coil of wire as in Fig. 4 to the wire B and to the middle point of the series of lamps, the two lamps nearest A will become brighter than the two lamps connected nearest the wire C, if the voltage AB is 120 degrees behind the voltage BC. If the reverse occurs, it means that that the electro-motive force BC is 120 degrees behind the electro-motive force AB. The proper connections for the loads are then to have the load of unity power factor connected to the line with the test lamps of least brilliancy and the lagging load connected to the line with the test lamps of greater brilliancy.

The Hydro-Electric Developments of the Great Western Power Company.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN)

BY R. B. MATEER, E. E.

THE generation of electricity for industrial, commercial, domestic and heating purposes by coal consuming apparatus was satisfactory so long as the development of the appliance was in process, but when the large industrial power users began to negotiate with the central station for current of an auxiliary nature and later for the complete operation of the factory, then the public-utility realized the folly of installing additional steam consuming equipment and searched mountain and plain for other fuels. Oil was located and manufacturers invited to produce prime-

R. B. MATEER, MANAGER AGRICULTURAL SALES, GREAT WESTERN POWER COMPANY.

movers adapted for such a fuel but no unit of sufficient capacity and such as would operate satisfactorily was built or such as would efficiently displace the steam engine and supply the increasing demand for electric energy.

Nature has placed water falls with a lavish hand that with little expenditure become the sites of huge generating stations. In the mountains of California rushing torrents of enormous power possibilities are to be found. Streams which had their origin in the snows, far from the home of man, trickle down the mountain slope, swelling wider and wider until every canyon, gorge and gulch is filled with a rushing torrent. At one point, the water plunges over two thousand feet to the valley below and continues its flow through canyon and gorge. Here is power. Coal mines may be exhausted and oil wells dry, but streams possessing an inexhaustible supply wind down, through the chasms of California's mountains as long as snow is to be found on her mountain tops.

Journeying through the rugged and steep hills of Plumas county, one can reach a point of vantage from which a view of the surrounding country is possible. At his feet lies Big Meadows with its gushing springs and volcanic rocks. To the north the white-capped Mount Lassen, some 10,400 feet high, outlined against the sky; while in the distance Mount Shasta can be dimly discerned, calmly overlooking the smaller hills about it. To the south, winding its way through precipitous heights, the North Fork of the Feather river circles around buttressed hills and is lost to

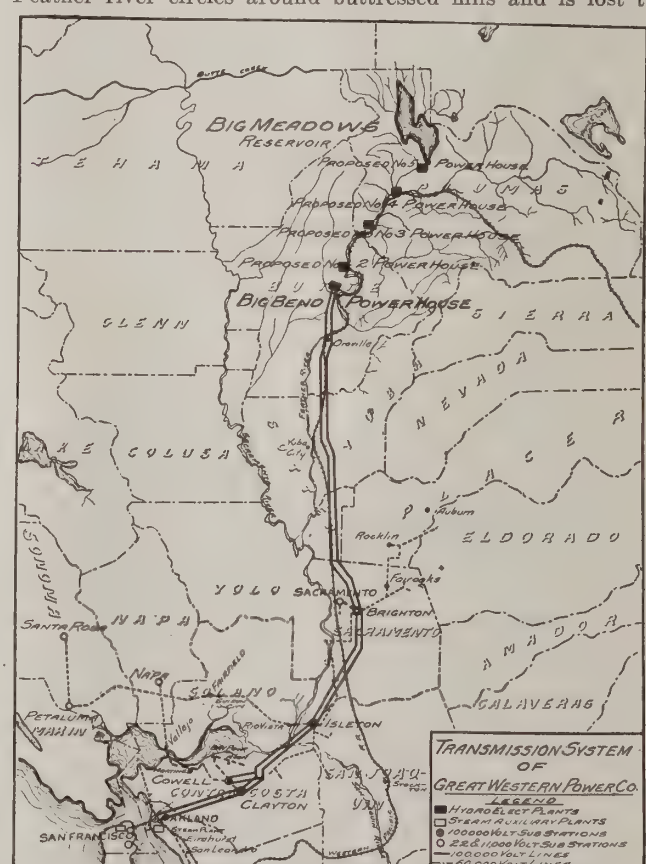


FIG. 1. TRANSMISSION SYSTEM GREAT WESTERN POWER COMPANY.

view. To the west mountains rise on all sides of fairly level tracts where the East Branch cuts its way to Gasners and joins the North Fork. To the east many creeks are visible, and in the valleys contiguous to Big Meadows and the North Fork of the river.

Viewing a country of this character one sees no fertile valley for prunes, plums or pears. Apple orchards and vineyards are not a feasible project nor is it practical to plant the hills with trees whose trunks would yield great wealth to future generations. The mind conceives the possibility of a huge hydro-electric development. Water in abundance and capable of great power is available. Surrounded on all sides by rocky cliffs are naturel dam sites where the immense flows of the wet season can be impounded and held in store, insuring the minimum amount of water necessary for power purposes. Here is the site of one of the largest impounding dams for power purposes.

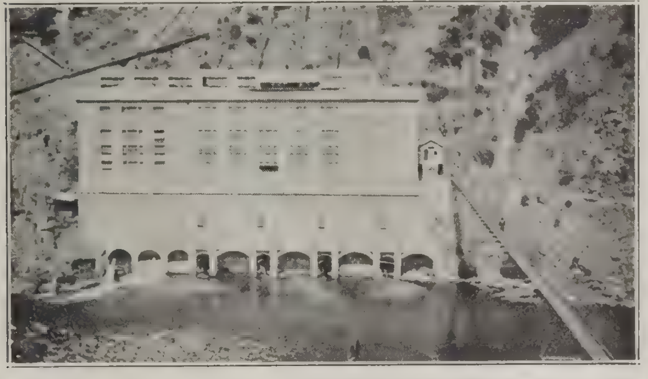


Fig. 2. Big Bend Power House, Great Western Power Co., Los Plumas, Cal.

By the construction at a point near Big Meadows of a dam, an artificial lake greater than any now in existence will be formed. The lake will cover approximately 40 square miles and impound some 54,450,000,000 cubic feet or in excess of 400,000,000,000 gallons. The breast of the dam will be 110 feet above the ordinary level of the river and beof the multiple arch type.

A report of the engineers as to the conditions of rainfall, storage and run-off assures an abundant supply of water, sufficient even in the direct periods for the generation of some 100,000 horsepower at Big Bend, and for some 400,000 horsepower at Yellow Creek and other points in the Big Meadows territory, ample to supply the power necessary for the development of the great inland empire of California.

BIG BEND.

In the Sacramento Valley, at the mouth of the Feather River Canyon, is the city of Oroville, the outlet of the most feasible pass through the Sierras. A few miles north of this city the river makes a detour in the range at a point known as Big Bend, returning on itself within three miles of where the bend starts. Years ago a company in search of gold conceived the idea of driving a tunnel through the bend and diverting the flow of the river, exposing its bed for some fifteen miles, and permitting of mining operations. A tunnel of some 11,800 feet was driven, at a cost of $1,250,000. The failure of the gold mining scheme permitted of the purchase by the Great Western Power Company of the tunnel, then incomplete. Additional development resulted in the diverting of a portion of the water from the North Fork of the Feather river, at the upper end of Big Bend, through a tunnel 15,000 feet long, to a point on the hillside and above the present site of number one power house. From here the water is carried through steel pipes 600 feet long to the huge turbine wheels at a head of some 420 feet. The tunnel was completed and enlarged, lined with cement and has a capacity of 2,500 second feet.

On the bank of the river a reinforced concrete and steel power house contains four turbine wheels designed and built by the I. P. Morris Co., of Philadelphia, and of the vertical shaft, inward flow type, which drive the four generators, each of 10,000 kw. and designed for 11,000 volts, each machine being of the revolving field, three phase, 60-cycle type. At the Big Bend power house the river level is 457 feet; the floor level at the station 506 feet; the middle head gate at the south entrance of tunnel 806 feet, and at intake 910 feet above sea level.

Characteristic of the Great Western Power Company is its substantial construction. The power house and substations are of reinforced concrete. There are no miles of leaky wooden flume carrying water from a dam at a distant point, instead a tunnel hewn out of solid rock with a factor of permanency as great as the hills through which it passes. Troubles from ice are eliminated as no ice forms along the entire waterway. In fact, the entire development is equal to the highest standard and is such as will withstand the ravages of time.

TRANSMISSION LINES.

Wooden pole lines are unknown on the circuits of this company. Steel towers anchored firmly in cement are used from one end of the line to the other. Suspension type insulators on the steel towers support duplicate lines of 000 copper over a private right-of-way. The towers are 75 feet high and are spaced 750 feet apart with transpositions every 3½ miles. In many sections where soft ground is found the towers are built on piles and concrete foundations. Much soft or marshy ground is found in the vicinity of Sacramento and to Antioch. The line passes through a hilly country from Oakland to Antioch; marsh and swamp from Antioch to vicinity of Oroville; and thence along the foothills to the mountains. The potential on both lines is 102,000 volts.

SUB-STATIONS.

Various sub-stations or points of transformation from 102,000 to 22,000 volts were planned and constructed. Near Sacramento is a sub-station connected to both 102,000 volt lines and with two banks of three transformers, each of 1,250 kw., from which point 22,000 volt circuits are conducted to the sub-station in Sacramento where the voltage is reduced to 2,200 volts for distribution systems for lighting, of single phase, together with a polyphase system for power purposes, placed at the disposal of the residents. Other sub-stations are the Cowell, containing a bank of three 1,250 kw. transformers and used for the operation of a large cement works; the Clayton and the Isleton with others now in course of construction.

OPERATION.

With construction complete and the Big Bend plant in operation, and the entire output contracted, bids were recently received on additional capacity such as will result in a plant of 80,000 kilowatts, the result of an expensive and aggressive business policy. Some 14,000 consumers are now either connected and receiving service or on the path of the distribution lines now under construction. Much of the output of this company was wholesaled to the Pacific Gas & Electric Company, but recent developments have prompted an elaborate expansive policy such as will bring "Electric Service" not alone to the city resident, but to the farmer, whose successful tilling of the soil and abundant crops spell prosperity.

When investigating the project particular reference was paid to further demands for current and proposed power house sites were selected, the tunnel locations surveyed and dam sites determined with special reference to the abutments.

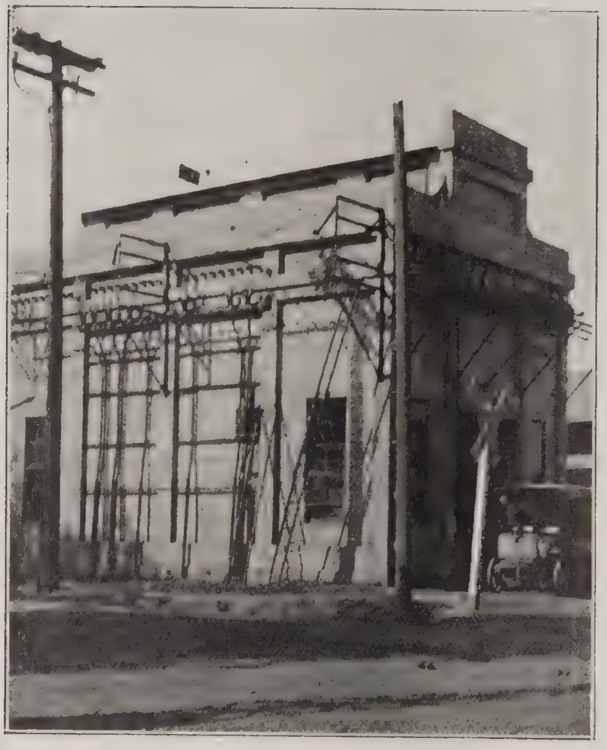


Fig. 3. Type of City Sub-Station at Sacramento.

As will be noted on the map illustrating the development of this company, ample provisions are made for current with which to supply the increasing demand for service.

IRRIGATION.

Provision to utilize all water at five huge generating plants does not rob the water of its ultimate value, that of irrigating the soil. The water discharged from the turbines at the Big Bend plant will be delivered to an irrigation system and conducted through various laterals for the irrigation of lands in Sacramento Valley below Tehama. The volume of water available will be sufficient to irrigate over 200,000 acres of land, utilizing natures "White Fuel" in such a manner as to secure all its latent possibilities.

CONTEMPORARY PROJECTS.

With construction under way on the Great Western Power Company's dam at Big Meadows we must not lose sight of other projects now rapidly assuming definite proportions. In Butte county, the Ora Electric Corporation, under the guiding hands of the Stone & Webster Company, of Boston, is preparing to construct a generating plant of some 40,000 kilowatt capacity, at an estimated expenditure of $10,000,000 for generating system, transmission and distribution.

In Placer county near Colfax the Pacific Gas & Electric Company is building a huge dam which will create a reservoir of some seven hundred acres. The storage from this lake is to be utilized in operating turbine generators each of some 9,000 kilowatts capacity at a plant near Towle. It is expected that when this project is complete sufficient power will be generated to supply existing needs and to permit of cancellation of the contract now existing with the Great Western Power Company, under which the Pacific Gas & Electric Company purchases much power at wholesale and distributes it at retail.

While remarkable developments in the use of water for current generation are occurring here in Northern California, the Southern Sierra Power Company is completing a transmission system with steam auxiliaries such as will permit it to cover much of the territory heretofore denied the advantages of electricity and resulting in much land formerly arid, being placed under cultivation and with contemporary projects prepare for the Western trend of colonization which will soon people the state of California, working out the manifold possibilities of her wonderful climate, soil and natural resources.

Annual Electrical Exhibition at Georgia School of Technology, Atlanta, Ga.

The third annual electrical exhibition of the Georgia School of Technology will be held February 7 and 8 in the laboratories and lecture rooms of the electrical department. This feature, originated by Prof. H. P. Wood, head of the department of electrical engineering, has met with remarkable success during the past two years and is now established in the affairs of the school open to the general public.

A wireles sstation has been erected on the campus and will be in full operation on the opening night. This station is capable of sending and receiving messages and will be in touch with the one at Fort McPherson so that those who desire can send and receive actual messages and get an opportunity to learn how it is done. The station has been erected by the students. A large Tesla coil designed and built by two students will also be on display, as well as a ladder of fire, a dancing table, perpetual top and a large number of modern electrical devices for the home, store and factory. Members of the senior class will be in charge and explain each exhibit in non-scientific terms.

The show is organized under a well planned management as follows: A. M. Wynne, managing director; A. F. Montague, business manager; J. B. Law, treasurer; R. L. Hughes, advertising manager; J. H. Berry, chief engineer. The admission will be 25 cents.

Annual Banquet of Ithaca Section A. I. E. E.

The sixth annual banquet of the Ithaca section of the American Institute of Electrical Engineers was held January 11 in the auditorium of Sibley College, (Cornell University). The banquet was attended by over 125, many coming from a distance especially for the occasion. Prof. E. L. Nichols, of the physics department, acted as toastmaster and addresses were made by the following:

Prof. G. S. Macomber, on "History of the Morse Telegraph Instrument." The original Morse instrument was in operation and a message received on it from Gano Duncan, past president of A. I. E. E. and principal speaker at last year's banquet. Mr. J. L. Harper, chief engineer, Niagara Falls Hydraulic Power Co., gave a talk on the engineering work at the Falls. Ralph D. Mershon, presiden of the A. I. E. E., gave personal experiences in the early days of power transmission in Colorado. Profs. Norris, Karapetoff, Smith and Kimball also gave talks on phases of the different branches of engineering which, as heads of departments, represented electrical engineering, experimental electrical work and steam and mechanical engineering.

Low Tension Distribution and Methods of Hanging Transformers.

Recommendations of Committee on Line Construction, Pennsylvania Electric Association.

A Comparison of Individual Transformers and Low-Tension Network Distribution—Methods of Installing Transformers up to 50 kva. Capacity.

LOW tension distribution for service connection is practically as old as the electric lighting business itself. This has special reference to the Edison D. C. system. Regarding its use for A. C., where the use of the individual transformer is an important factor in securing customers in outlying districts where low tension D. C. mains are unpractical on account of prohibitive cost, it naturally follows that the use of the individual transformer was carried beyond a point of the best economy. The grouping of a number of service connections on the same transformer has been carried on for a decade or more in the various parts of the country, and no claim is made in this report for any originality in the general scheme.

TABLE 1—COMPARISON OF INVESTMENT, EFFICIENCY, AND MAINTENANCE OF INDIVIDUAL TRANSFORMER AND LOW-TENSION NETWORK DISTRIBUTION.

Investment Per Consumer	*Individual Transformer*	*Low Tension Network*
1. Cost of poles	$ 8.00	$ 8.00
2. Cost of Primary Conductors, including supports	4.05	.60
3. Cost of Secondary Conduits, including supports	1.22	8.10
4. Cost of Transformers, including Protective Apparatus	15.50	2.30
5. Labor for Making Installation	6.00	5.00
6. Total Investment per Consumer	$34.77	$24.00
Efficiency, Losses Per Consumer Per Year.		
7. Transformer Core Loss	200 K. W. H.	24 K. W. H.
8. Copper Loss in Transformers and all Secondary Conduits	16.2 K. W. H.	25 K. W. H.
9. Total Losses	216.2 K. W. H.	49 K. W. H.
10. All Day Efficiency, Ratio of Known Input to Known Output	26%	71%
Maintenance and Depreciation Per Consumer Per Year.		
11. Depreciation of Transformers and Protective Apparatus, including Upkeep	$1.86 @ 12%	$0.18 @ 8%
12. Depreciation of Poles and Fixtures, including Upkeep	.60 @ 7%	.72 @ 9%
13. Depreciation on all Conductors, including Upkeep	.527 @ 10%	.522 @ 6%
*14 Average Cost of Changing and Altering Connections	3.71	1.12
15. Total Maintenance and Depreciation, including Interest on Investment at 5%	8.43	3.74

*This table covers the actual case illustrated in Figs. 1 and 2. The average cost of changing and altering customer's connection is the cost of changing only a certain percentage of the total number on account of increased load, moving, etc., and the value is arrived at by taking the average for a large district comprising 11,000 consumers.

INVESTMENT IS REDUCED.

When we group a number of service connections—whatever the character, the maximum demand is reduced. A large saving in transformer capacity is made and the total investment is reduced 31 per cent. This effect is most pronounced in the example used herewith on account of the load being residence service. The greatest saving is in the transformer investment and is explained by the fact that the small transformers removed cost $17 a kilowatt, while the larger units used cost only $8 per kilowatt. At the same time centralizing and reducing the maximum demand allows 15 kilowatts to carry the same load as the 53 kilowatts formerly supplied.

EFFICIENCY INCREASED.

Two transformers, with a total core loss of 180 watts, is substituted for 44 transformers with a total core loss of 1370 watts. In serving the small consumer from an individual transformer the core and copper losses average two to three times the metered consumption. Even when as high as twenty residence consumers are served from a party transformer the losses may exceed the metered energy. Grouping consumers makes it possible to take advantage of the small losses of large transformers. The increased copper losses in mains is of most importance as a condition

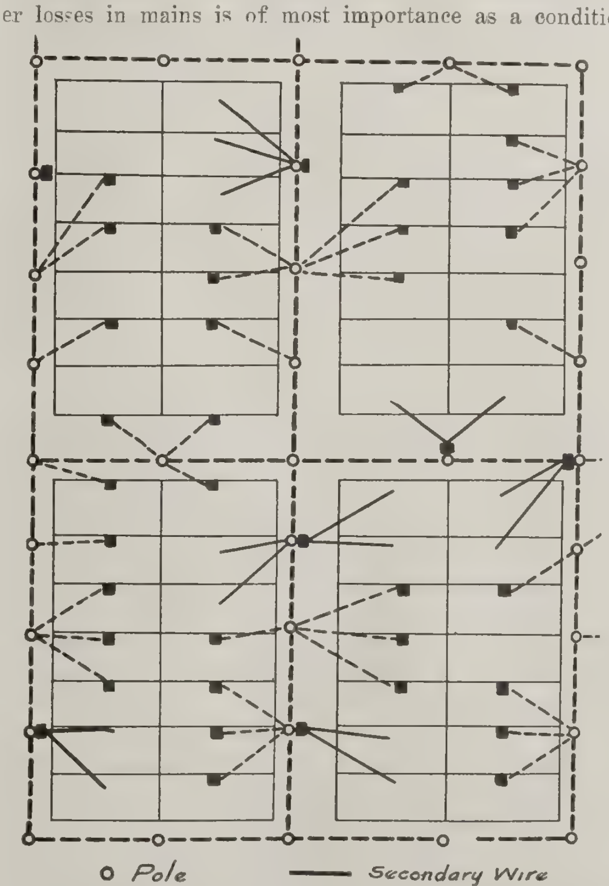


FIG. 1. LAYOUT FOR 60 RESIDENCE CUSTOMERS SERVED FROM INDIVIDUAL TRANSFORMERS.

affecting voltage regulation and when substituting a three wire network for the two wire mains of party transformers, the difference is negligible.

FLEXIBILITY AND RESERVE CAPACITY.

In connecting a consumer to an individual transformer, the labor cost for mounting the transformer and primary cutouts, and installing the primary service wires in a safe manner averages about three times the cost of making the same connection from the three wire mains of a network.

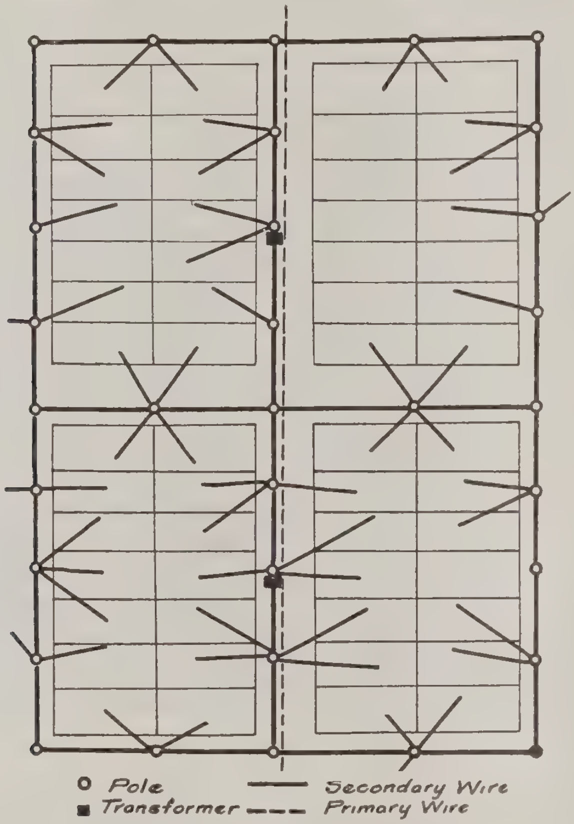


FIG. 2. LAYOUT FOR 60 RESIDENCE CONSUMERS SERVED FROM A LOW-TENSION NETWORK.

More time and judgment is required in properly adjusting the transformer size to the load conditions. The low tension service connection can be more closely standardized and once in place, disconnections when service is discontinued is simple. The reserve capacity of the connection is unlimited by transformer size and when the consumer has a social function, requiring all or extra lights, no changes are necessary and the quality of service is not impaired.

IMPROVEMENT IN VOLTAGE CONNECTION.

This improvement is a result of low tension distribution. With service from an economically arranged individual transformer, it is difficult to avoid an objectionable drop in voltage when supplying the maximum demand, on account of transformer regulation. The large reserve capacity of the network greatly reduces this condition. The difference is of more importance than is ordinarily realized since the maximum demand always comes on the occasion of some social function of special business effort, and the consumer is naturally more exacting.

CONTINUITY OF SERVICE.

The small transformer whether mounted on a pole or house, necessarily means a ramification of primary mains and service leads. It is impossible to avoid contact with trees and the wires are frequently broken by falling trees, limbs, or ice from roofs. When carried to the building, these wires and the transformer are often near windows and frequent accident to plumbers, painters or other mechanics have resulted. The removal of individual transformers removes the effect of maximum demands on transformers and primary cutouts. By removing forty-four individual transformers and substituting two large units, we reduce the liability of interruption by a ratio of approximately twenty to one. The effect of lightning is greatly reduced on account of larger air gaps and insulation factors in the larger transformers which are used in low tension distribution.

MAINTENANCE AND DEPRECIATION.

The total saving per consumer per year in the case mentioned is $4.67. Reducing the number of transformers decreases the maintenance of this apparatus in about the same proportion that the change improves the continuity of service. The effect of lightning and premature fuse operation, by reason of a much smaller number of units to be maintained and the practicability of more costly apparatus, can be eliminated. Removal of a larger amount of primary wire is more a factor in improving the continuity of service than in reducing the maintenance of conductors. Heavier wires on poles and pole fixtures necessarily increase maintenance unless a new type of construction is developed.

The greatest saving effected is in the future maintenance of the service connection. In a certain representative district of a central station system a record of three thousand cutins and two thousand cutouts were made. The average cost of making a service connection from individual and party transformers is about $3.71. The same connection from a low tension distribution system averages $1.12 per connection. The difference of these values is a saving which is progressive throughout the future growth and maintenance of the system.

PROBLEMS IN LINE CONSTRUCTION.

It has been shown that the use of individual transformers crowds the poles, subjects primary conductors—which have a low insulation factor and mechanical strength—to foreign elements. On the other hand, it is self-evident that low tension conductors of heavy cross section and weight

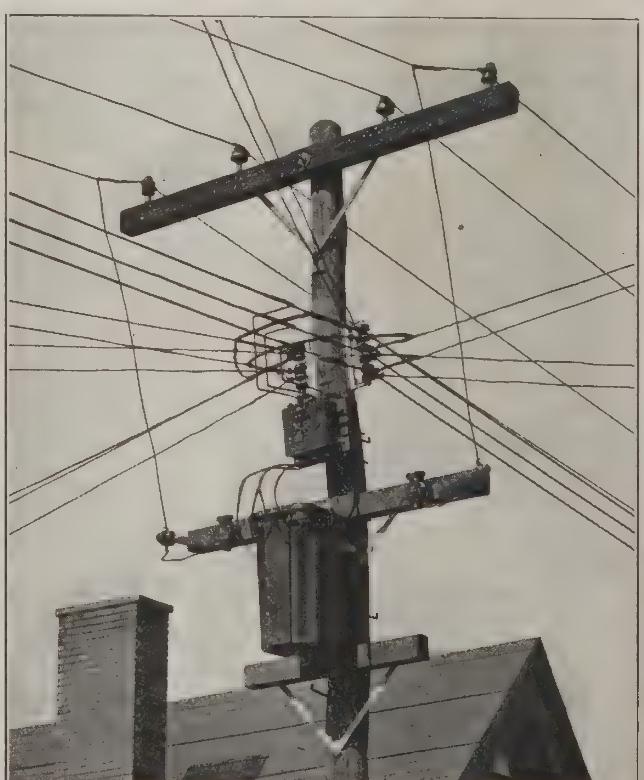


FIG. 2A. A GOOD METHOD OF LOW TENSION DISTRIBUTION.

greatly lessen these disadvantages, but increase the strain on the poles and the depreciation of existing overhead construction to a point demanding close attention. There is an increased strain on crossarms which lies in an inability to balance the weight of the three wires on the two sides of the crossarm, and maintain the arm in a horizontal position. New construction may have a good appearance, but with age the crossarm is displaced and the pole is bent, giving an unsightly appearance. The greatest of the additional strains on the pole is the torsion subjected by the unbalancing of the weight on the crossarm. When the wires are dead-ended or spans are of unequal length, there is a tendency for the pole to be twisted, which finally results in cracking and early decay at the top of the pole. To overcome these conditions a three-point galvanized distribution bracket of a type widely used gives an improvement in construction. This bracket served the double function of supporting the three-wire mains and as an attachment for service lines leading off from the pole. However wide use soon demonstrated that this bracket was not universally applicable to low tension distribution on account of its mecanical strength being insufficient to maintain the wires at the close spacing desired. To overcome these objections a new type of bracket was designed. The appearance and use of this bracket is shown in Fig 2a. It is fastened to the pole by two through bolts and gives absolutely rigidity and has sufficient strength to meet the stress of wires carried off in any direction. The insulators are cheaper, more rigid and much stronger. Wide use under the severe condition of supporting wire of 4/0 size has shown that this bracket will maintain proper spacing under all conditions, and on new pole lines where the setting of the poles often causes displacement and change in stresses.

A good appearance is not the only asset of a small spacing of wires in a vertical place. When the top wire is made the neutral, it can be grounded at the most desirable points, protects the circuit against injury from falling wires of a foreign potential, and is especially effective in protecting against direct strokes of lightning. Broken wires attached to the same pole and suspended in the same plane fall clear and telephone and signal wires, when the poles are jointly used for these services, can come in contact without receiving potential above that of the ground.

In conclusion attention is called to the report of the National Committee on the Grounding of Secondaries, the substance of which is that every low tension lighting service connection should be grounded. Low tension network distribution makes this safeguard highly practical and a few ground connections of the most approved form can be installed and maintained with the highest economy.

DEVELOPMENT IN TRANSFORMER HANGING.

Coincident with the general aggressive campaign carried on by the new business departments in securing industrial power customers for central stations, has come the realization of the need of the best character of construction, as to arrangement of apparatus and kind of material, in order to meet the demand for reliable service to be obtained by the use thereof. The committee being familiar with some recent modern installations feels it of sufficient importance to the member companies of this association to present the subject by illustration and description for adoption, in whole or in part, according to the judgment of the operating or construction man.

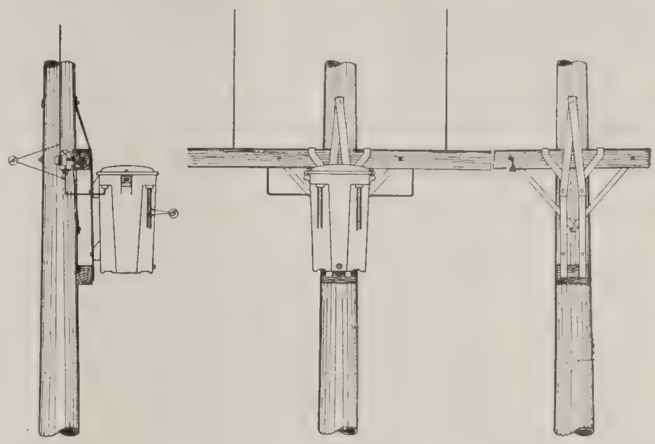


Fig. 3. Supports for a Single Transformer 5 to 10 kw.

The results sought in the development of this work were: 1. A greater factor of safety—electrically and mechanically. 2. Expeditious replacement of parts. 3. A minimum cost of material in securing the greatest mechanical strength thereof. 4. Improved appearance of construction. Some of the original installations are, at

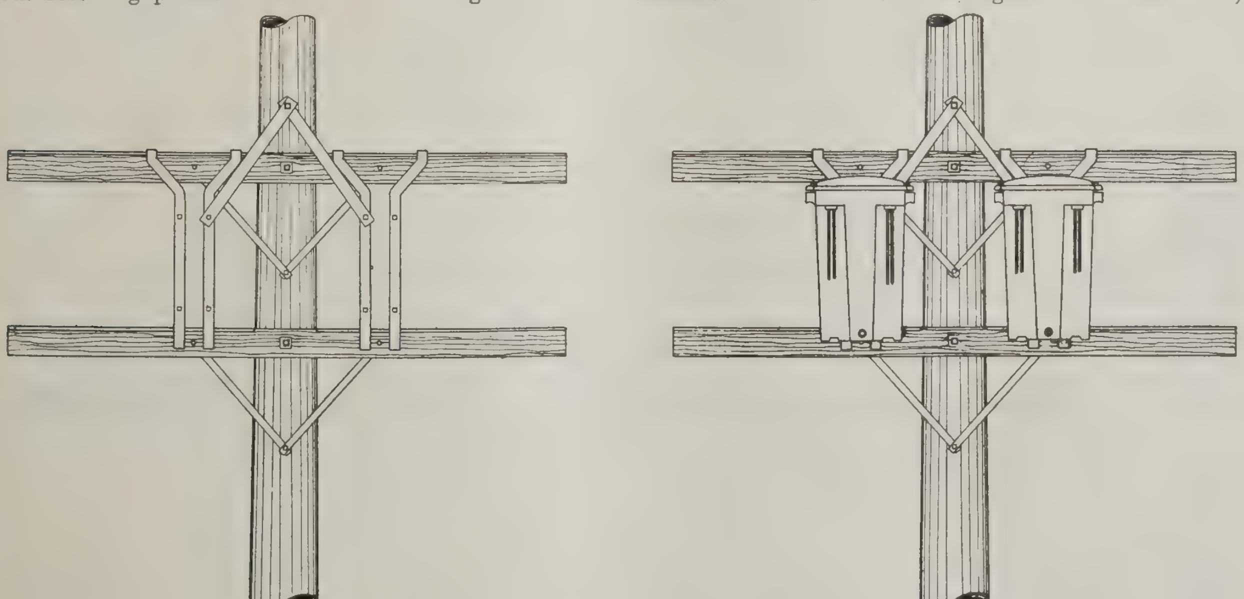


Fig. 4. Arrangement of Braces for two 5 kw. or Two 10 kw. Transformers.

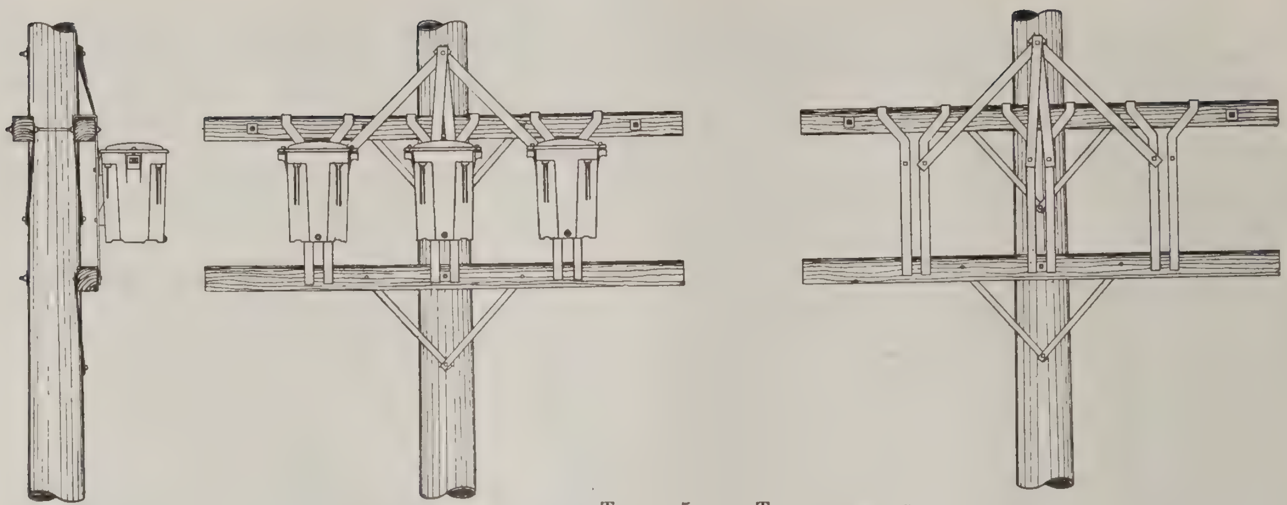


Fig. 5. Supports for Three 5 kw. Transformers.

best, crude makeshifts, insofar as the transformers are placed in some instances horizontally, and again in a vertical plane, not limiting the size or number of transformers to a pole. This makes it quite a puzzle in connecting primary and secondary lines which brings them in close proximity to each other, and many an interruption of service is directly attributed to wires coming together during wind storms.

METHODS OF HANGING TRANSFORMERS.

Single transformers from one to four K. W. shall be supported by regular iron hangers which accompany each transformer. They shall be hung from the central point on the crossarm and not out on the arm away from the pole. At the bottom of the hanger a section of an arm not longer than the diameter of the pole is to be fastened to the pole with two lag bolts. Transformers of the above size, *i. e.*, one to four K. W. can be hung on the bottom arm which is in place and supporting lines, provided this arm is in the second gain or lower and the primary mains which feed the transformer are on the upper arm.

In installations where the transformers are more than four feet below the arm supporting the primary mains, it is advisable to place Western Union pins or line arms from which the primary wires are tapped to maintain them rigid, also on transformer arms before entering the fuse boxes to take the stress from the fuse terminal screws. The costs for doing this work are about the same as the former methods.

SINGLE TRANSFORMERS FROM FIVE TO THIRTY KILOWATTS.

The same rule is to be followed as described in the preceeding paragraph with the following additions. The transformers on account of their increased weight and dimensions should not be hung on a linearm. A separate block should be used underneath existing arms and other apparatus. In addition to using the regular hangers which accompany transformers, a pair of iron braces 24 x 2 x 1/4 inches should be placed between the transformer lugs and the hanger with the hanger bolts connecting through one of the holes provided in the braces. These braces should be run in an upward direction and fastened to the pole with a standard through bolt as shown in Fig. 3. In the event of the arm weakening or entirely rotting away, these two braces are sufficient in strength to support the transformer and facilitate crossarm replacement.

SUPPORTING TWO 5 KW OR TWO 10 KW TRANSFORMERS.

In this instance similar construction is to be used except

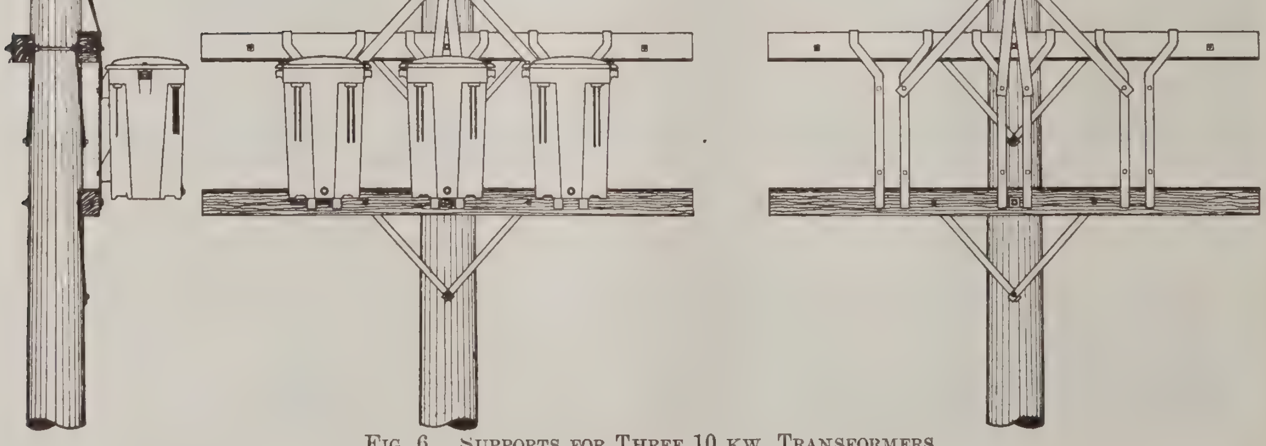


Fig. 6. Supports for Three 10 kw. Transformers.

that a standard arm is to be placed at the bottom for the hanger irons to rest against. Also only one special brace 24 x 2 x ¼ inches per transformers need be placed between the lug and the hanger iron next to the pole, as shown in Fig. 4.

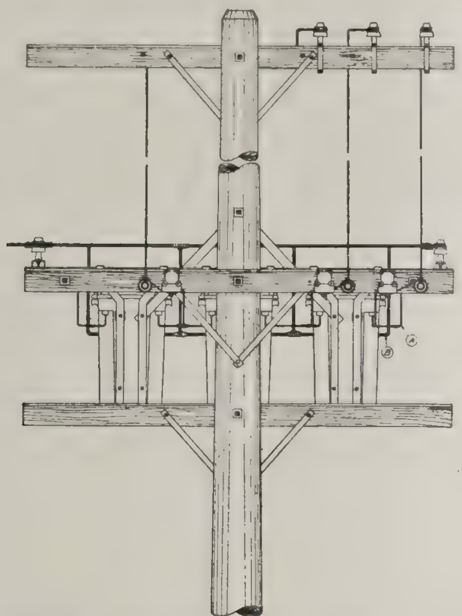


Fig. 7. Wiring Arrangement for Three 5 kw. or Three Ten kw. Transformers.

SUPPORTING THREE 5-KW TRANSFORMERS.

The construction should be similar to that shown and described in the preceding paragraph, excepting that the special braces supporting the outside transformers should be 33 inches between the center of the holes. It is also advisable to place an additional crossarm on the other side of the pole. This arm is for the purpose of bracing the front arm, also providing for the placing of fuse blocks thereon. The construction is shown in Fig. 5.

SUPPORTING THREE 10-KW TRANSFORMERS.

The construction is similar to that of the three 5-kw transformers with the following additions. The top arm supporting the transformers should be reenforced with a piece of angle iron 5 x 3 inches by the length of the crossarm, to be placed with the three inch leg on the top of the arm as shown in Figs. 6 and 7.

The average life o fthe long leaf yellow pine cross arm has been found from observation to be from four to six years. When these arms are carrying unusually heavy loads, such as supporting heavy transformers, their useful life as such is considerably decreased. This subject is more fully covered in later paragraphs, but is touched on here to explain the engineerng points involved.

The braces were introduced strictly as tension members to avoid the use of two or more crossarms to secure the same mechanical strength. The construction results in neater appearance; guards against falling of transformer in case the crossarm breaks or is burned off and facilitates the replacement of a defective arm and gives a longer useful life thereof.

SUPPORTING TWO 20-KW, TWO 30-KW, OR ONE 50-KW TRANSFORMERS.

For these capacities a single-pole platform is recommended. The material of the platform should be made up of two pieces of 2 x 4 inches, channel iron 8 feet long with two braces. The braces used should be a single piece of angle iron 3 x 3 x ⅜ inches bent in a V shape. Pine or oak planks 2 x 12 x 24 inches should be laid across the channel iron for the transformers to rest on. The wooden platform should be held together by a 2 x 2 inch strip of wood running on the outside of the channel iron, to which the

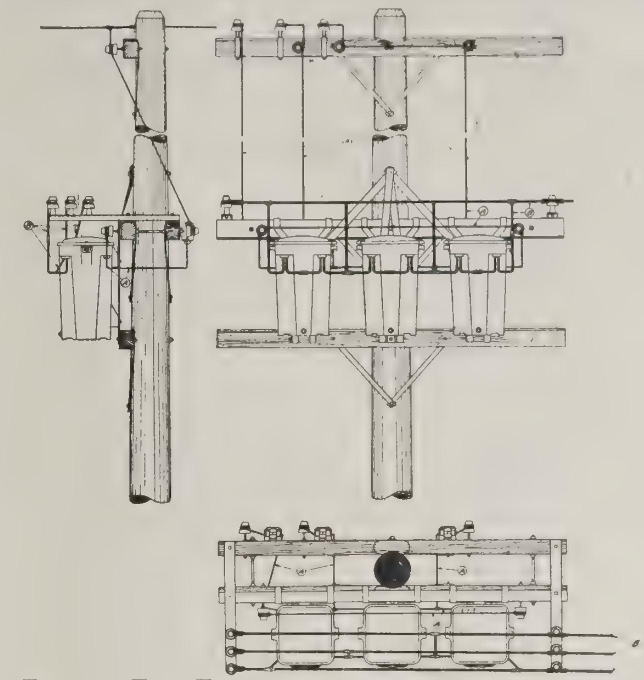


Fig. 7a. End, Front and Top View of Arrangement Fig. 7.

planks are secured by 4 inch wood screws or 20 penny nails. The construction is shown in Fig. 8.

SUPPORTING THREE 20-KW, THREE 30-KW, TWO 50-KW OR THREE 50-KW TRANSFORMERS.

In these cases it is advisable to use a double-pole platform. The poles should be placed 10 feet centers apart. The main channel irons should be 6 x 2 inches by 10 feet and six inches over all, the braces then should be 3 x 1½ inches channel, the construction is shown in Fig. 9. In line with the other iron and steel pole hardware, all material and fittings should be furnished cut, drilled and

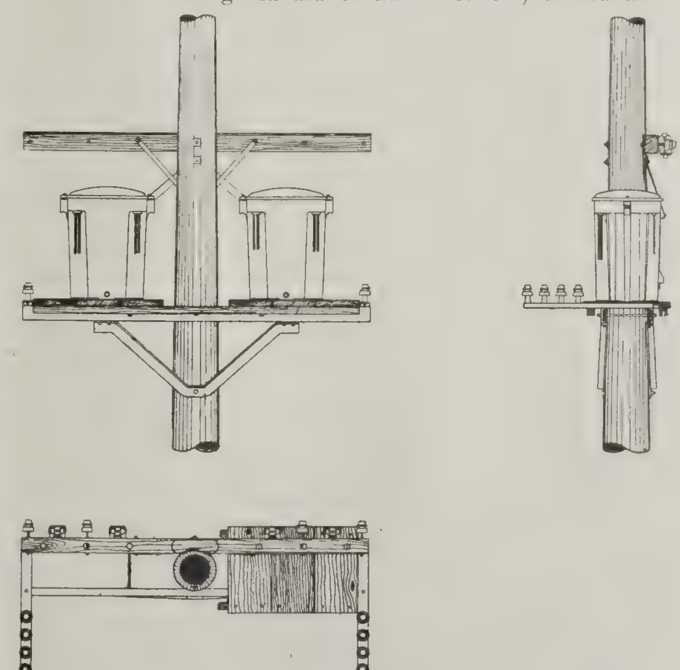


Fig. 8. Single Pole Platform for Two 20 kw., Two 30 kw., or One 50 kw. Transformers.

galvanized by the manufacturer according to the National Electric Light Association specifications for hot galvanizing.

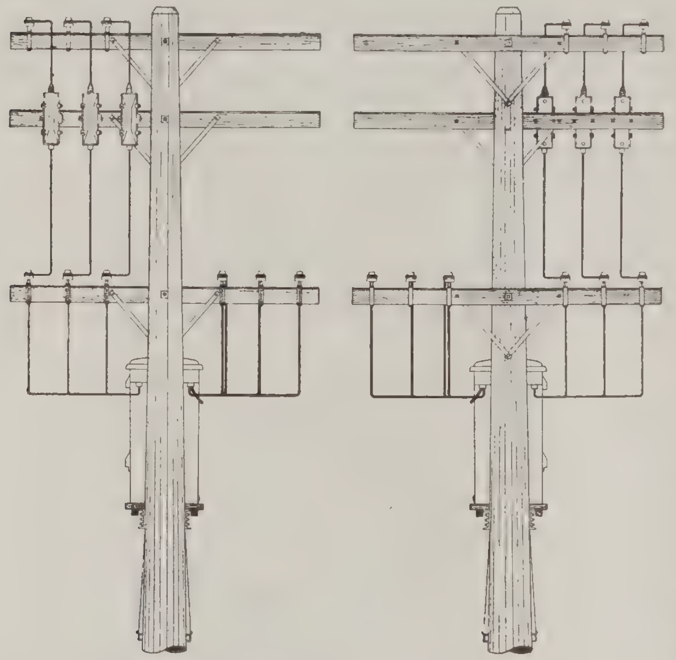


Fig. 9. End View of Two-Pole Platform for Three 20 kw., Three 30 kw., Two 50 kw. or Three 50 kw. Transformers.

The clamps and pins shown in these illustrations are not in any way required but can well be used and are used by many operating companies in an effort to avoid the failures caused by wooden pins. The following engineering arguments on this point have had several years' test in practical every day work and they have substantiated so far the following claims. The tendency on the part of the pins is to pry the crossarm apart to a noticeable degree where used for dead-ending wires. The trapping of water in pinholes promotes rot and decay showing an advantage in favor of the metal supports inasmuch as the metal rarely breaks and the bending of the pin gives ample warning of the weakening of this support. Also the clamping of the pin tends to support and strengthen the arm where checking due to too rapid drying out of green wood has a tendency to split the arm with the grain. The above results were obtained by the use of 6-pin long leaf yellow pine crossarms, 75 per cent heart, being 4 x 5 inches by 8 feet. These conclusions were confirmed by recent government tests, (Circular No. 204.) which shows that 70 per cent of the failures that occurred by compression or rupture of fibres were due to pin holes.

One of the main objects to be kept in view in pole line construction is to provide clearance to enable men to work on transformers, fuse blocks, etc., and also to provide sufficient climbing space to reach the wires on the upper crossarms without danger of coming into accidental contact with the wires or causing interference therewith. To accomplish this the rule should be made that where more than one transformer is hung on the same pole and close to the center of the crossarm, they should both be hung on the same side of the pole with reference to the protection of the line, that is, the other side of the pole which would be ordinarily used for climbing, must provide ample clearance for the linemen and the minimum climbing clearance on one side of every pole should be 36 inches.

The construction work discussed here refers to 220 volt single and polyphase service. With some modifications of insulators, it can be safely used on potentials up to 4400 volts. The largest installation covered in this report is three 50-kva transformers. It is recommended where larger installations are made, usually requiring oil switches, breakers, meters, etc., as well as the transformers, that they be installed in compartments or small sub-stations on the premises; although heavier construction of poles nearer the ground can be used where they can be erected in yards that can be protected and access to unauthorized persons avoided—in other words, the subject of this paper is for the erection upon streets or in alleys where the apparatus must be kept well above the ground.

An advantage in the favor of the use of platforms is the accessibility of the fuse blocks and the transformers for repairs and replacing. Any or all transformers can be replaced, while maintaining the wires in a fixed position between supports. This is a special feature in three-phase using three transformers in delta. Where, if one transformer should burn out or otherwise become defective, it can be disconnected and removed from the platform and the service reestablished with reduced capacity in the shortest possible time.

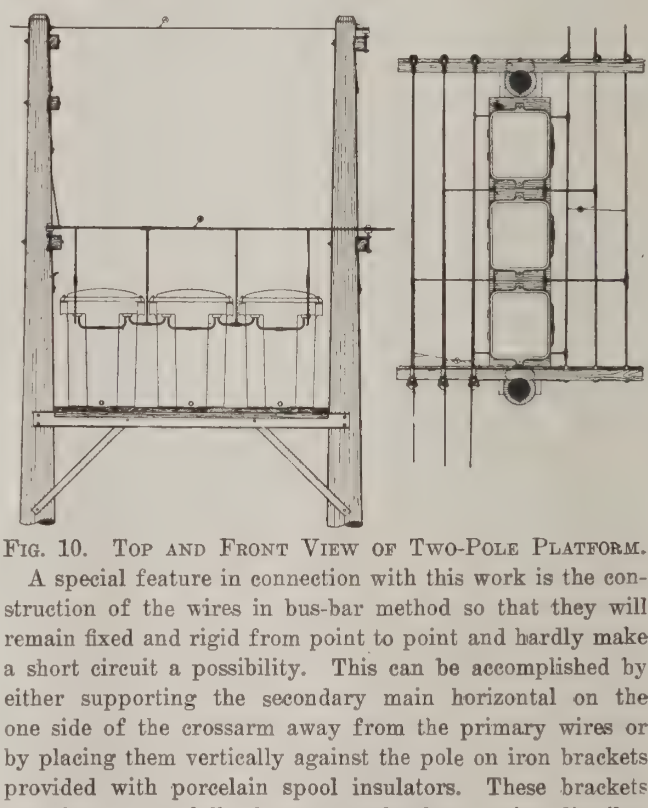


Fig. 10. Top and Front View of Two-Pole Platform.

A special feature in connection with this work is the construction of the wires in bus-bar method so that they will remain fixed and rigid from point to point and hardly make a short circuit a possibility. This can be accomplished by either supporting the secondary main horizontal on the one side of the crossarm away from the primary wires or by placing them vertically against the pole on iron brackets provided with porcelain spool insulators. These brackets have been more fully featured under low tension distribution. The latter method is recommended, as with the size of the brackets the size of the mains are only limited by the size of the transformers the platforms will support. Also there is no possibility of pulling the crossarms out of shape by dead-ending.

Transmission Voltage Going Up.

A transmission line some 275 mlies long is to be built by the Pacific Light & Power Company from a new plant on Big Creek, about 60 miles east of Fresno, to Los Angeles. This line will be designed for a voltage between 150,000 and 175,000 volts. It is claimed that climatic conditions are such in this section that 200,000 volts or more may be used on future transmission systems.

Design of Show Window Illumination.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN).
BY D. R. SHEARER, E. E., CONSULTING ENGINEER.

A GREAT deal has been written concerning the proper methods of designing and installing illuminating fixtures and equipment in different types of buildings and for rooms of different characters, but little has been said regarding show window lighting and the results to be sought by proper methods of design, or of the effects necessary for the best results. Several marked differences may be observed in the outset between the illumination of show windows, ordinary living room illumination and industrial lighting.

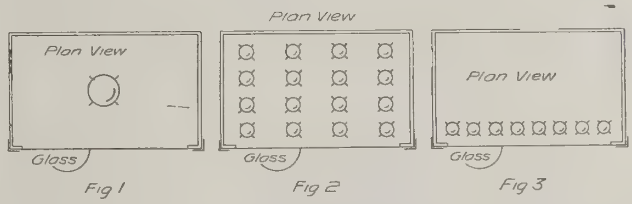
The lighting of a room is primarily for the use and benefit of the occupants and should be designed to furnish sufficient illumination for reading and other domestic pursuits, the lamps and fixtures arranged symmetrically, or artistically according to the taste of the owner. The entire lighting equipment of a residence should be considered from a practical standpoint as well as æsthetically or artistically and the general illumination of a room should be such that any article contained within its bounds may be reviewed from any point or angle in a plane of the observer's eyes. In contrast to this the articles in a show window are to be viewed from one, or at most, two sides, and from the outside of the containing walls. The glass also acts as a limit to the distance at which the observer can see the display.

In residence or living room illumination, the fixtures or lamp supports are to be considered a part of the artistic scheme and are secondary only to the actual light required, but in show window lighting, the requirement is purely illumination, properly proportioned, properly directed and in the right amount. Any visible fixture in a window detracts the attention of a possible buyer from the line of goods there shown and this detrimental effect would be heightened by ornate or showy fittings of any kind. Even the light sources or lamps, if visible, detract greatly from the effective lighting, as a usual thing, both by drawing the observer's attention from the display and by contracting the pupils of the eyes and thus weakening the apparent or useful light thrown on the goods in the background.

In this particular, window and stage lightings are very similar. The footlights, border and strip lights are all concealed from the audience and no light sources can draw attention from the scenic effects or from the performance. However, a vast quantity of light must be thrown on the scenery in order that the appearance may be made more natural. We note also that a stage manager has absolute control of the quantity and quality of light, so that great variations may be had to harmonize with the stage setting. In general, then, window illumination should be such that there is nothing to detract from the display and yet the light must be of such intensity and arrangement as to bring out all the delicate shadings and good points of the merchandise.

It is preferable that the wiring be so done that the window dresser can control or vary the amount of light to correspond with different backgrounds and with special effects in display work. If drapery is used to any extent, the colors make a marked difference in the quantity and quality of the apparent light. By apparent light in this case, we mean the illumination in foot candles on a given plane less the amount absorbed by any material or articles in the window other than the natural background. One foot candle intensity of illumination is produced on a plane one foot from a light source of one candle power.

Before taking up in detail the proper iluminating quality and quantity for various displays, we will consider in a brief way some phases of layout or design and location of lights for attaining certain results. A window will be assumed of the simplest construction with a rectangular floor, three enclosed sides forming the background, the side facing the sidewalk formed of a single glass, and veiled horizontally at an average height. We will consider three kinds of systems of lighting, *viz.,* the unit system, the distributive system and the angle or concealed system, shown respectively in Figs. 1, 2 and 3.



FIGS. 1, 2, AND 3. LAYOUTS FOR THE UNIT, DISTRIBUTIVE AND ANGLE SYSTEMS OF WINDOW LIGHTING.

The unit system contemplates the use of a single large light source centrally located in the window and protected by a suitable reflector. This kind of lighting, while frequently used and sometimes desirable, has several inimical features, among which are lack of flexibility, visible to the observer as a light source, gives a flat effect directly under the light and creates distorted shadows near the edges of the window space. For these reasons such arrangement is barred from the best practice except in cases where first cost of installation is of prime importance or where some special effect is desired.

The distributive system, while an excellent method of industrial lighting, is not usually suitable for show windows. The defects of the previously mentioned system still obtaining except in regard to the distorted shadows, there being a flat effect with practically no shadows in this case.

The angle system has proven, in the writer's opinion, to be the best adapted, most economical and most satisfactory for all general show window illuminating purposes although the initial cost is probably greater. Such a system, as shown in detail by Fig. 4, furnishes an evenly distributed light, economically placed with correctly proportioned shadows.

It may be noted here that a certain amount of shadow is highly desirable as it gives depth and richness to the goods displayed and brings out the finer points of detail, creating a natural and pleasing appearance more nearly like daylight. Natural daylight when the sun is shining, although seeming to come from a single source, is diffused and reflected from innumerable objects, hence shadows are softened and we have the appearance and effect to which we are accustomed and in which we can accurately judge or estimate contour, distance, and surface characteristics. The more nearly we can approach this result in window lighting, the more natural goods or articles of merchandise appear and the more desirable to the observer, who can appreciate the good points or the workmanship of the material on display.

For the present we shall eliminate all types of show window lighting from this discussion except the angle system, or in other words a series or line of light sources placed near the ceiling of the window at the front or near the glass and concealed from view on the street side, protected and assisted by various types of reflectors. Illumi-

Fig. 4. Fig. 5.

Figs. 4 and 5. Angle Reflector Showing Requirements of Different Ceiling Heights.

nation of this kind is in itself subject to many variations, and many kinds of reflectors or systems of wiring may be used in effecting the desired results For instance in Fig. 5, it is seen that window ceilings of different height require reflectors of different angles as 15, 30, 45 and 60 degrees. Such reflectors are made in several sizes and in the different angles named so that the field of illumination may be covered adequately regardless of the size and shape of the window enclosure.

Another type is the trough or continuous steel reflector which may be secured in several styles and sizes adapted to all sizes of tungsten lamps. It is preferable that in all such window fixtures the receptacles be so arranged that the lamps hang in a vertical position. The wiring, also, should be arranged so that the lamps may be burned in thirds, each third controlled by a separate switch. An arrangement of this kind allows the window dresser three or more variations (if different size lamps are used) and illumination to meet the differing conditions of his arrangement and background. Fig. 6 shows a diagram of this wiring system.

Trough reflectors may be used with corrugated mirror lining, plain mirror or dead white enamel. The enamel, paradoxical as it may seem, is fully as efficient as the mirror, and in addition is much lighter in weight, more easily installed, cheaper, and furnishes a better color toned light. Reflectors of this type are usually concealed from view by a painted strip on the window glass or a sign of some kind, or the ceiling may be raised a sufficient height above the glass and the fixture placed in this space. Lamps are usually spaced one to the foot, so that it is necessary to calculate the size of the lamps from the space to be illuminated per lineal foot. Assuming a maximum illumination of 12 foot candles' intensity, the methods of determining the size of lamps is as follows:

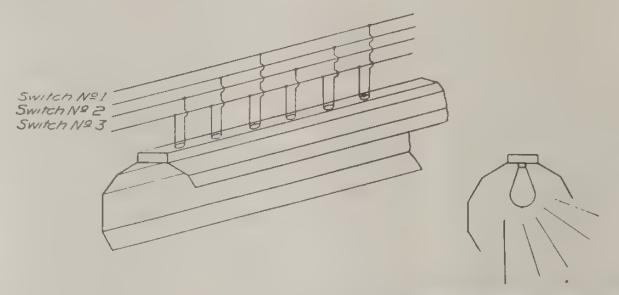


Fig. 6. The Trough or Continuous Reflector and Wiring Scheme.

Let A equal area of plans to be illuminated; I equal intensity in foot candles required; in this case 12.; K equal illuminating constant or ratio of useful light to total amount produced, usually about 50 per cent or .5; Q equals total quantity of light given out by light sources; L equals total quantity of light on plane of illumination; l equals quantity of light from each lamp; X equals number of lamps of the size required.

Then in general, AI equals light needed on plane of illumination, and AI/K total quantity of light needed measured at light source. And AI/KL equals X or number of lamps of the size required. The following case is worked out. Given a window eight feet wide. By width here we mean to include both the floor and back wall as far as the illumination should extend as provided by the reflectors used. Assume $K = .5$ and $I = 12$, trough reflectors, one-ft. spacing of lamps. Then A per lineal foot $= 8$. Quantity of light needed per lineal foot $= A \times I = 8 \times 12 = 96$ lumens. Then Q per lineal foot $= L = (A \times I)/K = 96/.5 = 192$ lumens.

Nearest this value in the table of lumens is 200 lumens requiring a 25 watt lamp.

Table of reflection values of different wall and ceiling finishes:

White blotting paper	.82	Brown	.20
Foolscap paper	.70	Emerald green	.18
Chromo yellow paper	.60	Dark brown	.13
Orange paper	.50	Vermillion	.12
Yellow painted	.40	Blue	.12
Light pink	.36	Black paper	.05
Yellow cardboard	.30	Black velvet	.004
Light blue	.25		

The lumen is the quantity of light falling upon an area of one foot illuminated with an intensity of one foot candle.

Approximate Table of Lumens for Mazda Lamps.

Watts	M.H.C.P.	Total Lumens
25	20	200
40	33	333
60	51	500
100	88	868
150	134	1300
250	227	2200

A table of the relative absorption of colors is here given for the convenience of those desiring to properly proportion the light for mixed color drapery displays. First, the relative area of the light plane to be covered by the different colors must be approximated and the color correction factor applied to each portion covered by a certain color.

After finding the amount of light needed, arrange the number of lamps to most nearly reach the result calculated.

From the above it may be seen that a great deal of the efficiency of a lighting system depends on the colors and finish of the ceiling walls, a dark wall absorbing more than half o fthe available light. A glazed or glossy finish is olso to be avoided as the reflection of the light sources causes a glare and sometimes the reflection of the lamp itself may be seen. Probably the best finish to use on the interior of a window is a paneling of light cream and white or other dead finishes in very light tints. When white goods are on display in a window properly finished, only one or at most two-thirds of the light is necessary for the proper degree of illumination, and the remainder may be switched off, to be used only for a dark or deep color display.

In a brief review of this kind, it is not possible to go into the detail necessary to cover even a small part of the design of show windows or the many methods of lighting and of making attractive displays, but the writer desires to call attention to the fact that there is much room for improvement in the average window. In fact, improperly lighted and poorly designed windows are much more numerous than those economically and artistically illuminated. With this in mind, it should be the constant aim of the lighting solicitor and the electrical contractor to bring to a higher standard this field of illuminating work.

Recent Development in Electric Meters.

BY H. W. YOUNG.

Single and Polyphase Integrating, Portable Watthour and Graphic Recording Meters of Mercury Flotation Type.

A LINE of meters, known as the mercury flotation type is now successfully established by the Sangamo Electric Company. The principle of operation is based on an old discovery by Faraday who discovered that a pivoted metallic disc carrying an electric current would tend to rotate under the influence of a magnetic field. The Sangamo meters are most ingenious in their make up and have been designed to cover a wide field of electrical power measurement. In what follows the recent developments in this particular line of meters will be given as related by one of the company's engineers before the Illinois State Electric Association. The developments here given are those of particular interest to the central station industry.

INDUCTION METERS.

The past two years have been especially prolific in the production of new forms of single-phase induction watthour meters, and in some cases, the various manufacturers

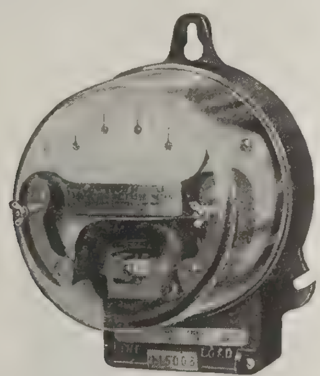


Fig. 1. Single-phase Induction Meter.

are producing several types. One of the new types departing to a considerable extent from the heretofore accepted designs, is shown in Fig. 1. The chief characteristic of this type aside from its accuracy, is its great accessibility, the design being such that the meter can be taken entirely apart and reassembled in a few moments without disturbing the adjustments. This simplicity of design is of great importance to the central station meter department, as replacement and repairs of elements can be quickly and cheaply made. The meter can be used interchangeably on inductive or non-inductive circuits, and is self-contained in all capacities up to and including 100 amperes.

POLYPHASE INTEGRATING METERS.

A new form of polyphase watthour meter recently developed is illustrated in Fig. 2. A unique feature of this design is in the arrangement of the moving system, which is carried on a single grid, so that by simply taking out four screws, the elements can be removed and the two shunt

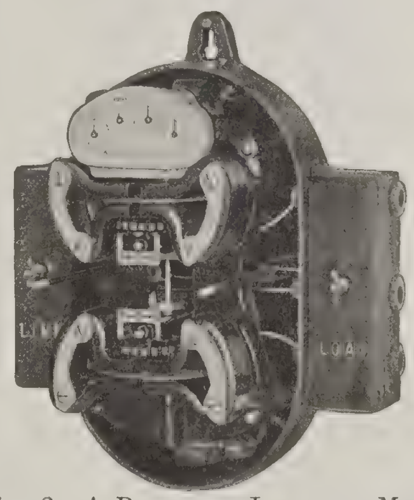


Fig. 2. A Polyphase Induction Meter.

magnets are left in the base of the meter. It is then a very simple matter to repair and replace either shunt magnets or series coils without distrubing the other meter elements, removing the recording mechanism or the moving system. To conform to the requirements of modern central station practice, the losses have to be kept at a minimum and the torque ratios high. The full-load torque is 85 m. m. g., the moving element weighs 32 grams and the ratio of torque to weight is 2.6. The meter can be used interchangeably on balanced or unbalanced noninductive and inductive circuits and is made in all commercial capacities for two and three-phase circuits. Particular attention has been given to the full and light load adjustments, which are very accessible and positive.

VERY LARGE CAPACITY D. C. METERS.

The tremendous growth in central station loads has developed the necessity for extremely high capacity meters.

in fact, much greater than seemed commercially possible a few years ago. The largest meter ever made has been recently designed, having a capacity of 60,000 amperes at 650 volts, and as will be noted, has a measuring capacity of over 50,000 H. P. at full load. The shunt is so designed as to be capable of carrying continuously an overload of 50 per cent. Some interesting problems were encountered in the design of this very large shunt. With a drop of but 50 millivolts, the minimum which should be used with a mercury type watthour meter, the loss at full-load is three kilowatts. To properly dissipate this energy, the entire shunt will be mounted in a corrugated sheet steel tank and immersed in oil. Copper pipes for cooling water are placed in the upper layer of the oil above the shunt so that under heavy overloads, additional capacity can be gained by passing water through the pipes.

One of the most difficult features in the design of this shunt was the arrangement of connections between the copper end blocks of the shunt and the set of 112-5 inch x ¼ inch aluminum bus bars to which the shunt will be connected. Aluminum has a very high contact resistance against copper and other metals, owing to the rapidity with which the surface of aluminum oxidizes, so it was necessary to provide a contact area of about 25,000 square inches between the copper blades from the end blocks of the shunt, and the aluminum bus bars, thus keeping the current density in the contact down to approximately 2.6 amperes per square inch, instead of 60 to 80 amperes as usually allowed for copper to copper.

Owing to the size and arrangement of the shunt and its end blocks with the connecting straps to the aluminum bus bars, the entire weight of the shunt, without the tank or oil, is approximately 1,600 pounds. A number of terminals are brought from the end blocks of the shunt to a point above the oil from which the connection is taken for the meter circuit; the arrangement of these terminals giving a uniform or average of potential drop between the ends of the shunt. The end blocks are built in sections bolted together with heavy copper rods so that the coefficient of expansion of the entire mass is exactly the same throughout and the drop of the shunt under all conditions will be uniformly maintained.

Two switchboard watthour meters will be operated from this shunt; one as a check against the other, and one of these meters will also operate a distant dial mechanism located about one-half mile away from the shunt and meter. The mercury motor type of meter, owing to its freedom from the effects of external magnetic fields, is particularly well suited for this heavy capacity, as there is an enormous stray field created by the conductor carrying 60,000 amperes, which would seriously affect the registration of a meter susceptible to stray field effects. This large meter with two other 25,000 ampere meters will be employed for metering the enormous loads used in reducing Bauxite to make aluminum.

THREE WIRE D. C. METERS.

A new shunted type three-wire direct current meter has been developed and will shortly be available in all capacities. In this meter the general principle and construction features of the well-known two-wire mercury flotation meter have been preserved, but in order to meter both sides of the system, two motor elements are required, insulated and entirely separate from each other, but driving a common shaft. The desired construction was obtained after long experimenting by an arrangement of the shaft for the upper moving system so that it is carried through the bottom of the upper mercury chamber or motor element, and connected by a coupling to the shaft of a lower element in the other side of the three-wire system. The space between the two elements is occupied by a pair of shunt coils on two straight laminated cores having a return magnetic circuit through a yoke or return plate in the upper side of the top motor element, and in the lower side of the bottom motor element. By a very simple arrangement the magnetic flux is exactly balanced through the two elements, thus giving an equal torque and proper rate of rotation to each motor element for a given load. The upper part of the three wire meter is exactly the same as a two-wire, that is, a single damping disc, one pair of damping magnets, recording train, etc.

In capacities up to and including 100 amperes, the three wire meter is operated with two internal shunts. For larger capacities, two external shunts are used, one in each side of the line. The full load torque is approximately 150 millimeter grams and as the weight of moving system is floated against the upper bearing, the friction is negligible and the ratio of torque to friction is extremely high.

MEASURING ROTARY CONVERTERS—OUTPUT AND INPUT.

In rotary converter installations supplying direct current it is sometimes necessary or desirable to run the converter inverted, feeding direct current and supplying alternating current. A convenient method of recording the entire direct current output and input is by means of a watthour meter, having a register of the double dial type, the upper row of dials recording the direct current output under normal operating conditions, and the lower set of dials record the direct current input when the machines are running inverted. The exact distribution of direct current is, therefore known, and the sum of the dial readings gives the total direct current energy delivered and supplied. While the application of this meter is commercially limited, yet it offers a convenient and simple solution of a problem ordinarily requiring two meters.

SPECIAL PORTABLE TESTING METERS.

Operators of isolated plants, central station power solicitors, consulting engineers, etc., often find it difficult to secure accurate data of power consumption over short intervals of time, as the ordinary integrating meter does

Fig. 3. A Portable Watthour Meter.

not have a sufficient range of dials and capacities. To meet this demand for a suitable meter, the portable type illustrated in Fig. 3. has been recently developed and embodies several novel features. The construction of the meter is the same as employed in vehicle service mercury motor type watthour and ampere-hour meters, so that the most severe service will not injure the moving system or recording mechanism. The meter proper is of 10 amperes capacity, and by suitable arrangement of binding posts, the outfit can be used either as a 10 ampere meter for small loads, or with any desired range of self-contained internal shunts from 60 to 500 amperes capacity. In addition, any number of larger external shunts can be used.

The arrangement of the registering mechanism is especially novel, as the four small dials record the total energy passing over a given period in the usual manner, thus permitting long time tests to be made, and for short interval tests, the large dial and fast moving hand are used. This hand is of the key operated, reset type capable of being set back to zero without in any way affecting the reading of the four small dials. With this combination any desired load can be measured, and, furthermore, the current consumed by motor driven tools, etc., over short intervals of time can be accurately read. This combination will be found very useful in collecting data on shop or street car operation where the ordinary type of meter with its slow moving dials would not be suitable.

MERCURY FLOTATION GRAPHIC RECORDING METERS.

The graphic meters illustrated in Fig. 4 embody a number of unusual features, including ability to withstand most severe handling and shocks due to the mercury motor principle of operation, with consequent flotation of the moving system. The meters are the direct acting type, have a high torque without relay or control circuits, the standard types have a torque of 450 to 600 millimeter grams at full load.

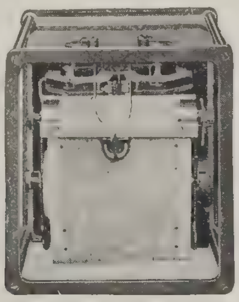


Fig. 4. Switchboard Type of a Graphic Recorder.

The moving system is excellently damped with a maximum period of as high as one second for full swing, but the damping can be varied as desired. The meter also has a speed chart feature which will be valuable in taking starting and acceleration curves, as the mechanism is so designed that by simply throwing in a special gear the chart can be made to run one inch per second and can be started and stopped at a distance by push button control.

The method of applying the power to the chart, the control of speed, the holding of the moving system during shipment, the damping, the method of inserting and removing the paper, is all new and much simpler than in any previous type. It is furnished for both A. C. and D. C. wattmeter, ammeter, and A. C. volt-meter service. A similar instrument with some modifications in the mercury motor arrangement will be furnished for D. C. voltmeters.

The candle power efficiency of carbon filament lamps varies with the voltage, while the light varies inversely with the voltage.

The useful life of a lamp is considered to be the number of hours it burns until the candle power drops to 80 per cent. of the initial readings.

January Meeting of Society for Electrical Development.

A meeting of the Society for Electrical Development, Inc., was held January 14, 1913, at the Engineering Societies building, New York City. At this meeting the various work done by the organization committee was approved, as were also the by-laws of the new society. Immediately after the meeting, a further meeting was held of the board of directors, who were selected by the associations which they represent from the various branches of the industry. The funds which have been advanced by the organization committee to carry out the organization work of the society were turned over with all records of meetings of the organization committee to the society, and officers were elected as follows: Henry L. Doherty, president, and Ernest Freeman, A. W. Burchard, W. H. Johnson, J. R. Crouse and W. E. Robertson, vice-presidents. These men, with Messrs. L. A. Osborne, Gerard Swope and J. R. Strong, compose the executive committee, on whom will lay the heavier responsibilities of the further organization work of the society.

Appointments were also made of J. M. Wakeman as general manager and Philip S. Dodd, as secretary-treasurer. Both Mr. Wakeman and Mr. Dodd are well known in the electrical industry and have a very intimate acquaintance with publicity problems of the kind, involved in the present propaganda on behalf of electrical development.

P. S. Dodd, Secretary and Treasurer Society for Electrical Development.

As already explained in these columns, the work of the society will be devoted to various lines of effort for the greater development of the electrical industry at large and will be carried out along broad-gauge lines aiming to increase in every way the uses of electricity, especially for light, heat and power.

The society has the endorsement of the executive committees of the National Electrical Contractors' Association, the National Electrical Supply Jobbers' Association, the Executive and Public Policy Committees of the National Electric Light Association, together with the support of a large number of manufacturers, both large and small. With such endorsement there can be very little question of its practicability and value to the industry at large. The membership is open to every interest in the electrical industry. dustry.

The New Secretary and Treasurer—P. S. Dodd.

To those who have followed the commercial activity of the National Electric Lamp Association, that of the Commercial Section of the N. E. L. A., and finally the birth and organization of the Society for Electrical Development, the name of Philip Stevens Dodd and the personality of the man behind this name is most familiar if not intimate. Although yet a young man, through his untiring energy and enthusiasm he has forged a prominent place for himself in the electrical industry. He has given of his time and energy freely to every activity that has had for its purpose the welding together of its various branches. In the conception and early promotion of the Society for Electrical Development, which also has the above as its definite purpose, Mr. Dodd has been very conspicuous and to him must be given a large per cent of the credit for preliminary work and management of details since its organization.

It is of interest to learn that his efforts are to be more closely connected with this work through an appointment as secretary and treasurer of the society. He will resign his position as director of the commercial development department of the National Quality Lamp Division of the General Electric Company, to take up this work. Mr. Dodd's early training has been largely responsible for his success, we believe, as a promoter. He successfully covered important sections of New York City as a reporter on the New York Journal for two years, later entering the electrical field as business manager of the Electrical Review and Western Electrician, and finally accepting the position of director of the department of publicity of the National Electric Lamp Association, with which organization he has been connected up to the present time. To use a homely phrase, he is a "killer" in making friends and accomplishing his aims. We know the work recently entrusted to him is in the best of hands.

Mississippi Electrical Association Question Box.

Under this heading will appear each month questions and answers to questions from members of the Mississippi Electrical Association. All readers are invited to discuss any question or topic presented. Address all correspondence, including questions and answers, to Clarence E. Reid, Question Box Editor, Agricultural College, Miss.

New Questions.

QUESTION NO. 9. On some series transformers recently received, I find the terminals which are to be connected to the meters short-circuited, with a copper wire, and the instruction tag sent with them states that these terminals should always be short-circuited when the meter is not connected. Why is this?

QUESTION NO. 10. About how many times normal full load current will a modern 3-phase, 2,300-volt, 60 cycle, 40 kw. alternator give on short circuit with normal full load field current?

QUESTION NO. 11. Why is the air-gap between pole-face and armature so much larger in the case of turbine-driven alternators than in the case of other generators of corresponding dimensions?

QUESTION NO. 12. Where may auto-transformers be used instead of two-coil transformers to advantage, and in general, where may they not be used?

QUESTION NO. 13. Kindly explain how an alternating current motor with no brushes or external connections to the armature, is caused to rotate.

QUESTION NO. 14. The common impression is that the older a carbon incandescent lamp gets, the more current it takes. I have been informed by an electrician that this is not so, but I have noticed that an older lamp gets hotter than a new one. Why is this so, if it is getting less power?

QUESTION NO. 15. Why are the manufacturers of some modern direct current generators putting slots between the commutator segments instead of mica? Is not there some danger of carbon and other dirt short-circuiting the commutator?

QUESTION NO. 18. In the armature of a 3-phase, 110-volt,, 60 cycle, 3-h.p. induction motor, I notice that the conductors are not well insulated from the iron core. The motor is in operation, and seems to be all right. How will the above effect the operation of the motor?

QUESTIONS UNANSWERED—SEE NOS. 2, AND 3 IN JANUARY ISSUE.

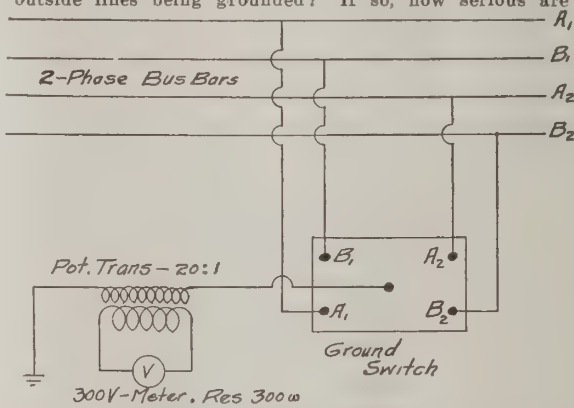
Answers to Questions.

QUESTION NO. 5.

The sketch shown here refers to a two-phase plant, using transformer type ground detector. The following readings were noted, with all line switches open, for first set, and second set taken with all line switches closed:

	All lines open	Closed.
When A_1 is selected, voltmeter reads	61	66.5
When A_2 is selected, voltmeter reads	61	65.0
When B_1 is selected, voltmeter reads	61	68.0
When B_2 is selected, voltmeter reads	61	68.5

When line switches were open, giving the first column of readings the house or station primary circuit was connected where it taps the fuses. Do these readings indicate a condition of station and outside lines being grounded? If so, how serious are the grounds? If not, what is the explanation of the readings of the voltmeters? Is there naturally and normally a difference of potential between the ground and any conductor of a high voltage system?



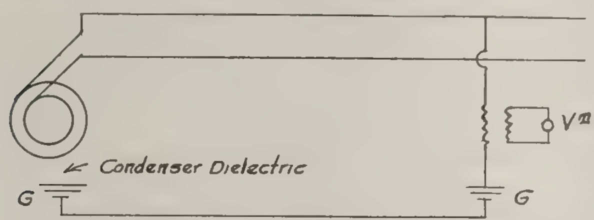
Ground Detector Diagram.

Evidently the resistance of the voltmeter should be 3000 ohms, as this is nearer the usual resistance of a 300 volt A. C. voltmeter than is 300 ohms. This being the case, a reading of 61 volts on the 300 voltmeter, Res. = 3000 ohms, would mean a current through the meter of 61/3000 amp. or about .02 amp. which would be the current through the low potential side of the transformer. On the high potential side this would mean a current equal to 1/20 of .02 amp. or .001 amp., as the load current on the high potential side of the transformer, or that due to the secondary and voltmeter current, not taking into account the exciting current of the transformer.

If line B1 is grounded, and the transformer detector is connected to A1; and supposing the line voltage to be 1,000 volts, the total impedance of the circuit would be E/I or 1,000/.001 or 1,000,000 ohms. The usual impedance of a potential transformer may be taken at about 400,000 ohms or less on open circuit, and much less under load, leaving the resistance of the ground to be 600,000 ohms or more. It will be noted that in the above, the transformer impedance (assumed) is subtracted directly or arithmetically from the total impedance, while it should be subtracted vectorially, that is, the phase angle should be taken into account. Data are not available for that however, and in any case, the result would be to make the apparent ground resistance higher. So in any case with the above readings, assuming them to be due to grounds, the grounds would be of such high resistance as to be negligible.

It is, however, the writer's opinion that a part at least of the current through the high tension side of the potential transformer is due to a capacity effect between the armature and line conductors and the ground as the plates of a condenser, and the insulation of the armature conductors serving as the dielectric. The amount of capacity required under this supposition would be as follows:

The equation for current in a capacity circuit is $I = 2\pi fCE$, where, I = current in the capacity circuit, as above, = .001 ampere; E = E. M. F. impressed on the circuit, as above, 1,000 volts; C = capacity in farads; F = frequency, assumed to be 60 cycles; Then, $C = \frac{1}{2}\pi fE = .001/2\pi \times 60 \times 1{,}000 = .000{,}000{,}0026$ farads = .0026 Micro-farads, or about 1/1000 that of a small telephone condenser. So it would be entirely reasonable to expect to find this amount of capacity in the circuit consisting of ground, and generator conductors, with the generator armature conductor insulation as dielectric.



The illustration shown here will serve to illustrate where the condenser effect is found. In any case, there would not seem to be serious grounds on the circuit. A 5 kw. transformer, or any larger power transformer instead of the small potential transformer would require so much exciting current that most of the drop would be across the condenser effect, an dthe voltmeter would not read.

Answering the last question, when one side of the line is grounded, from the figure it is evident that there would naturally be a difference of potential between the other side and the ground.

QUESTION NO 7.

How do member-companies store and care for their reserve supply of transformer oil? When moisture is suspected, how do you test it? When moisture is found in the oil, how do you remove it?

If the oil is not used immediately by the company it should be stored so as to be protected from the weather, and preferably in a place not having extreme variations of temperature. The cans or barrels should not be opened or unsealed before the oil is actually needed as any change in temperature will cause an exchange of air or "breathing" in the receptacle. This, of course, will cause condensation of moisture inside and when precipitated will lower the insulating qualities of the oil. Oil barrels should be placed on their sides to prevent water from collecting on the heads.

There are several ways for making a rough test for finding the presence of water in oil. One of these would be to draw off a small sample of oil in a vessel and note whether water has settled in the bottom. Another would be to drop some oil on a hot iron. If moisture is present you will get a crackling noise. The only satisfactory and reliable method for detecting small quantities of moisture is by measuring the dielectric strength of the oil as even a small quantity of moisture is detrimental to the insulating quality of the oil.

There has been developed for this purpose a small testing outfit consisting of a box provided with ½-inch metal discs, the distance between which can be adjusted for 0.2 inch outside the box thus permitting ready connection to the adjustable voltage testing transformer.

In the case of oil which has been removed from transformers in service it would, of course, be well to filter and clean. This can readily be done with what is known as a transformer oil drier and purifier. This, of course, is a rather expensive piece of apparatus for a small central station, but where the station is large enough to have a considerable number of transformers in service it is believed to be an economical device. L. W. C.

QUESTION NO. 8.

Do members experience trouble with cotton gin loads on account of large motors used and consequent demand on the station at no regular period? What rates have been found suited for this load?

One company in Central Georgia operating a hydroelectric system makes a rate to cotton gins of 2 cents and 2½ cents per kw. hr., depending upon the capacity of the gin. This company has found that it requires from 16 to 18 kw. hrs. to gin a bale of cotton.

Atlanta Jovians Attend New Orleans Street Parade.

A number of Atlanta Jovians chartered a private car and made the trip to New Orleans to attend the Jovial electrical street parade held during the Carnival week under the direction of Statesman F. B. Stern. The party left Atlanta Friday, January 31, reaching New Orleans for some of the Carnival events and attending the rejuvenation, banquet and street parade. While in New Orleans the party lived on their car, and returned, leaving New Orleans on Monday night, reporting a most enjoyable time.

The following were the members of the party: W. T. Gentry, president of Southern Bell and Cumberland Telephone Companies; M. O. Jackson, general manager, and R. E. Hastings, chief clerk of the same company; L. S. Montgomery, district manager National Metal Molding Company, and Eleventh Apollo; T. A. Burke, sales manager of Western Electric; W. B. Wallace and C. A. Hawkins, of the same company; J. J. Smith, manager of the Baltimore Supply Company, and F. V. L. Smith, manufacturing agent all of Atlanta. On reaching Birmingham, the party was joined as guests by Past Jupiter Oscar C. Turner, president of the Southern Wesco Supply Company, together with three of his friends.

Before the advent of the wire drawn Mazda lamp, series street Mazda lamps were used in the majority of cases, but the drawn wire multiple lamp has practically superseded the series lamp at the present time. Ninety per cent of the installations going in along business streets are multiple installations at the present time, however, if residence streets are to be lighting, necessitating long distribution, the series proposition is the better. For general street lighting, the incandescent lamp has advantages over the arc lamp, and smaller units by other illuminants are gradually gaining ground in this direction. The one great advantage which the incandescent lamp has over the arc lamp is that smaller units with a closer spacing can be used, the resulting illumination being therefore more uniform

New Business Methods and Results.

Representing Interests of Central Station, Electrical Jobbers, Dealers and Contractors.

THE NATURE OF CONTRACTS AND THE DETAILS OF SERVICE.

After the question of the rates to be charged for electric service has been settled, there remains a number of questions of policy in regard to matters which are often considered as details and yet of considerable importance in their effect upon the extension of business. Among these may be mentioned the nature of the contract to be executed with the customer, its provisions regarding deposits, service connections, extensions, discounts, and billing, together with the general policy of the company in the other general matters affecting the service.

In many cases, far too many, the companies seem to have no settled policy in regard to anything. There are no definite instructions, no rule to go by, with the natural result that questions are almost entirely decided by personal judgment and not as a matter of company policy. This opens the way for discrimination and caprice, since the best of us are not entirely free from prejudice, and in the absence of specific policy it is hard to prevent the exercise of personal judgment from working hardship, to say nothing of the losses liable to be incurred by not having an equitable rule and requiring an adherence to it.

The result of such a policy or lack of policy is that if a customer comes into contact with different employes in seeking an adjustment of any kind, he is bound to become more or less confused by conflicting statements, and after such an experience he will certainly be of the opinion that the company does not know its own mind about anything, and then if neighbors compare notes, as they often do, and find that they have not been treated alike, there is a chance for more trouble. The only sure way to avoid ill feelings due to this cause is to have all matters of any consequence reduced to a settled policy and this placed in the hands of every employee in printed form so that the treatment of all customers will be alike, regardless of personal opinions, weather or dyspepsia. A further and still better development of this idea—and one which will save much misunderstanding and many disputes, is to publish a small booklet giving the rules of the company in simple form, placing this in the hands of every employee, every new customer, and every prospective customer. This idea is not new, and where it has been put into practice, it has been found that such literature in the hands of solicitors has been of value in securing new business.

CONTRACTS. Regarding contracts, the first question which will arise is, "Are written contracts necessary, and why?" This question was the subject of quite a lively discussion in the Question Box of the N. E. L. A. some time ago, and while the majority of those who expressed their opinions were in favor of written contracts, yet there were few who gave any logical reason for thinking so, and there were one or two who considered contracts unnecessary. The questioner took the stand that since butchers, bakers, and grocers did a volume of business with individual customers much greater than that done by the average customer of the public service corporation, without any such instrument, why should it be considered a necessity in the case of central station service? Without quoting the arguments presented, we may say that the real logical reason for having formal contracts is this: In buying from tradesmen, whatever the volume of business, a commodity is purchased. Each transaction is complete in itself, even though the account continues open. On the other hand, the patrons of the central station do not purchase simply a commodity, but a service. This service is to be rendered under certain terms and conditions and it is important that these should be reduced to writing and subscribed to by the parties entering into the agreement.

The editor of this department has had experience under both methods and we would decidedly favor having written contracts with all customers on the following grounds: First, a contract constitutes a definite record of an application for service. It is a starting point for action, which if left in the form of verbal instructions or pencil memorandum, may easily get side-tracked, be postponed or forgotten. Secondly, it produces a moral effect upon the customer, because he feels that he has entered into a definite agreement to accept service under the terms stated and he has less excuse for trying to evade his part of the contract. It may be faulty or even useless as a legal instrument, yet its moral effect will hold the great majority of the customers in line. In fact it is very rarely that public service corporations put their contracts to the legal test.

As to the form and wording of the contract, it should set forth as simply and briefly as possible the principal terms and conditions under which service will be furnished. There is absolutely no use in expressing the agreement in high sounding legal phrases, which accomplish no purpose but to mystify and intimidate the prospective customer. In one case coming under our notice, a very lengthy contract printed on the front of a sheet was reinforced by a list of 21 additional conditions on the back in fine type. Upon examining this document, it was found that the same statement was repeated four times in slightly different wording. After revision, the new form contained every essential feature of the old contract, but was less than a fourth of the length.

DEPOSITS. The question of deposits is a live one. This has also been the subject of several queries in the N. E. L. A. Question Box, and a large number of replies published. While there is no doubt at all as to the right of an electric light company to protect itself against bad accounts by requiring deposits from every one, yet the consensus of opinion among those who answered, seemed to develop the facts that as a rule, the arbitrary requirement of deposits from all customers serves no useful purpose and is generally undesirable, and further that the proportion of uncollectable accounts incurred by taking on customers without deposit is so small as to be negligible, being in most cases but a small fraction of one per cent. Of course, the central station must accept applications for service, no matter from whom they come and if there are well founded doubts as to the intention of the applicant to pay his bills, that is, if he bears the reputation of a "dead beat," there is only one thing to do, and that is to demand an adequate deposit or other security. It may be true that the asking of deposits is not a serious bar to business in the sense that it appreciably reduces the number of customers, since anyone that is otherwise persuaded to use electric light will not refuse to put up security for a couple of months bill, but the worst effect that this ruling has that it is an arbitrary and unreasonable attitude on the part of the company. It is secretly resented by a majority of those who have to put up the money, and as a matter of public policy, nothing should be done that is likely to foster an unfavorable mental attitude on the part of customer

While the matter of guaranteed revenue or minimum bill, properly belongs under the subject of rates, it may not be irrelevant to say here that excessive minimum payments have a similar effect, particularly if they often run above the metered rate. A minimum payment is clearly justifiable, but on the small contract it should be nominal, and on the large ones so proportioned that it will rarely exceed the charge at the metered rate.

SERVICE CONNECTIONS. As to service connections, most companies now make no charge, but include such work in their overhead expense. This is the better way, because there are a great many landlords who would not pay for a service connection for a tenant, and if a tenant pays for it it is not just because future occupants of the premises have the benefit of it gratis. Such a policy would be sure to shut out many who would otherwise be customers. Of course if a customer lives at some distance from the public street, and the company must go to considerable expense to reach him, it is necessary to make some kind of a service charge, and in such cases the company should adopt as liberal a policy as is consistent with making a profitable investment.

EXTENSIONS. In regard to extensions of the street mains necessary to reach parties desirous of becoming customers, it is better in this case, as in the others, to make a direct charge, because it is evidently unjust to ask one party to pay for the construction of a line which will probably be used later to supply others. The company should estimate what amount it is justified in spending in order to obtain a given amount of revenue and base its policy on this. A common policy is to set one pole if necessary to reach one new residence customer, or to run two or three sections, or from 300 to 500 feet of wire (doubled). If service extensions are required in a locality where it is reasonably certain that the applicant will be the only one to be benefited, a charge should be made just the same as for an extension on private property.

BILLING. After having come to an understanding as to the terms and conditions of services and after the connection has been made, there is usually but one point of contact that the company has with the customer and that is in regard to the reading of the meter, the presentation and settlement of the monthly bill. Discussions as to the amount of bills (except where the flat rate is used) or neglect in paying them are responsible for more friction and strained relations between the parties concerned than anything else, and anything that can be done to reduce misunderstandings on this score will be trouble well spent. This section of Southern Electrician in the next number will be devoted entirely to a discussion of complaints and delinquencies, and we invite the fullest discussion of these important subjects.

The bill should in all cases show the meter readings for the beginning and ending of a definite period with dates showing the dates the meter was read so that the customer can check up the readings. Thus in case of a consumption which appears abnormal he can ascertain whether the consumption is still going on at a proportional rate. It has been found that customers are glad to know how to do this, and it would certainly be an advantage if every one knew how to read his meter. It is astonishing how many persons have an idea that public service corporations send ou the bills according to what they feel like charging without any reference to the meter readings. There is one idea adopted now by some companies that will do much to remove the distrust of the meter and the meter reader. Postal cards are printed bearing representations of the meter dials, and if the meter reader is unable to gain admission to the house on his regular trips, one of these cards is mailed to the customer with a request to mark on the dials the position of the pointers and mail the same to the office of the company to be used in making out his bill. It will at once be seen that this inspires confidence.

Result of Christmas Campaigns Among Byllesby Properties.

Remarkable results were accomplished by the Byllesby organization in securing new business between December 1 and 27, of 1912. Two box-cars of electric appliances were sold as a result of the campaigns, and 5,203 new appliances have been placed on the lines of the various companies. The general plan of the campaign consisted of newspaper advertisements, (employing regular space) and circular letters to customers and prospects followed by personal solicitation. Special window displays were also used at most of the properties with good effect. A conservative estimate places the total load of these appliances at 2,321 kw., and the total annual revenue to be derived from their use at $25,757.

Mr. R. E. Flower, manager of the new business department of the Mobile Electric Company, attributes the large sale of flat irons in Mobile during the Christmas appliance campaign to a letter-selling plan. Letters were sent to all customers advising them that the letter was good for $1.50 if applied on the purchase of an electric flat-iron. The reason given for the bonus was that most business firms gave away calendars or souvenirs of some sort during the holiday season, and that the Mobile Electric Company wished to give something of real value. The result of these letters was the sale of 325 flat-irons. All irons were sold for cash only, and the receipts paid not only for the irons, but the cost of advertising.

Manager Brandli, of the Consumers' Power Company, Minot, N. D., attributes the sale of 110 appliances during the campaign to newspaper advertising and a folder which was mailed out with November statements. The company also maintained two attractive window displays which were changed each week. The Friday afternoon before Christmas the company gave a special discount of 20 per cent for cash sales.

Mr. E. F. Stone, superintendent of lighting and power of the Arkansas Valley Railway, Light & Power Co., credits its newspaper advertising and attractive window displays with the very satisfactory sale of appliances in Pueblo and the Arkansas Valley district.

Mr. L. G. Gresham, assistant manager of the Appalachian Power Company, in reporting the sale of 108 appliances, says: "I think this is a remarkable showing considering that the report covers only Bluefield, Wytheville and Pocahontas. We have no one at Marion or Pulaski to push the sale of appliances. I attribute the success of the sale to initiative, aggressive methods and newspaper advertising."

The 1,353 appliances indicated below as sold by the Minneapolis General Electric Company during the campaign does not include some 500 Christmas tree lighting outfits. Manager Pack believed that the large sale of electric Christmas tree lighting outfits in Minneapolis this year was due to the company's action in loaning electric tree lighting outfits to churches and charitable institutions and to the advertising done by the company concerning their safety. The total number of appliances sold in Minneapolis does not include all of those sold by department stores and electrical supply dealers, as it was impossible to get a complete record from the dealers.

Manager Stephens, of the El Reno Gas & Electric Company, credits the success of the Christmas appliance sale to personal effort and interest of the local supply dealers, attractive window displays and the newspaper advertisements. During the day before Christmas the telephone was used in calling up prospects with good results.

The Canon City window display of the Arkansas Valley Railway, Light & Power Company consisted of a small colored boy who popped corn on an electric grill. The corn was given away to visitors and many people were attracted inside—resulting in the sale of many appliances.

During the week following Christmas, the Minneapolis General Electric Company reports the sale of 125 appliances, and although the number is not included in the report below, a large number of sales were undoubtedly due to the stimulus given by the electric appliance campaign.

The result of the campaign in detail follows:

Total Appliances Placed During Campaign Lasting From Dec. 1 to Dec. 27.

Property	Flat Irons	Toasters	Grills	Chaf. Dish	Percolators	Discs	H't'g Pads	Curl Irons	Wash Mach.	Vac. Cleaners	Miscel.	Total
Albany to 24th	36	31	...	3	3	...	1	2	...	...	2	78
Bluefield	15	7	41	3	22	1	5	1	...	...	9	104
Dallas	5	2	...	2	22	...	3	12	...	...	3	12
El Reno	29	10	4	1	8	...	4	10	1	2	27	96
Enid	18	7	6	1	8	1	1	...	...	...	1	43
Everett	23	...	...	...	3	1	5	5	...	...	...	37
Eugene	9	8	...	1	1	...	...	1	...	...	2	22
Eureka	32	7	4	...	1	2	4	2	...	...	7	59
Faribault	30	13	6	3	4	6	6	2	...	...	6	76
Fort Smith	98	24	12	3	20	15	6	5	...	1	26	210
Fargo	48	36	11	1	15	...	5	11	...	...	...	127
Galena	8	6	...	...	1	...	1	...	1	1	...	18
Grand Forks	22	1	11	1	4	...	5	...	...	...	...	44
Kalispell	7	17	1	...	2	2	...	...	...	...	10	39
Louisville	30	5	8	1	5	1	7	4	...	...	22	83
Minot	24	32	5	5	9	2	8	5	2	1	17	110
Mankato	44	31	2	3	9	3	10	...	2	...	32	136
Minneapolis	564	313	18	22	65	115	38	87	12	8	111	1353
Mobile	341	15	5	5	8	4	2	...	...	...	29	400
Muskogee	32	25	11	4	14	...	4	3	...	...	4	97
Marshfield	19	6	...	...	18	...	4	1	...	...	1	49
Nashville	79	16	27	4	19	3	8	21	...	...	294	471
Ottumwa	35	25	5	...	14	...	5	7	1	3	6	102
Oklahoma City	243	73	52	10	50	18	.25	23	...	...	36	530
Pueblo	118	38	31	2	22	6	14	6	3	...	27	260
Richmond	35	3	...	...	3	...	2	...	...	...	6	49
San Diego	209	57	3	4	26	...	4	...	...	...	13	316
Stillwater	14	8	1	...	2	2	1	...	...	...	7	35
Sandypoint	2	5	3	1	...	...	1	1	1	...	2	16
Sapulpa	4	1	2	2	4	1	3	5	2	...	1	25
Stockton	49	10	3	8	9	9	3	...	1	...	7	99
Sioux Falls	55	21	9	1	6	...	3	1	...	...	2	98
Total	2277	846	281	91	375	192	186	203	26	16	710	5203

The frosting of the lower portion of the glass bulb of the Mazda lamp softens and diffuses the light with good effect and little reduction in candle power.

COMMENTS ON CONTRACTS AND SERVICE.

Mr. L. J. Wilhoite, Contract Agent of Chattanooga Railway & Light Company, Chattanooga, Tenn., Gives the Routine of His Sales Department In Reference to Contracts.

When the application for service is taken, either by the solicitor or through the office, the contract is filled out complete, in original and duplicate except the installation, kilowatts connected, possible maximum k.w.h. consumption, and the rate. The work orders are next issued and passed to the operating department, one copy of the order being retained in the sales department, one copy retained by the credit department. When the order has been completed by the operating department, it is returned to the sales department. Upon its receipt by the sales department it is pinned to the contracts which have been retained in the sales department pending the return of the executed order. The contracts are then completed from the information given on the returned work order, the work order then being forwarded to the accounting department for entry on customer's ledger, and the duplicate copy of the contract mailed to the consumer, the original copy being retained in the company's file.

As far as possible all contracts are taken for a period of one year, and when so taken no charge is made for service connection. However, when it is impossible on account of the transient nature of the business to secure a one year agreement, temporary contracts are taken and a charge made for service connection and disconnection. No special contract blanks are provided for taking care of the temporary business, but our standard form is used by the striking out of the one year clause, and the insertion of a rider.

LIGHT

AGREEMENT FOR ELECTRICAL ENERGY

CHATTANOOGA RAILWAY & LIGHT CO.

CHATTANOOGA, TENNESSEE

Chattanooga, Tenn.,..............................191.....

The undersigned ...., hereinafter called the Consumer, hereby applies to the **Chattanooga Railway & Light Company**, hereinafter called the Company, to be supplied, subject to the terms and conditions stated below, with electric energy for lighting purposes and small motors (3-4 h. p. or less) installed or to be installed at premises—

No ....in...

Hamilton County, Tennessee, for the sole and exclusive use of said Consumer, all Electrical Energy required or used for a period of ONE YEAR from the date of this agreement, by equipment consisting of..

....

....equivalent to ....kilowatts, which would consume..kilowatt hours if used continuously for thirty (30) days.

The Consumer agrees to take and pay for said Electrical Energy, as measured at and by the meter on said premises, which will be provided by the Company, at rates as follows, based on a possible maximum kilowatt hour consumption of.............. kilowatt hour per month of thirty (30) days for the use of the equipment above designated:

First 5 per cent of said possible maximum K. W. H. consumption (......................) K. W. H. at 12 1-2c per K. W. H.

All in excess during same period of...K. W. H. at 6 1-2c per K. W. H.

On account of meter, clerical and all other necessary service, and for interest and depreciation on investment necessary under this contract, the CONSUMER hereby agrees to pay a minimum charge hereunder of $..............per month whether any energy is used or not. It is further agreed that all bills for Electrical Energy shall be rendered by the COMPANY to the CONSUMER monthly, and paid by the CONSUMER prior to the delinquent date stamped or written on such bills. All such bills to be paid by the CONSUMER at the office of the COMPANY, in Chattanooga. Failure to receive bill will not entitle CONSUMER to the discount for prompt payments

A cash discount of 5 per cent. will be allowed if the bill is paid within fifteen (15) days from date thereof.

This application is for service to continue for the term of ONE YEAR from the date hereof and thereafter until it is discontinued on 48 hours' notice in writing given by one of the parties to the other, except as otherwise hereinafter provided.

The current is to be supplied, measured and paid for, and the apparatus for supplying and utilizing it is to be installed and maintained in accordance with the Rules and Regulations of the Company, on the reverse side hereof, which are hereby made a part of the agreement formed by the acceptance of this application.

The Consumer agrees that during the life of the contract formed by the acceptance of this application, he will, upon the same terms, take from the Company all additional current which he may use.

The Consumer agrees to provide a suitable place, to be approved by the Company's inspector, for the installation of the Company's meter.

Before any change or addition thereto is made in equipment, in number, size or type of lamps or otherwise, due notice of change must be given by the CONSUMER, and written assent obtained by the COMPANY, and it is hereby agreed that the possible maximum kilowatt hour consumption, which is the basis of this agreement, will be increased or decreased as affected by such change.

Witness.

....

Consumer.

Accepted the ....day of................191...

CHATTANOOGA RAILWAY & LIGHT COMPANY

Form 143 By..

General Manager.

We have no definite rule to be followed in the matter of deposits; other than that the applicant assures us that he would be entitled to the courtesy of credit extension by any representative merchant in the city. Where the credit of the applicant is bad, a deposit ranging anywhere from $3.00 to $50.00, depending entirely upon the applicant's probable monthly bills, is required.

We divide the city into 27 districts, and endeavor to have the meters read in one or two districts at approximately the same time each month. Bills are rendered every day during the month, for example, bills for route No. 20 are rendered on or as near the 20th of the month as possible. A discount of 5 per cent is allowed on all bills paid within 15 days from date of bill. We have no arbitrary rule governing the collection of discounts on bills presented for payment after maturity. As to whether or not we insist on the collection of discounts on over-due bills, depends entirely upon the merits of each individual case coming up.

As a general rule, we build extensions to new customers on the basis of 100 feet per consumer. This rule is not followed invariably, but is merely used by the solicitors as a working basis in developing new territory.

The power contract differs little from the light contract except in the following respects. The reference to rates is as in the following form. First, 10 per cent of said possible maximum kwh consumption (........) kwh at 5 cents per kwh and all in excess during same period at 2 cents per kwh. A minimum charge of $1.41 per month per kw connected is paid whether any energy is used or not.

At the right of the rules and regulations on the back of the contract form appears spaces for consumer's name, address, his employer's name, occupation, who succeeds, date succeeded, previous consumer, where, when, lighting previously used and 3 references.

On the left of the rules appears spaces for estimated annual revenue, guaranteed annual revenue, business—old, new or additional, estimated 50 watt equivalents. A space for contract O. K. by contract agent, credit O. K. by cashier, installation O. K. by line superintendent. Spaces also are provided for the class of consumer, connected load in watts, whether owner of property, renews contract and date, cash deposited and space for guarantee of payment by an endorser.

Mr. B. W. Mendenhall, Commercial Agent, Utah Light & Railway Company, Salt Lake City, Utah, Outlines His Company's Practice In Securing New Business.

Complying with your request, I give you herewith a brief statement of this company's practice with reference to the following subjects:

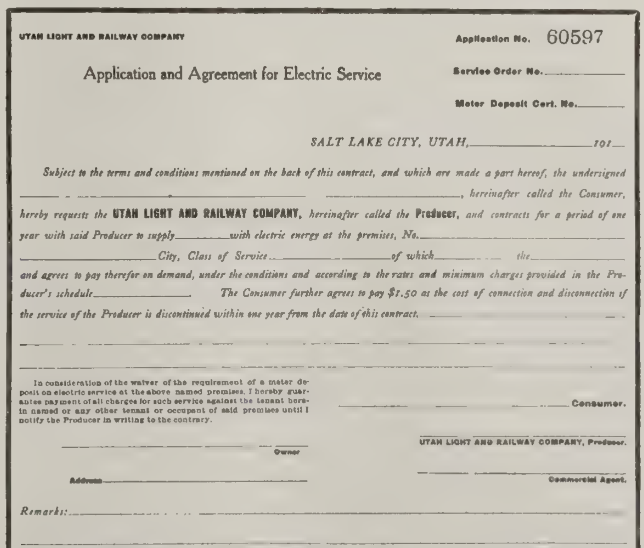
CONTRACTS.—We use a standard form of application and agreement for electric service, copy of which is shown here. This agreement makes reference to our printed schedule of rates and designates the particular schedule to apply. The printed schedule states all the conditions applicable to the rate, and is drawn in substantially the same form as is recommended by the Rate Research Committee. We require the signature to this application before service is rendered. However, in exceptional and emergency cases, order is issued for connection and the signature secured later, the idea being not to give the customer the impression that our rules are so inflexible as not to meet such conditions.

DEPOSITS.—No deposit is required where the consumer owns the premises where service is delivered, or where the owner of the premises where service is delivered will guarantee the account of the consumer, the guarantee clause being printed on the application and being a part of it. Where the consumer does not own the premises where the service is delivered, and the owner of the premises will not guarantee the account, a deposit is required, the almost universal deposit being $10.00. If the consumer's account should materially exceed $10.00, and we have any doubt as to his financial responsibility, the account is billed semi-monthly or weekly. On moving picture houses and variety theaters, where the management is subject to frequent changes, a $50.00 deposit is required.

We pay 5 per cent interest on all deposits, which is credited to the customer's account at the end of the year. All deposits are refunded promptly when the service is discontinued, and we have a system of telephoning in the meter readings where this is necessary to accommodate the customer. We allow a 10 per cent discount on all charges for electric service and find that this reduces to a minimum our outstanding delinquent accounts and our loss through bad accounts.

SERVICE CHARGES.—We make a charge of $1.50 if our service is discontinued in less than a year. However, a transfer from one location to another is not considered as a discontinuance, so that the consumer may have his meter moved as often as desired without cost, and the $1.50 service charge is made only in case the customer permanently discontinues the use of our service within one year from the time it was installed.

EXTENSION LIGHTING.—We will make any extension to reach a new customer where the cost does not exceed $40.00, or where an additional customer can be secured for each $40.00 of additional expense. We estimate our aver age residence consumer's bill amounts to $20.00 per annum, so that if no other customers were secured the gross revenue from the sale of current in two years would equal the cost of the extension. If the consumer's residence is considerably larger than the average, and the cost of the extension did not exceed the estimated gross revenue for two years, we would build it without charge to the consumer. If, however, one customer cannot be secured for each $40.00 of cost of extension, then we will make the extension if the


UTAH LIGHT AND RAILWAY COMPANY

Application No. 60597

Application and Agreement for Electric Service

Service Order No.______

Meter Deposit Cert. No.______

SALT LAKE CITY, UTAH,______191__

Subject to the terms and conditions mentioned on the back of this contract, and which are made a part hereof, the undersigned ______, hereinafter called the Consumer, hereby requests the **UTAH LIGHT AND RAILWAY COMPANY,** *hereinafter called the* **Producer,** *and contracts for a period of one year with said Producer to supply______with electric energy at the premises, No.______ ______City, Class of Service______of which______the______ and agrees to pay therefor on demand, under the conditions and according to the rates and minimum charges provided in the Producer's schedule______. The Consumer further agrees to pay $1.50 as the cost of connection and disconnection if the service of the Producer is discontinued within one year from the date of this contract.*

In consideration of the waiver of the requirement of a meter deposit on electric service at the above named premises, I hereby guarantee payment of all charges for such service against the tenant herein named or any other tenant or occupant of said premises until I notify the Producer in writing to the contrary.

______ Owner

Address______

______ Consumer.

UTAH LIGHT AND RAILWAY COMPANY, Producer.

______ Commercial Agent.

*Remarks:*______

CONTRACT OF LIGHT AND RY. CO. NOTE BREVITY AND SIMPLE WORDING.

customers on it desire the service and will make an advance payment equal to the difference between the cost of the extension and $40.00, multiplied by the number of customers secured. This amount is placed to the consumer's credit and refunded to him in electric service.

In some cases, where real estate firms are exploiting an addition, we will build our lines throughout the addition provided they advance the cost of the extension, and the money is refunded to them at the rate of $40.00 for each customer connected to the extension as fast as the customers are connected.

EXTENSIONS; POWER.—On these we require an advance payment equal to approximately one-quarter the cost of the extension after deducting the cost of the transformers, on the theory that this will represent approximately our loss in case the consumer should not continue to use our service and we are required to take the line down before his use of power has justified us in making the investment. This advance payment is placed to his credit and is refunded to him in power, in some cases, 25, 50, 75 or 100 per cent of his monthly power bills being placed against the payment, depending upon the character of his business and the likelihood of its permanency. No interest is allowed on advance payments. We have little difficulty in securing advance payments and making extensions on this basis.

R. B. Mateer, Manager Agricultural Sales, Great Western Power Co., Writes on Methods of Handling Electric Service.

CONTRACTS. The main reason that the public utility of today requires of a prospective consumer, a written contract, duly signed and approved, and containing clauses relating to the charge for service rendered, the time of payments, the rules governing the installation and use of measuring devices—meters, prior to running the necessary service wires to connect the distribution system of the electric company with that of the consumer, is on account of an absolute lack of appreciation or the value of service at one time supplied at a flat charge by the customer and the tendency to evade payment claiming a verbal agreement to be without force and not binding on either party. Another potent reason for written contracts arises from competitive situations and the tendency to discontinue the service of one company for that of another, regardless of the expense incurred by the utility to supply the demands of the customer. This has resulted in the use of a clause specifying the duration of the contract and its renewal. Clauses of this character are merely moral obligations on the consumer as it is doubtful if a court would render a decision granting relief to the central station, other than actual damages suffered by reason of the breaking of the contract. Such relief would largely depend upon the ability of the quasi public utility to use its equipment within a certain period of time at another place and the return expected from investment in such apparatus.

In view of public sentiment, it is, therefore, best to draft and place in effect, contracts that are brief, eliminating qualifying clauses. Contracts should be concise and easily understood by each customer. A form now in use for agricultural purposes and superseding the old legal document of flowing language, is here submitted, as one receiving criticism only of a favorable character.

DEPOSITS. No deposits are required on contracts of the character here shown as collections may be made at the option of the company, permitting of collections weekly or semi-weekly, or even bi-weekly, where the credit of a customer is questionable. A policy of this character increases

Form 259

CONTRACT FOR ELECTRIC CURRENT

.... California, ... 191 ..

To the GREAT WESTERN POWER COMPANY:

Subject to the terms and conditions printed on the back of this contract which are hereby made a part hereof, you will please connect your distributing system to the premises No.. Street, occupied as .... and furnish electric current for the equipment therein installed which..............agree to use during the term of.................... year...., from installation of service hereunder and thereafter until a thirty (30) days' notice in writing has been given by either party hereto of a desire to terminate the same.

.... agree to pay for the service monthly, weekly, or by-weekly, as the Company may elect, at the following rate per meter:

AGRICULTURAL SERVICE

3.0c pr K.W.H. if monthly consumption is less than 31 K.W.H. pr H.P.	2.0c pr K.W.H. if m'thly consumption is from 194 to 221 K.W.H.prH.P.
2.9c " " " " " from 31 to 42 " "	1.9c " " " " " " 221 to 250 " "
2.8c " " " " " " 42 to 55 " "	1.8c " " " " " " 250 to 280 " "
2.7c " " " " " " 55 to 70 " "	1.7c " " " " " " 280 to 312 " "
2.6c " " " " " " 70 to 86 " "	1.6c " " " " " " 312 to 346 " "
2.5c " " " " " " 86 to 105 " "	1.5c " " " " " " 346 to 381 " "
2.4c " " " " " " 105 to 124 " "	1.4c " " " " " " 381 to 418 " "
2.3c " " " " " " 124 to 146 " "	1.3c " " " " " " 418 to 457 " "
2.2c " " " " " " 146 to 169 " "	1.2c " " " " " " 457 to 498 " "
2.1c " " " " " " 169 to 194 " "	1.1c " " " " " " 498 to 540 " "
	1.0c " " " " " 540 K. W. H. per H. P.

ORIGINAL

This schedule is for all agricultural power, including irrigation and reclamation, and the rate and minimum charge shall be based on the maximum demand of the consumer's apparatus and not on the rated H.P. in motor or motors installed. The maximum demand shall be determined by a test or tests made from time to time by the Company as they may elect, and each 750 watts as shown by these tests shall constitute a H.P. for the purpose of this schedule. The consumer is entitled to have a representative present at any and all tests made for this purpose, and may have tests made by the Company at his request to determine the maximum demand, provided ten days' notice in writing is given the Company, and provided that no more than two such tes. shall be requested per year. The maximum demand as determined by any test shall remain in full force and effect until the next succeeding test, and the result of any such succeeding test shall be effective only from and after such test and until the next succeeding test.

MINIMUM $6.00 PER H. P. PER YEAR

It is agreed that no bill shall be rendered for less than $1.00 per month per meter.

The undersigned Consumer agrees to notify the Company before making any change in the connected load as specified on the reverse side hereof, and to use electricity for light, heat and power, from the Company exclusively, at the above premises during the term of this contract.

This contract shall not be binding on the Company until accepted by its Sales Manager.

Service D. C. .... Volts. Signed ....

A. C. .... Phase.................. Volts. By ....

Installed.................................... 191....... Accepted .... 191.......

GREAT WESTERN POWER COMPANY,

Salesman .... By .... Sales Manager

S. F. 2131

TERMS AND CONDITIONS

1. The Company will place upon the premises of the Consumer, at or near its street service the meter and other appliances necessary to connect the Consumer's premises with its distributing system. The appliances furnished at the expense of the Company shall remain its property and shall be protected from injury by the Consumer.

All other wiring shall be done at the expense of the Consumer and subject to the approval of the Company and the proper Municipal Authorities.

2. The Consumer agrees not to interfere with the meter or other appliances furnished by the Company. In case of defective service, notice of such fact shall be sent to the office of the Company immediately.

3. If the seal of the Company's meter is broken or if the meter from any cause does not properly register, the Consumer agrees to pay an average bill. Meters will be tested from time to time and the Consumer shall have access to the records of such tests and may have a representative present at any regular or special test, but only an employee of the Company shall be permitted to break the seal of the meter.

4. The Company has the right to enter upon the premises of the Consumer at all reasonable times for the purpose of inspecting, repairing or removing its property.

5. The Company reserves the right to discontinue the supply of electricity without notice in case the Consumer is in arrears in the payment of the Company's bills, or fails to comply with any of the conditions herein specified.

6. The Company will use reasonable diligence in providing a regular and uninterrupted supply of current, but in case of interruption or failure by reason of accident, State or Municipal interference, or any cause beyond its reasonable control, the Company shall not be liable for damage and such interruption or failure shall not constitute a violation of this contract.

7. This contract and written acceptance constitute the only agreement between the Company and the Consumer, and no modification shall be binding on the parties, or either of them, unless the same shall be in writing and approved by the Sales Manager of the Company. This contract is not transferable.

CONTRACT USED BY GREAT WESTERN POWER COMPANY, WHICH IS BRIEF AND DEFINITE.

the collection expense, but eliminates the interest paid by most companies on deposits and permits of closer contact with the customer and general business conditions.

SERVICE CHARGES. No charge is made for service wires or installing meters, this expense being assumed by the company and assures it control at all times of the entire system up to the meter. The charge for service wires exacted by some companies, even tho nominal, is subject to complications as to ownership, even though a clause is inserted granting the utility the option of removing the wires and assuming tentative ownership. Return on expense of this character should be covered by the charge per unit consumption, where a scale or straight rate is used.

EXTENSIONS. Extensions are freely made where revenue is sufficient to return the original investment in a period of from 24 to 36 months. All construction materials are purchased by the company and installed according to its standard and as required by law and the character of the territory covered. Rural extensions will return the investment in many cases in a period of three years, but five years is permitted where pioneer work is undertaken and a new territory developed. Commercial and industrial business will return the investment in periods of one year and sometimes less, dependent upon the extension, whether of the overhead or underground type.

In conclusion, the writer would reiterate the necessity of using written contract forms that are clearly drawn and are concise, containing only such clauses as refer to rates, time limit payment and exclusive service.

On the back of the contract shown here, there is a space left as the side of "terms and conditions" for information concerning the customer and the following data on the connected load. For light, space is left for watts tungsten and others, cp carbon and others, and amperes, with the total kw. For heating, amperes of irons, and other devices with total kw. For power the hp and voltage with total hp and kw.

Eugene Creed, New Business Manager Lexington Utilities Company, Lexington, Ky., Outlines New Business Policies of His Company.

This company pursues a very liberal policy with its customers, demanding a deposit but from one class of people. We bill monthly allowing a discount for payment within ten days, but maintain a strict rule as to discount date in justice to those who pay bills promptly.

We make no service charge and when an extension is necessary we rebate the cost of same by allowing one-half of the customer's bill.

Contract Rates, Billing, Service Charges and Extensions in Connection with the Service of Georgia Railway and Power Company, at Atlanta, Ga.

Beginning with January first, 1913, the contract rates for light and power in Atlanta were greatly reduced. At the present time few Southern cities enjoy as low rates. The maximum light rate has been reduced from 9 cents net to 7 cents net and the monthly minimum charge from $2.00 to $1.00 net. The maximum power rate has been reduced from 5.4 cents net to 4.5 cents net and the monthly maximum charge of $1.00 per horsepower to 50 cents per horsepower, net.

A bill for both light and power is rendered on the first of the month and a discount of 10 per cent allowed if payed on or before the 10th.

No service charge is made for either light or power when customer is located on a line.

The company erects the necessary extensions to any customer 200 feet without charge both in cases of light and power service.

Contract Rates of Various Southern Cities.

According to data gathered and given out by J. Prince Webster of the Georgia Railroad Commission, the following are the contract rates for light and power together with the minimum charges now made by a number of Southern central stations:

Nashville's rates are 12 cents to 7.2 cents for light, according to quantity used; 10 cents to 6 cents for power, according to amount used.

Richmond, 9 cents to 5.4 cents for light; 8.1 cents to 3.6 cents for power. Minimum, $1 each.

Norfolk, same rates as Richmond, served by the same company.

Chattanooga, 12½ cents to 6½ for lights, $1.26 per month minimum; service charges for each kilowatt, minimum $1.25 per month, graduated scale.

Memphis, 10 cents to 8 cents for light; 9½ to 3 cents, general rates for power, and 4 cents to 2 cents, manufacturing rates for power.

Birmingham, 12 cents to 6 cents for light; 7 cents to 5.6 cents for power.

As to cities in Georgia, the following rates are shown:

Columbus, 10 to 5 for lights, minimum, $1; 4½ to 1.8 for power, minimum $1 per horsepower per month.

Athens, 9 to 7½ for lights, minimum 50 cents; 4½ to .8 for power, in addition to a service charge of practically $1 per horsepower per month. Flat rates are also charged for lights.

Brunswick, 11 to 9.35 for light; 7½ for power.

Augusta, 12 to 4.8 for light; 6 to 1½ for power. Minimum charge for power ranging from $1 per horsepower per month, to 50 cents per horsepower per month.

Macon, 12 to 4.8 for light; 10 to 4 for power.

In Savannah the rates are supposedly 12 to 6 for light, and 3 1-3 for power; but, says Rate Expert Webster, there are practically no fixed rates now because of competition. The city has, however, entered into an agreement or contract with the Savannah Electric Company to pay, when the competing company has been killed, 12 to 7 1-2 for light, and 5 cents for power.

Atlanta now pays 7 cents down to 5.4 for lights, dependent upon the current consumed, and 4.5 down to 1 1-2 for power, regulated by the same condition. The minimum is $1 per month for lights, and 50 cents per horsepower per month for power.

The oil used in transformers performs two functions: It serves to insulate the windings from each other and from the core and it conducts the heat from the windings and core to the external casing of the transformer, where the heat is radiated to the surrounding atmosphere. In water-cooled transformers it transfers the heat from the windings and core to the cooling pipes placed at the top of the transformer. The oil should be free from any conducting material, especially moisture, and should be sufficiently thin to circulate rapidly when subjected to different temperatures. It should not be ignitable until its temperature is raised to a very high value.

Questions and Answers from Readers.

We invite our readers to make liberal use of this department for the discussion of questions as well as for obtaining information, opinions and experiences from other readers. Answers to questions or letters need not conform to any particular style. All material is properly edited before publishing it. Discussions on the answers to any question or on letters are solicited, however, the editors do not hold themselves responsible for correctness of statements of opinion or fact in discussions. All published matter is paid for. This department is open to all.

WHY DID MOTOR REVERSE?

Editor Southern Electrician:

(350) Recently the writer had called to his attention the reversal of a three-phase motor caused by the breaking of one of the line wires through a falling tree. What conditions must have existed in the motor to have caused this reversal? W. C. B.

STAR-DELTA STARTING SCHEME.

Editor Southern Electrician:

(351) What are the objections if any to the use of a star-delta wiring arrangement for starting an induction motor without use of a starter? Up to what size of motor can this scheme be used when motor starts under load? What is the reason the Underwriters do not favor this method of starting? W. H. D.

THREE-PHASE MOTOR ON A 3-WIRE CIRCUIT.

Editor Southern Electrician:

(352) I would like to have some one explain how a 3-phase motor would operate if connected to a 3-wire system where there is 110 volts between each outside and inside wire and 220 volts between the two outside wires. H. H. Keily.

MOTOR AND STEAM ENGINE IN PARALLEL.

Editor Southern Electrician:

(353) In our plant we have a steam equipment that is running overloaded. Some of the additional load is now being motor driven from outside power. Can a motor be belted to the line shaft driven by the engine and can the line shaft then be loaded up to the capacity of the motor in addition to the present load? That is, will the motor and engine operate in parallel, and the capacity of one be added to the other? W. T. S.

LIGHTING EQUIPMENT AND STATION APPARATUS FOR SMALL PLANT.

Editor Southern Electrician:

(354) Kindly request readers of SOUTHERN ELECTRICIAN to give information on the following proposition. The writer is located in a country town of 3,000, where it is proposed to install an electric light plant. There will be practically no motor load except fans in summer. The town is fairly level, the streets rather narrow with many shade trees and two telephone companies occupying both sides of the streets. The area of the town is a little over one square mile.

What the writer desires to know is the proper system to install for lighting, A. C. or D. C. Also something as to the size of generator to serve a town of the size mentioned, judging from other systems in operation. Which system, arc or incandescent is preferable? What is a fair price per lamp per month for each system? For a system using 50 100-watt tungsten lamps on a series arrangement, what would be a fair flat rate for street lighting? For a small plant of this sort would it be advisable to install new machinery or good rebuilt machinery? Any information or suggestions will be thankfully received. C. R. K.

DESIGN OF SERIES A. C. ARC SYSTEM.

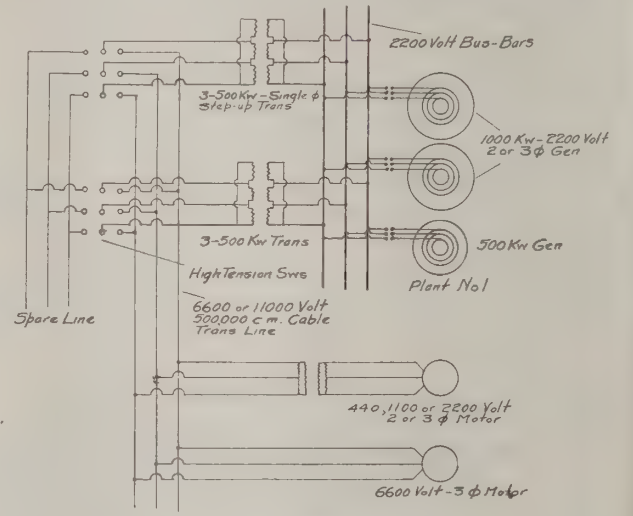
Editor Southern Electrician:

(355) I would like to know how to calculate the size of wire required for a series A.C. arc system operating 40 lamps all on one circuit and of the 6.6 ampere type with 72 volts at the arc. The farthest point from the tub transformer will be 1¼ miles. What line loss can be taken into consideration? Furnish diagram of circuit indicating apparatus required for a single circuit. J. P. Long.

Generating Voltage, Ans. Ques. No. 318.

Editor Southern Electrician:

For the load and distance mentioned by Mr. Carrigan in his question No. 318, I should think that a voltage of 6600 volts would be about right. Above this, the saving in copper would hardly pay for the increased cost of the line and transformers. Three generators, two of 1000 kw. and one of 500 kw. might be used at station No. 1, stepping up from 2200 to 6600 volts by means of two sets of three 500 kw. single phase transformers. With a single line 500,000 c. m. cable could be used, but if duplicate line is run, 4-0



LAYOUT FOR STATION APPARATUS.

would be sufficient. The sketch shows a suggested arrangement of generating units, transformers and switches. One advantage of using this voltage is that motors can be operated directly from the 6600 volt line, thus saving the expense and upkeep of transformers.

Design of Transmission Towers. Answer to Last Part of Ques. No. 322.

Answering the last part of question 322, I would say that for short lines it makes no practical difference as to the arrangement of the conductors, but on long lines the effect of an unsymmetrical arrangement would be to produce an unbalanced reactance drop. As we know, each conductor carrying alternating current is surrounded by a rapidly reversing magnetic field. This field reacts on both of the other conductors to quite an appreciable extent so that in designing transmission lines we have not only to consider the resistance drop, but also that due to the reactance. If the conductors are not symmetrically arranged, as for instance in a horizontal plane, it is evident that the middle wire will be in a stronger magnetic field than the outer ones, and consequently will have a greater reactance drop. The effect of this is to unbalance the circuit, and reduce the capacity of the circuit.

Condition When Transmission Line Breaks. Ans. Ques. No. 326.

It is impossible to answer question 326 with the data at hand, since there are so many factors involved. If the high tension line were well insulated from the ground, the only current received by either horse or man would be the leakage current, which would depend altogether upon the design and quality of the insulation. If, as more likely, the line was grounded, then the voltage from any conductor to ground would depend upon the point of connection to ground. If the ground were at the middle point of the transformer winding, it might be 17,000 or 14,700 volts. If as less likely one conductor were grounded, both the others would be at a potential of 17,000 from ground. The actual current received by the horse and the man would vary greatly with the condition of the soil, and the moisture present at the point of contact with the bodies of both. A horse is extremely sensitive to electricity. By experiment it is found that they will start at as low as ten volts, while 110 volts is generally fatal. With the horse lying on the ground, holding down the man's leg, the latter would receive at most, but a shunted current, and if the horse's hair was dry, as well as the man's clothing, it is entirely possible that he would receive only a slight shock.

Trouble With Mr. Metcalf's Motor Driving Pump.

In further comment upon Mr. Metcalf's difficulty with the motor driving a centrifugal pump, one would be apt to think with him that the holes in the fan blades would have reduced the load on the motor, but when we consider that with blades properly fitted that there is hardly any leakage in this type of pump but that the water passes thru with considerable velocity, while with the holes in the blades there would be a large leakage, it may be possible that by creating eddy currents within the pump, they would have actually increased the load. If the speed of the motor, the current taken, and the volume of the water delivered under the two conditions were given, we could probably suggest an explanation. A. G. Rakestraw.

Poles of Induction Motor.—Ans. Ques. No. 329.

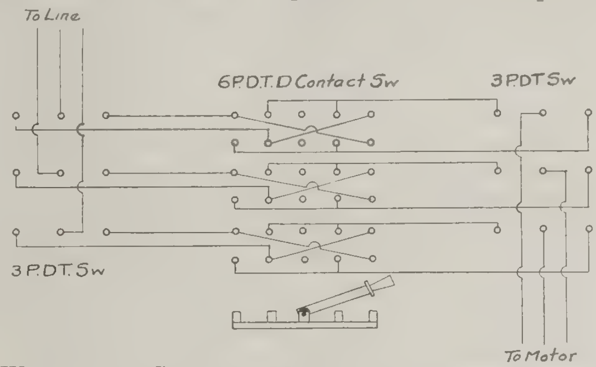
Editor Southern Electrician:

In answer to question No. 329, if P. D. S will use the following formula he will be able to tell how many poles his motor has, or if he knows how many poles it has, can tell the speed. Knowing the speed and number of poles, he can tell the frequency. $F = (P \times S)/120$ or $P = (F \times 120)/S$ or $S = (F \times 120)/P$ where F = frequency in cycles per second; P = number of poles; S = R.P.M.

In the stator of an induction motor with a distributed winding there would be no fixed poles as from the nature of the currents and winding the poles keep shifting around and drawing the rotor after them. By examining the winding P. D. S. can tell how many coils there are per pole per phase, and by dividing the number of coils on the stator by the number of poles times the number of phases will give the coils per pole per phase. $N/(P \times f) =$ coils per pole per phase where N = whole number of coils on stator; P = number of poles; f = number of phases.

Starting a Motor From Three Points. Ans. Ques. No. 330.

The diagram shown here is for a three-switch control of a 3-horsepower, 3-phase motor, without using any automatic starters. As you will no doubt see, by using the 6-pole switch any number of places can be wired up. The

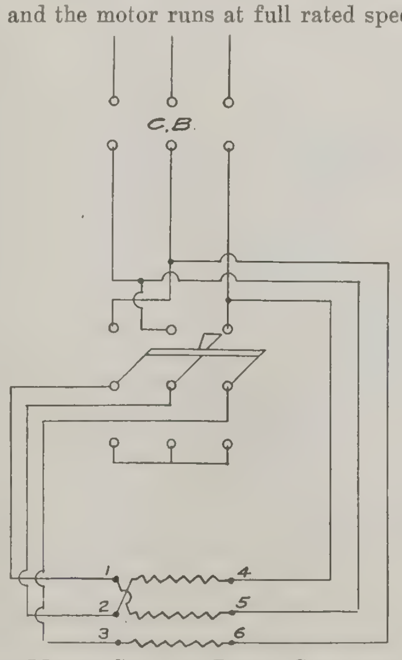


Wiring for Starting Motor from Three Points.

motor can be started and stopped from any station regardless of how the other switches are set. The only thing that must be remembered is that when a switch is opened to stop the motor, it must be thrown over in the other contacts.

Induction Motor Wiring.—Ans. Ques. No. 340.

In answer to question 340, the writer will say that the diagram shows a 3-phase motor with the ends of each phase brought out to the motor terminal block (making 6 leads). Now by throwing his switch in the starting side so that leads 1, 2, 3 are short circuited, he connects the coils of the motor in Star or (Y) thereby impressing across each phase a little over half voltage $\sqrt{3} \times 220 = 127$ volts, and by throwing the switch in the running position he connects the coils in mesh or delta and impresses full voltage across each phase and the motor runs at full rated speed.



Induction Motor Star to Delta Starting Scheme.

This way of connecting up a motor does away with the compensator, and is very much cheaper. The reason that the entrance leads were crossed was to change the direction of rotation, for to change the direction of rotation of a 3-phase motor you interchange any two of the line wires.

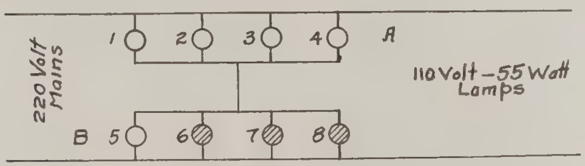
If Electrician will look on pages 297 to 301 of the I. C. S. Hand Book, he will find some very valuable information on watt meters and their connections. If he does not have one of these valuable books, he should get one at the earliest possible moment. Wm. F. Phillips.

Series Multiple Wiring.—Ans. Ques. No. 338.

Editor Southern Electrician:

Answering question 338 in the December issue, it may be said that the principle objection to the series-multiple system of wiring is the unbalancing feature to which such wiring is subject. A brief study of the system, with its existing conditions of voltage and current will easily show the undesirable and impracticable features which render this method of wiring both unsatisfactory and hazardous.

From the name series-multiple, it is evident that we must have a series of multiple connections, as shown in the sketch. That is to say we have several distinct groups A and B, the lamps in each group being connected in multiple, while the different groups are each considered as single units and connected in series with each other.



SERIES-MULTIPLE WIRING.

The conditions existing are as follows: Voltage across mains, say 220 volts; voltage across each lamp, 110 volts (neglecting line drop); current through each lamp, from Ohms Law is, C = watts/volts = 55/100 = 1/2 ampere. The total current drawn by group A = 4 × 1/2 amp. = 2 amperes. The current through group B is of course also equal to 2 amperes, since the same current traverses all portions of a series circuit.

Now supposing for some reason a portion of the lamps in group B is turned off, as indicated by the shaded circles 6, 7 and 8. It is evident that the remaining lamp 5, of group B must carry the entire current flowing through group A. This excessive current would probably establish an arc in the socket, speedily destroying same, dropping the molten metal, and very probably igniting the drop cord.

Z. C. Adams, Elec. Inspector.

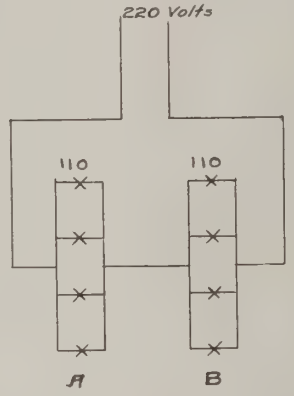
Series Multiple Wiring. Ans. Ques. No. 338.

Editor Southern Electrician:

Both multiple-series and series-multiple systems of incandescent lamp lighting were once used, but they proved generally unreliable and caused much trouble and inconveniences. At the present time because of better insulated wires, better made lamps and wiring devices, the results obtained through the use of the above systems would be better but not sufficiently so to warrant their use or to make them desirable for many purposes.

Sign lighting is sometimes accomplished by means of multiple-series circuits, a series of say eleven parallel circuits being connected to 110 volt service. As there are eleven parallel circuits connected in series each operates at 110/11 or 10 volts. But in each parallel circuit there may be twenty 10-volt, 5 watt tungsten sign lamps. Each of these circuits will receive (5 × 20)/(10 volts) = 10 amperes and this 10 amperes will flow even if some of the lamps in one or two of the parallel circuits are removed, broken or burned out. This is one defect, for if only 18 lamps are burning in one of the circuits, these 18 will each get a little more of the 10 amperes than if the 20 lamps were burning. This is one reason why burned out or broken lamps used on signs wired on the multiple-series system should be replaced at once as the higher current will shorten the lives of the lamps remaining in that particular parallel circuit. Lamps of exactly the same kind and voltage, must of course, be used.

For interior lighting, however, multiple-series systems might not prove inconvenient if at all times the same size lamps were used, and all operated at the same time. No serious results would follow if some lamps were not turned on except that the remaining ones would be operated at a higher amperage and would be burned out. The following example will show that damage would most likely follow the general use of the multiple-series or series-multiple systems.



SERIES MULTIPLE WIRING SCHEME.

In the accompany illustration is shown a 220-volt service with two multiple circuits connected in series, each circuit therefore operating at 110 volts. If there are four 55-watt, 16 candlepower lamps used on each multiple circuit, each circuit will require (4 × 55 watts)/(110 volts) = 2 amperes and each of the four lamps ½ ampere. If one lamp was turned out the other three would each receive ⅔ ampere which would in a short time ruin the lamps.

If it were desired to connect an electric iron to one of the outlets in circuit A, the ½ ampere would not be sufficient to heat the iron while if other large units were used on the circuit so as to increase the total amperes from 2 amperes up to say 5 or 6, this same large amount current would flow through circuit B because this circuit is in series with circuit A. The lamps would be burned out and if a toaster, heating pad or cigar lighter were being used on circuit B at this time, it would be destroyed and be liable to cause a fire.

It may be seen therefore that in these systems, if one of the multiple circuits requires a large current this same current will be supplied to the other circuits. From an engineering, fire-hazard and practical standpoint such systems are not desirable for general interior work. The constant potential multiple system of wiring is so much better in all respects that it is in almost universal use now. With this system the voltage is the same for all outlets and the operation of some of the lamps or devices connected to the system does not effect the current passing to the others. Lamps, heating devices or motors of different current carrying capacities can be used at different parts of the systems without trouble or damage. Geo. J. Kirchgasser.

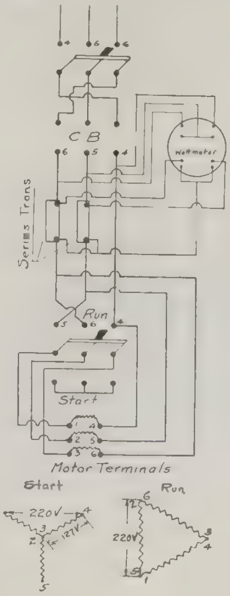
Connections for Induction Motor. Ans. Ques. No. 340.

Editor Southern Electrician:

The connections for the motor indicate that it is arranged to start with the stator windings connected in Y and to run with windings in "delta," thus doing away with the necessity of an auto-transformer starter. Thus, with windings connected in Y the volts per phase have the value $220/\sqrt{3} = 127$ volts, or about 52 per cent of rated voltage. With "delta" connection the full voltage is impressed upon each winding. The diagram of connections shown below is identical with that in Ques. 340 with the addition of the motor windings and proper connections to the wattmeter.

By reference to this figure it will be seen that the purpose of the short-circuited connection on the starting switch is to connect the stator windings to a common point for Y connection. The entrance wires were evidently crossed by the person installing the motor in hunting for the combination which would connect the proper windings together for the running of "delta" arrangement. This need not have been done on the entrance wires but could have been accomplished by a proper connection of the wires leading to the motor, and a better looking job would have been the result.

As to the meter connections, the current transformers might be inserted in any two of the wires, provided that the potential coils of the meter were connected from these two wires to the third wire. The system is symmetrical and 220 volts exist between any two wires. To reverse the



WIRING FOR INDUCTION MOTOR AND WATTMETER.

direction of rotation of the motor the entrance wires now crossed above C. B. should be connected straight instead of crossed. B. C. Dennison.

New Apparatus and Appliances.

Electrically Controlled Draft Regulation for Steam Boilers.

To admit the use in steam boilers of cheaper grades of anthracite coal, No. 3 Buckwheat for example, which is much cheaper than No. 1 Buckwheat in general use, the Diehl Manufacturing Company has evolved a system of forced draft, electrically energized, and automatically controlled, which necessitates only a comparatively small initial outlay for small boiler room. A multivane high speed fan is utilized in connection with a variable speed steel frame motor coupled direct on the shaft with a relief motor or steam engine ready to swing in on the other end in case of breakdowns. The motor is shunt wound and semi-enclosed with screens of wire mesh to guard against dust and dirt in the fire room.

The automatic action is as follows: Assuming that there is considerable natural draft over the fire and that the steam pressure is high, the damper regulator piston is at the extreme end of its stroke, thus bringing the contact levers in the position shown, which stops the motor. As soon as conditions demand more steam, the regulator opens, which action transmitted through the chains, connect the two circular contacts which close the clapper switch and operate the automatic motor starter, giving the minimum speed available. The chains and sprockets transmit further movement of the damper regulator to the motor field resistance attached behind the board and not shown, the contact lever traveling over a series of 60 contacts which movement increases the speed to any given point or maintains it on any one point, according to draft requirements. As the counterweight drops, so that the contact lever returns to the slow speed or "full off" position. A series of small limit switches are attached to the panel allowing the speed to be set for a maximum of revolutions.

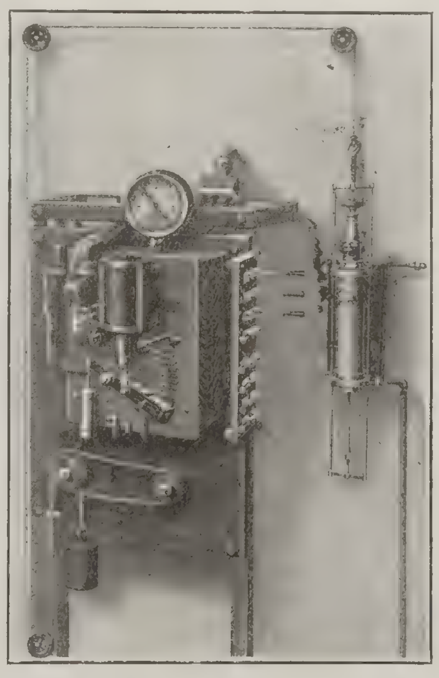


FIG. 3. SHOWING AUTOMATIC REGULATOR AND MOTOR STARTER.

The cost and saving in a typical boiler room is as follows:

Fan, Engine and duct	$800
Motor	550
Controlling panel	125
Wiring and connecting	25
Foundation Work	50
Total	$1550

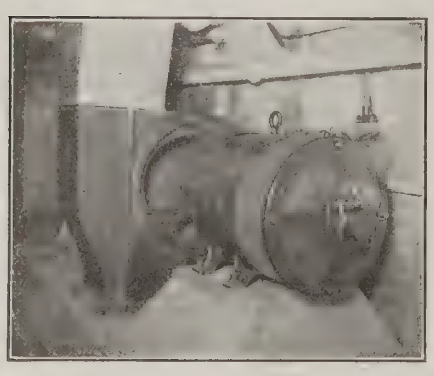


Fig. 1. Showing Motor Side of Fan.

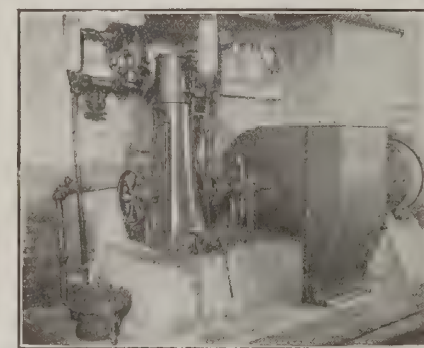
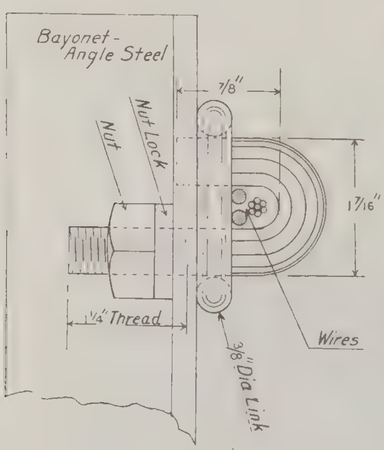


Fig. 2. Showing Engine Side of Fan.

Allowing for the additional amount of the smaller coal consumed, a saving of 50 cents per ton or $7.50 a day was shown, a year's saving amounting to $2,737.00 or $2,644 net, deducting 6 per cent interest on expenditure.

A Ground Wire Clamp.

A ground wire clamp is being manufactured by Hubbard & Company, of Pittsburg, Pa., as invented by W. E. Belcher, and designed to connect steel strand to a bayonet angle or steel tower. It consists of an elongated link and a bolt either U or J shaped as shown in the illustration. The strand is gripped on all sides between rounded surfaces and is at the same time held away from the steel supports to avoid injury to the strand. The strength of the clamp is about 1,500 pounds, so that there is no danger of the ground wire slipping through. The grounding wire running down the pole is fastened by the same device, by looping it under the ground cable. This clamp satisfies the purchaser from point of cheapness, is satisfactory to the lineman because it is simple and to the operator because it does the work required.



The Belcher Ground Wire Clamp.

An Accomplishment In Motor Design.

A novel motor drive of a continuous duty flasher manufactured by the Reynolds Electric Flasher Company, of Chicago, is shown in the illustration below. The illustration shows motor and flasher with the hinged cover hanging down to expose the interior arrangement. The flasher itself is a novelty inasmuch as its construction involves a new principle, the only moving current carrying member being a feeder brush. The motor is unusually light, with laminated field frames, and aluminum end covers to reduce weight to a minimum. It was furnished by the Diehl Manufacturing Company, the motor frame weighing less than 3 pounds and showing what may be accomplished in electric motor design.

A Small Motor Operating an Electric Flasher.

New Plant of H. W. Johns-Manville Company.

The completion of the new plant of the H. W. Johns-Manville Company, at Manville, N. J., marks another important chapter in the history of this enterprising concern. Beginning with the consolidation of the H. W. Johns Manufacturing Company and the Manville Covering Company, in 1901, the H. W. Johns-Manville Company has grown until today it ranks as the largest concern in the world engaged in the manufacture of asbestos and magnesia products. They have branch houses in practically every city of prominence in the United States and Canada, and representatives in almost all foreign countries. Their manufacturing plants are located in Brooklyn, N. Y., Milwaukee, Wis., West Milwaukee, Wis., Hartford, Conn., Nashua, N. H., Lockport, N. Y., Jersey City, N. J., and an asphalt refinery at South Amboy, N. J. Their asbestos mines at Danville, Province of Quebec, Canada, are the largest in existence.

New Plant of H. W. Johns-Manville Company.

The new Manville plant consists of nine buildings which, together with their products, are classified as follows: A—Textile and Packing. B—Rubber plant; Electrical Specialties and Printing Department. C—Pipe Coverings. D—Paper Mill. E—Magnesia. F—Roofing. G—Mastic and Waterproofing. H—Roofing Coatings. Power Plant and Pump House. These buildings represent the most advanced ideas in fireproof construction, being of brick, steel and concrete, with roofs of J-M Asbestos Roofing. They are planned not only for safety but to afford the best operating conditions for the employes. The "daylight" form of construction which is employed throughout permits a flood of light to enter the buildings through large triple-unit windows placed close together. The walls, ceilings and uprights are coated with J-M Fireproof Cold Water Paint. Artificial illumination is provided in the form of J-M Linolite lamps and Frink reflectors. Power is furnished by the company's power plant, which consists of the latest type of General Electric turbo-generators, six Babcock & Wilcox high-pressure water-tube boilers aggregating 5,000-horsepower. About 3,000 men will be employed at this new plant, making a total of about 7,000 who are now employed by this company.

Southern Construction News.

This department is maintained for the contractor, dealer, jobber, manufacturer and consulting engineer. The material is obtained from various sources and includes the latest information on new Southern engineering and industrial enterprises. We ask the co-operation of new companies by furnishing authentic information in regard to organization and any undertakings. We also invite all those who desire new machinery or prices on electrical apparatus to make liberal use of this section. No charge is made for the services of this department. Every effort is made to avoid errors in any item, and if such occur, we want to know about them.

ALABAMA.

BIRMINGHAM. The Tidewater Power Co., is preparing to begin construction work on a power plant as soon as a franchise has been secured, covering operations in Birmingham. An electric light franchise in the city has already been secured. The plants will be located on the Warrior river, near the coal mines of the company.

ENTERPRISE. It is understood that the city plans to extend its street lighting system in the near future. The superintendent is W. Thompson.

GADSDEN. The Alamama Power Co., is arranging to bring its transmission lines into Gadsden, furnishing power from a hydro-electric plant now under construction at Lock 12 on the Coosa river. It is understood that plans include the distribution of 600,000 H. P. between Anniston, Gadsden and New Orleans.

WETUMPKA. The Alabama Interstate Power Co., is arranging for the construction of a second dam on the Coosa river at Lock 18, about four miles from Wetumpka. This dam will make the river navigable and is understood will cost about $7,000,000. The dam will be practically the same construction as the one at Lock 12.

FLORIDA.

OCALA. The Florida Power Co., has purchased equipment for an additional installation including 1200 K. W. generator, 2000 H. P. water wheel and governor.

PALATKA. The Board of Trade has appointed a committee to make investigations in regard to the installation of a municipal lighting system.

ST. AUGUSTINE. Plans are now formulated for the incorporation of the Jacksonville and St. Augustine Public Service Co., to build a generating station to furnish energy for light, heat and power. The company is capitalized at $2,000,000 and with A. W. Corbett, president; J. D. Andrew, vice-president; D. L. Dunham, secretary, and A. E. Daya, treasurer.

GEORGIA.

ATLANTA It is understood that the Georgia Railway and Power Co., is negotiating to purchase the transmission lines in Georgia owned by the Eastern Tennessee Power Co. This company has also contracted with the Hardaway Contracting Co., of Columbus, Ga., to complete the dam at Mathias, above the Tallulah Falls development.

CHIPLEY. Messrs. Hall & Gocha has applied to the city council for a franchise to construct and operate an electric light plant in this place.

JONESBORO. An election has recently been held voting on an issue of $10,000 in bonds for electric light plant.

LYONS. Bonds to the extent of $12,000 has been voted for a municipal electric lighting system.

ROME. Soloman & Norcross has been engaged as consulting engineers to prepare plans and estimates for a municipal electric light plant.

SPRINGFIELD. Bonds to the extent of $10,000 have been voted for the installation of an electric light plant.

KENTUCKY.

ELIZABETHTON. The Tygert Valley Water & Electric Co., has been incorporated with a capital stock o' $20,000, by G. H. Hall, W. M. Carter, George Snyder and W. W. Carter.

FULTON. The Fulton Light and Power Co., has been purchased by the St. Louis capitalists, the consideration being $40,000. Improvements and additions will be made at an expenditure of an equal amount. The president of the new corporation is G. K. Mitzenberger, of St. Louis.

LEXINGTON. The Kentucky Utilities Co., of Lexington, has secured the services of Sargent & Lundy, of Chicago, Ill., in connection with proposed improvements to their plant.

MUNFORDVILLE. Bids will be opened February 1st by the Munfordville Electric Light & Power Co., to erect an electric light plant, installing a 25 H. P. alternator and generator. J. O. Bryce is engineer in charge.

PADUCAH. The Board of Public Works has plans for the installation of an ornamental street lighting system in the downtown district of Paducah. This system will cost approximately $50,000.

PERRY. The Kentucky Utilities Co., has recently purchased the Perry Gas & Electric Co., and has closed contracts with the city council for furnishing electricity for lighting the streets of the city for two years. This company has also recently taken over the United Water & Traction Co., of Somerset, Ky., and will improve the local plant. Later it is planned to build a new plant at a cost of $75,000.

LOUISIANA.

BATON ROUGE. The Baton Rouge Electric Co., has been granted a franchise to construct an electric railway from Lafayette St., out 10th street and on 10th street to North Boulevard and other streets in the surrounding territory.

DONALDSONVILLE. The municipal electric lighting plant is to be remodeled at a cost of $41,000. The equipment will be supplied by the Fort Wayne Electric Works and the Lawrence Machine Co.

LAFAYETTE. The site has been purchased in LaFayette by the Louisiana Traction & Power Co., for a proposed power house from which energy will be generated for the operation of electric railways in Southwest Louisiana.

NAPOLEONVILLE. The city will vote on February 8th to construct an electric light plant.

NORTH CAROLINA.

ANDREWS. The J. B. McCrary Co., of Atlanta, has been retained as engineers on the Junaluska creek power development, where a 20-foot frame dam and power house are to be erected. A 150 H. P. and 450 water wheel and generator will be installed.

CHARLOTTE. The proposition submitted by the Southern Power Co., recently for the installation of an ornamental street lighting system has been authorized by the board of aldermen and the executive board has entered into a ten-year contract with the company. Under the contract the installation will consist of magnitite arc lamps replacing those now in use, except those in special lighting districts where cluster lamps will be erected on ornamental standards. Wires will be placed underground.

SOUTH CAROLINA.

FORK SHOALS. Plans have been formulated by the Cedar Falls Light & Power Co, to enlarge its hydro-electric plant at this place. The temporary wood dam is to be replaced by a masonary one and the generating capacity increased about 500 H. P. Transmission lines will be constructed to the Kotrine Mfg. Co., at Fork Shoals to Fountain Iron, Simpsonville, and other cities.

HAMLET. The power plant of the Seaboard Air Line Railway Co., in Hamlet, has been damaged by a boiler explosion.

ORANGEBURG. The city council has decided to issue bonds to improve the municipal electric light system.

PERSONALS.

PRESTON S. MILLAR, manager and illumination expert of the Electrical Testing Laboratories of New York City, last year general secretary of the Illuminating Engineering Society and a charter member, has recently been honored by election as president of the society. Mr. Millar, although as yet a very young man, stands in the field of illuminating engineering among the first as engineer or expert with an enviable reputation for his grounding in the fundamentals and the exactness of the science which forms the basis of present day illumination. He is an acknowledged authority in testing of lighting units and with Dr. C. H. Sharp, of the same laboratories is the inventor of several devices to aid in testing work, these including the well known Sharp-Millar universal photometer. One of the reasons for Mr. Millar's high position in electrical engineering circles, we believe, is his willingness to assist in the promotion of illumination as a science at any time that he may be requested, even at the sacrifice of valuable time at his own work. Without a question the literature on illumination has had as many if not more real engineering contributions from him than from any other single engineer closely connected with the work. He has contributed to the technical press, prepared numerous papers for the Illuminating Engineering Society, the Association of Edison Illuminating Companies, the National Electric Light Association, delivered each year numbers of lectures and given time further to International Electrical Congress as business manager, and as editor of illuminating questions for the revision of the Question Box of the N. E. L. A. He is further a member of all the engineering societies having an interest in his field of activity and is active in all of them. As a president of the illuminating engineering society we know of no better and feel sure that the next twelve months will not only bear this statement out but mark a definite year of accomplishment in the history of the society.

MR. C. E. ALLEN has recently been appointed assistant manager of the detail supply department of the Westinghouse Electric & Mfg. Company at East Pittsburgh, Pa. Mr. Allen has been closely identified with the transformer industry in various capacities for the last ten years, and has a wide circle of acquaintances in the electrical fraternity. He was born in the state of Virginia, and, after attending high school, entered the Virginia Polytechnic Institute, from which he graduated in 1901. Immediately after graduation, he entered the employ of the General Electric Company, taking the apprenticeship course. From here he was transferred to the engineering department, where he was engaged in the design of transformers, on which work he was successfully employed for several yeras, having charge during most of this period of the development designs. While in charge of this work, Mr. Allen invented the "distributed core type transformer," now being manufactured by the General Electric Company. Upon completion of this work, he was transferred to the commercial department in which he continued until 1909, when he severed his engagement with the company.

In the fall of 1909, Mr. Allen entered the employ of the Westinghouse Electric & Mfg. Company as head of the transformer division of the detail and supply department, which position he retained until he assumed the duties of assistant manager.

PROF. J. A. SWITZER has charge of the hydraulic work and D. R. Shearer the electrical design and installation of a small hydro-electric plant at Banner Elk, N. C. Both engineers are of Knoxville, Tenn.

GEORGE F. SCHOEN, Empire Bldg., Atlanta, Ga., a well known factor in Atlanta's electrical supply business, has recently been appointed southern representative for the American Conduit Manufacturing Company, of Pittsburgh, Pa. This company manufactures the brands of conduit well known to the trade under the names of "American" and "Galvanite" rigid conduit, and "Wireduct" flexible tubing. Mr. Schoen has been in the electrical business as a jobber and manufacturer's representative for a number of years and is well known to buyers of electrical goods throughout the south. The line which he has recently taken on is not unfamiliar to the trade in this section and with the increasing building activity and electrical construction an increased consumption of not only this but all types of conduit is expected during 1913.

MR. FRANK F. FOWLE, who for the past year has been one of the joint editors in charge on the staff of the Electrical World, has resigned and will resume his electrical engineering practice with offices at 68 Maiden Lane, New York City. When laying down his engineering work at Chicago Mr. Fowle, although yet a young man, had a large clientele and a most enviable reputation among engineers and in engineering societies. Mr. Fowle's career has been one which ably fits him for the work to which he now plans to devote his time. After graduating at the Massachusetts Institute of Technology in 1899, he entered the engineering department of the American Telephone and Telegraph Co., in New York, remaining there from 1899 to 1903. He then went with the railway department of the same company and in 1906 was appointed manager of the Chicago territory of the long-distance system with headquarters at Chicago. Here he remained until 1908 when he established as a consulting electrical engineer. During the period of 1908 to 1912 he acted as appraisal and rate expert for the City of Beloit, Wis., in connection with the Beloit case heard before the Wisconsin Railroad Commission; examined St. Paul water mains to determine extent of damage from electrolysis; appraised telephone property; investigated isolated plant economy; gave expert testimony; made extended investigations into the properties and economic uses of copper clad steel wire; advised in reference to rates and standards for street lighting; miscellaneous technical investigations and reports for public service corporations, railroads, manufacturers and municipalities. Mr. Fowle has contributed no less than 50 technical papers and articles to engineering societies and publications. He is a member of the A. I. E. E., the Illuminating Engineering Society and the N. E. L. A.; an associate member of Railway Signal Association; and a member of the Technology Club of New York He is also a member of the Telegraph and Telephone Committee and the Patent Committee of the A. I. E. E.

MR. S. B. JOHNSON, a well known salesman of the Reynolds Dull Flasher Company, of Chicago, has been appointed manager of this concern. Mr. Johnson is thoroughly familiar with the sign business and through his large acquaintance with the customers of the company he will be in an excellent position to further the company's policy of giving individual attention to each and every order. While he will still continue to visit the trade, Mr. Johnson will devote a larger part of his time than heretofore to office affairs. This arrangement takes much of the routine office work off the shoulders of Mr. E. R. Dull, who was formerly office manager, and will permit him to give a larger part of his time to creating new effects. It will be remembered that Mr. Dull is one of the pioneers in the electric sign field and in the design and manufacture of flashers.

MR. S. B. JOHNSON, Manager, Reynolds Dull Flasher Co.

H. M. BYLLESBY AND COMPANY will hold its fourth annual convention, recently announced to be held January 23d and 24th, sometime in June. This action has been taken on account of certain important activities which prevent the attendance of some of the officials of H. M. Byllesby & Company and many managers of local properties.

MR. HUGH T. WREAKS, who for the past year has been acting as special agent on wires and cables for the Underwriters' Laboratories in Chicago, tendered his resignation, effective January 1, in order to devote his entire time to the work of the Wire Inspection Bureau, of which he is secretary.

JAMES H. MASON, general manager of the Simplex Electrical Co., 201 Devonshire St., Boston, has left for an extended trip around the world.

MR. J. J. HUMPHRIES, general manager of the Louisville Company, has been elected a member of the Rotary Club of Louisville, Ky., which organization is comprised of one representative from each line of business.

MANAGER E. HOLCOMB, of the Consumers Power Company, St. Paul, Minn., has been elected president of the Minnesota Electrical Association for the year 1913. The next annual convention will be held in St. Paul, March 11-12-13.

MR. F. V. INSULL, general auditor of the Arkansas Valley Railway, Light & Power Company, Pueblo, Colo., has resigned (effective January 1) to accept another position.

MR. N. C. DRAPER, manager of the Sioux Falls Light & Power Company, Sioux Falls, S. D., was recently elected president of the Dakota Club, a social organization having a membership of more than 200 Sioux Falls business men.

SOUTHERN ELECTRICIAN

PUBLISHED MONTHLY

Vol. 45. MARCH, 1913 No. 3

PUBLICATION OFFICE
DALTON, GA.

EDITORIAL and ADVERTISING DEPARTMENTS
GRANT BUILDING ATLANTA, GA.

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SUBSCRIPTION RATES

Domestic..$1.00 For Two Years

Canada..$1.00 Per Year

Foreign..$1.50 Per Year

Complaints of failure to receive SOUTHERN ELECTRICIAN regularly or of any errors of any nature, should be promptly made to the Atlanta office.

Advertising copy or change orders for standing advertisements must reach the Atlanta office by the 5th of the month preceding the month of publication.

Entered at Dalton, Ga., Postoffice as Second-class Matter.

CONTENTS.

Joint Line Construction.

This is a time of the year when, with the results of sleet storms practically gathered with every assurance that equal results may be expected 12 months hence, the telephone and electric light and power companies are particularly interested in improving their line construction. In those cities where the construction has been made according to no universal standard and where a lenient or inefficient inspection has been maintained, the lines and drops of the telephone companies are found crossing and recrossing power lines in such a way that sleet storms exaggerate the seriousness of the conditions, to a point where public attention is attracted. This is the time then that public agitation for underground construction and the dangers of the existing conditions burst into life anew.

In such cases where there is no absolute necessity for under ground construction, the question of joint pole line construction comes up in all its seriousness. While in all cases such construction is not possible and not advisable, it is on the other hand in many cases a solution of a perplexing problem. There is undoubtedly within the observation of many of our readers certain leads where through paralleling of wires and the crossing of each, a dangerous construction and an unsightly congestion has developed that exceeds certain limits of civic decency and yet where the lines ultimately terminate in and serve a district where demands for service are scattered over a wide range and there is an absence of congestion. Where individual leads are maintained to such districts, aside from the evils that grow out of the construction from points of danger and ugliness, in case of storm there is the additional danger of financial loss and interruption of service through the failure of poles or lines of any one of the paralleling or crossing constructions. For the undeveloped and rapidy growing districts, where these conditions are evident at the start, there is little argument against joint construction, while for the older districts there is usually a favorable solution over a period of a few years by adopting such construction as fast as the natural life of the existing overhead lines expire or the capital charges against such can be satisfactorily eliminated.

By the suggestion made here, it is not to be inferred that promiscuous permission by one company should be given to another to use its poles whenever the case may present itself and thus build up a shabby line looking more like a suspended wire fence than a transmission line, but the agreement on and the maintainance of a definite construction such as will pass a rigid inspection from points of good construction and safety to life and property. Where the telephone companies can and are using the multiple conductor cables, the joint construction lends itself to the greatest flexibility, for the joint system is then established with the power wires placed above and the telephone wires and cables occupying the lower position. This construction presents features of safe construction and even in those cases where a considerable number of pairs of telephone wires are run, there is infinitely less danger than results in the average construction where the telephone drops and wires are allowed to cross and recross at the discretion of a line man in a hurry to install apparatus with the least difficulty possible. As a rule the linemen of telephone companies do not favor joint construction on account o possible danger to themselves in working on the lines. This has been brought about for the most part through faulty standards of joint construction for the danger to linemen through the arrangement is less on well constructed lines than from any other condition.

The proper construction seems to be that with the light and power lines on the cross arms at the top of the pole with the telephone lines below, a distance of at least 6 feet being maintained between the primary light and power wires and the top cross arm of the telephone lines. This allows a sufficient clearance for hanging transformers and enables the lineman to stand on the top telephone cross-arm when working on the power circuit. A clearance of at least 24 inches should be provided at the pole in the telephone construction for the power line men. With these standards maintained, much of the prejudice against the joint construction from those who are forced to work on the poles may be easily overcome.

Such joint construction arrangement has worked satisfactorily when held to proper standards, notably at Los Angeles, California, where nine companies operate in the same territory and maintain a joint pole line agreement. The combined use of the pole lines from a financial aspect, while obviously costing less than two or more separate lines in initial outlay, have a proportional maintenance expense in the same degree, as far as poles are concerned. In Los Angles as far as possible each company uses eight feet on the pole and uses this space as if it were a seperate line no company being permitted to use any other space on the pole than that allotted to it. Each company maintains its own wires at its own expense and no construction of joint lines is permitted where there is a voltage in excess of 6600 volts. In the combined use of existing pole lines, the owner of same bills the combining parties for a proportional interest. Where it is desired to reconstruct a pole line in a location where the existing poles are not suitable for combination use, one of the parties operating in the location sets new poles of standard size for combination use, the constructing or owning party then selling a proportional interest to each party making the combination. Each party transfers its own wires and removes its poles at its own expense. In such cases it is evident that this transfer is always justifiable unless there is a considerable natural life unexpired in the existing pole lines. Even then there is often an advantage for a new line is secured costing in no case more than an individaul new line and more often much less for the poles of the existing line can be used elsewhere on other extensions. The Los Angeles agreement has been in effect for 5 years and a considerable saving has resulted to each combining company over and above the capitalization that may be placed on a reduction of public agitation for underground construction and saving from absence of accidents on the joint poles on account of the superior construction. Considering all these features the question of joint construction where feasible and possible should be a decidedly live issue.

Southeastern Section of N. E. L. A. Officially Created—Convention In August.

The final details in connection with the formation of a Southeastern Section of the National Electric Light Association were completed at the executive committee meeting of the Georgia state section at Macon (Ga.) on February 5. These details were then presented by President E. C. Deal, of the Georgia Section, before the executive committee of the National body at its New York meeting on February 15. At this meeting the arrangements made by the Georgia State Section, whereby it should become a Southeastern geographical section, were unanimously approved. The convention to be held at Macon (Ga.) August 14, 15 and 16 will therefore be a convention of this newly organized Southeastern Section.

Already plans have been laid for an elaborate program of papers and entertainment. President Deal has appointed W. L. Southwell (Macon) chairman of the committee on entertainment and arrangements for exhibits by manufacturers, and W. R. Collier (Atlanta) chairman of the committee on papers. He also advises that assurance has been given him that the first meeting will be attended by a number of the officials of the National Association as the event is considered by them as a most important one in the rapid country-wide growth of the organization.

The tentative plans for the organization of this geographical section were effected at the convention of the Georgia Section last year and the installation of permanent officers and adoption of extensive plans are included in the work of the coming convention. In addition to the membership of the Georgia Section, applications are already in the hands of President Deal for the affiliation of companies in the states of Florida, Alabama, North and South Carolina. These applications have made it possible for the Georgia Section to expand from a state section into the largest geographical section with a field of five states and 420 central stations.

The coming convention will be one of decided importance to Southern central station interests, as it will represent the largest gathering of such interests for the exclusive discussion of topics common to the five states mentioned. With a membership of 110 in the Georgia Section, drawn from 129 stations in the state, it is a substantial guess that the convention this year will report a membership twice this figure and the one a year hence twice this figure again.

Interest has run high in the organization of the Southeastern Section and great credit is due President Deal for his able efforts in bringing the companies of the various states together so that the new officers elected at the coming convention will have to do with the interests of not one state, but five.

The Chicago N. E. L. A. Convention.

The exhibition committee of the N. E. L. A. is now making arrangements for the thirty-sixth annual convention to be held at the Medinah Temple, Chicago, Ill., from June 2 to 6, inclusive, 1913. The lower floor of the temple which is 200 x 100 feet has been secured for the exhibition of the products of Class D members. A room adjoining has been set apart for the meetings of the commercial section and the representatives attending from this section will of necessity be obliged to pass through the exhibits to reach same.

Hydro-Electric Plant of Yadkin River Power Co., at Blewitt's Falls, N. C.

(*Contributed Exclusively to* Southern Electrician)

BY FRED A. OLDS.

NORTH Carolina is taking a very notable position in the development of hydro-electric power. The situation is extremely favorable, as some streams, originating in the highest mountain range east of the Rockies, fall first into the Piedmont section and then in several cases take a final fall into the low country. Thus they afford two and in some cases three opportunities as producers of that power which of all others is the most valuable, the most economical and the most conservative, since it utilizes without destroying, a force of nature.

North Carolina, roughly speaking, is divided into three power-zones. The western or mountain one may be said to center at Asheville, the Piedmont one at or near Charlotte, and the eastern one at Raleigh. At the latter point conditions are particularly interesting because three streams furnish water power, the Neuse, six miles away, the first to be harnessed and furnished one of the earliest developments of this type in the state; the Cape Fear and the Yadkin. There is also at Raleigh an auxiliary steam plant of considerable size which at periods when the water is low in all three of the streams plays an important part in electrical generation as shown during the phenomenally dry summer of 1911 when it enabled the Carolina Power & Light Company to maintain its supply for all the points it then covered. The length of line between Raleigh and the Neuse is six miles; between this city and Cape Fear twenty-six miles and between it and the Yadkin is eighty-eight miles.

In what follows the hydro-electric plant at Blewett's Falls, on the Yadkin river will be described. This pant is located only a few miles from the South Carolina line and a little distance above the point where the Yadkin river becomes the Pee Dee. It is at the point where the last fall, the drop from the Piedmont into the coastal-plain occurs, and the stream is quite wide with a considerable fall. Up this stream and in a rugged region is the place known as the "Narrows" of the Yadkin, where the river rushes between walls of stone and there the Whitney plant, intended to develop 45,000 horsepower, is being completed, having remained for five years uncared for and practically abandoned after some $2,500,000 had been expended upon it by what was known as the Whitney Company. The present owners, a French syndicate, has now taken it over and will utilize the power for various purposes, largely, however, for the manufacture of fertilizer from the atmosphere.

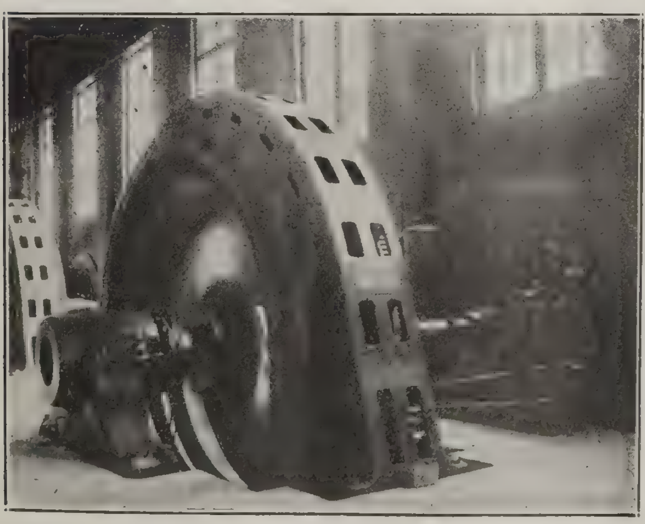


Fig. 1. Water Wheel Unit in Blewitt Station.

Fig. 2. Blewitt Station of Yadkin River Power Co.

The Yadkin River Power Company which constructed the major portion of the dam and all the buildings at Blewett's Falls, was a company largely composed of North Carolinians. It began work more than ten years ago at this point, and spent something like a million dollars on the dam, etc., but failed and the plant remained for some time incomplete with only about a fourth of the dam finished. The Yadkin River Power Company was finally reorganized and took it over and began operations in February, 1912. The completed dam is 1600 feet long by 50 feet high and is entirely of concrete, with a filler of granite, taken from a quarry on the edge of the stream, a few hundred yards away. The construction of the dam is of the latest type of concrete masonry, while the Whitney dam, already referred to, is built with the down-stream face of cut granite blocks, put in by the extravagant constructors and amaze the engineers of today.

The construction work on the Blewett Falls power plant, starting from the small portion which the former company had built, did not really begin until August 1, and was completed in December, much earlier than was thought to be possible. The gravel was brought in from the Pee Dee river, at a point a few miles to the southward, and the granite came from the premises. A branch railway seven miles long, from the Pee Dee station on the Seaboard Air Line, brought the other materials directly to the dam and powerhouse. The situation was very fortunate, as two great shoulders of hills on either side of the stream projected in such a way that from these the dam was built, with

Fig. 3. High Tension Switch Gallery at Blewett Plant.

these natural abutments. On the southward a cutting was made through one shoulder and in this recess the powerhouse was constructed. The dam backs water about forty miles and steamers are to ply upon this stretch and go to a point not far below the Whitney dam.

The generating equipment of the plant consists of six turbine units, directly connected to generators of the General Electric type. The generators operate at 4,000 volts and by step-up transformers, the voltage is stepped up to 100,000 for transmission.

The powerhouse at Blewett's Falls is of brick, steel and concrete, 250 feet long, 60 wide and 75 high. The present installation of generating units is six, with space for a seventh, giving total present capacity of 32,000 horsepower.

From this station power is transmitted at 100,000 volts to Method and Durham and to Lumberton, and at 22,000 volts to Hamlet, Cheraw, Wadesboro and Rockingham. The Yadkin River Power Company embraces the following transmission system and properties, besides that at Blewett's

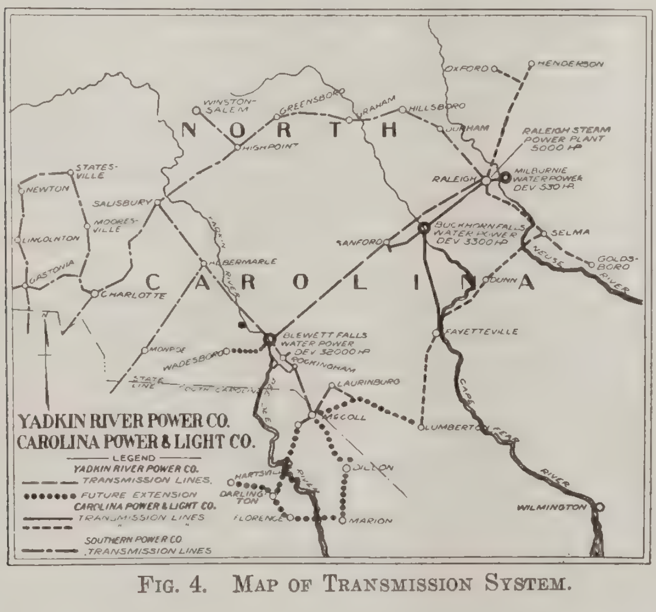


Fig. 4. Map of Transmission System.

Fig. 5. Control Board at Blewett Station.

Falls: Double circuit line to Durham, 120 miles; single circuit line to Lumberton, 60 miles; single circuit to Lumberton, Hamlet and Cheraw, 32 miles; single circuit to Wadesboro, 11 miles; steam generating plant at Rockingham, Hamlet, Cheraw and Wadesboro; sub-stations at Rockingham, Hamlet, Cheraw, Wadesboro, Lumberton and Method. The latter is the Raleigh sub-station, being located two miles west of this city and between the state Agricultural and Mechanical College and the village of Method, and alongside both the Seaboard Air Line and the Southern railways, which there have parallel lines. This sub-station, which was completed in the spring of 1912, is regarded as one of the best equipped in the section.

The Blewett's Falls-Durham transmission line, which transmits power to the Carolina Power & Light Company at the Method sub-station at Raleigh and to the Southern Power Company at Durham, at 100,000 volts, is 120 miles long and is a double circuit of six wires carried on steel towers, 72 feet high and spaced about 700 feet apart.

The Blewett-Lumberton line, which is under construction, will transmit power to Lumberton and vicinity, and will carry 100,000 volts, its length being 60 miles. It is a single circuit of three wires, carried on steel towers 50 feet high and spaced about 700 feet apart.

The Blewett's-Rockingham, Hamlet, Cherew line is in operation and feeds the towns of Rockingham, Hamlet and Cheraw, carrying 22,000 volts and being 32 miles long. It is a single circuit of three wires, carried on steel towers and wooden poles, cypress being used for the latter.

The Blewett's-Wadesboro line feeds Wadesboro and its vicinity and carries 22,000 volts. It is eleven miles long and is a single circuit of three wires, carried on wooden poles.

The town of Rockingham, which is the center of an important cotton mill industry, with numerous mills, uses the power for municipal purposes and lighting. At Hamlet the current is used for municipal lighting and power, as it also is at Cheraw, while at Wadesboro and at Lumberton it is thus used and also by numerous cotton mills.

The Yadkin River Power Company furnishes power to the Carolina Power & Light Company of Raleigh, which uses it for municipal lighting and power at Raleigh, Hen-

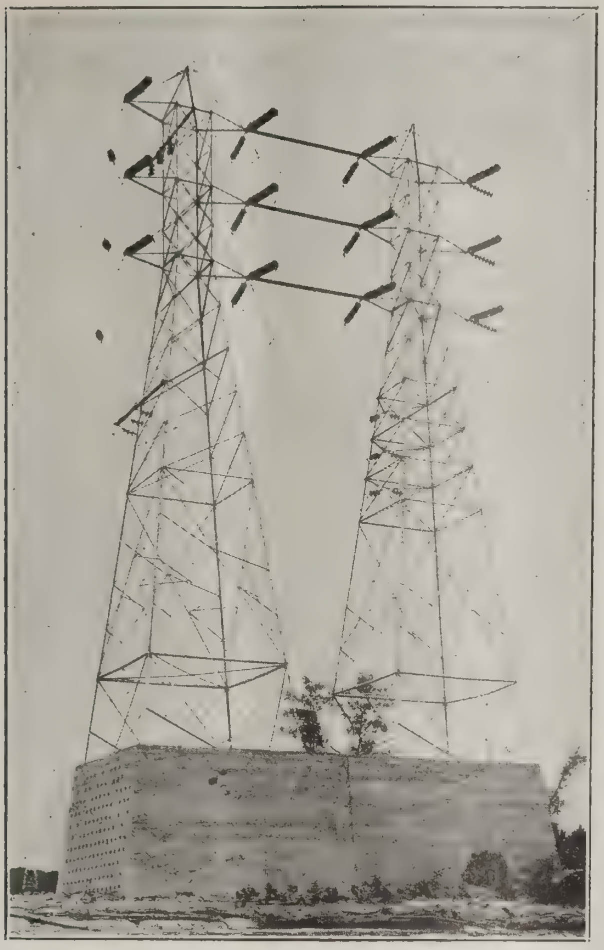


FIG. 6. TYPES OF STEEL TOWER USED ON TRANSMISSION SYSTEM.

derson, Oxford, Sanford-Jonesboro and Fayetteville, and is also now constructing a line to Goldsboro, 45 miles to the eastward. Many cotton mills take power from this company, and it operates the street railways at Raleigh, and has taken over the Raleigh gas plant as well as the one at Durham and Goldsboro. The transmission line from Raleigh to Henderson and Oxford, which are to the northward, is on wooden poles, as is also that now being constructed from here to Goldsboro.

Mention has been made of the fact that the Yadkin River Power Company supplies power to the Southern Power Company at Durham, which is one of the most important manufacturing towns in the state, with large tobacco and cotton factories. The company is under contract to furnish not less than 12,000 horse-power to the Southern Power Company at Durham. These two companies are under the same ownership and are so blended that the power from the sub-station, technically known as the Method sub-station, can be sent over the Southern Power Company's lines all the way to Greenville, S. C., in case the necessity should arise. The Catawba river furnishes the chief supply for the Southern Power Company, which in 1911, during the unprecedented drought in June, July and August, was very low and hundreds of cotton mills had to shut down. The Yadkin is a much more reliable stream than the Catawba, and hence the importance of the plant at Blewett's Falls may be imagined, for the power companies which will link together the wide sweep of territory between Greenville, S. C., and Goldsboro, N. C., will have four streams available, and also auxiliary steam plants. The power obtained from Neuse river, near Raleigh, is almost negligible, averaging only 600 horse-power throughout the year.

The engineering on the plant was done by Lockwood, Green & Co., with Fred W. Abbott, manager of construction.

Testing High Tension Transformers.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN).

BY H. G. DAVIS.

IN the articles that follow under this heading, the details and calculations for the following tests will be given: (1) Resistance Measurements; (2) Polarity; (3) Ratio Determination; (4) Tap Voltage Measurements; (5) Parallel Run; (6) Core Loss; (7) Impedance; (8) Heat Run and (9) Potential Tests. Four transformers having the same ratings and guarantees as follows were tested: 1,500 Kva. 60 cycle water cooled type-primary voltages-38,100-36,400-34,600-secondary voltages 13,800-13,500-13,200-12,900-12,600-6,600-6,000 and 3,300. They were to opreate in a three phase connection to give 66,000 volts on the primary side and had two separate windings on the low tension side each winding capable of carrying the full Kva. rating with heating guarantees of 40° *C* rise on normal load and 55° *C* rise after 25% overload for two hours immediately following the normal. These low tension windings were also to operate at the same time with a total load of the rating as given.

The efficiency guarantees were as follows:

Load.	Efficiency.
375 Kva.	95.7 Per Cent
750 Kva.	97.6 Per Cent
1125 Kva.	98.1 Per Cent
1500 Kva.	98.3 Per Cent
1875 Kva.	98.3 Per Cent

The regulation guarantee on noninductive load=.0095 and at .80 power factor=.031.

The following tests were made to check these guarantees with results as follows on the four machines.

RESISTANCE MEASUREMENTS.

In taking resistance measurements, since the transformers were guaranteed for full output at the minimum voltage of each windings, the resistances were measured foi the minimum voltage tap of each winding when the transformers were at room temperature and before the oil had been heated. The temperature of the oil was read by thermometer and taken as the temperature. The resistance of the high tension 34,600 volt winding was read by a voltmeter-ammeter method, but low tension windings were read by a potentiometer.

Example. Through No. 1 transformer primary, 5 amperes direct current was forced. Room temperature 21° *C*. Voltage reading 9.75. Res. = 1.95 ohms. This corrected to a temperature of 25° *C* gives a resistance of the primary 34,600 volt winding of No. 1 transformer as 1.98 ohms. The resistances of the four transformers are given in the table below in ohms:

Transformer	No. 1	No. 2	No. 3	No. 4
34600 V. Winding	1.98	1.98	1.98	1.995
12600 V. Winding	.342	.3405	.342	.344
6000 V. Winding	.0737	.0737	.0737	.0743

The resistances as measured at the cold temperature gives a reading for the determination of the temperature rise after the heat run. When transformers have full load guarantees on a minimum winding, the heat runs should be taken on that winding and consequently the cold resistances should be read on that winding. Cold resistances should bear the same relation at a given temperature to the resistance of the minimum winding that the voltages of the full winding has to the minimum voltage. For example the resistance of the 38,100 volt tap or full primary winding at 21° *C* was 2.18 ohms as found for No. 1 transformer.

The resistances as given in the above table were in ohms for each winding. If the calculations were to be made using the total resistance of the transformer the resistances expressed in terms of one winding with total resistances for the primary with one secondary would be according to the following table for transformer No. 1 at 25°*C*: ....

	Ohmic Res.	Primary Terms	Secondary Terms	
34600 V. Winding	1.98	1.98	.262	.0592
12600 V. Winding	.342	2.58	.342	.0771
6000 V. Winding	.0737	2.45	.325	.0737

The total resistance in primary terms of 34,600 volt winding and 12,600 volt winding is 4.56 and in secondary terms=.604. The total resistance in primary terms of 34,600 volt winding and 6,000 volt winding is 4.43 and in secondary terms = .1329.

POLARITY INDICATIONS.

With the transformer cold and after the resistance measurements were taken, polarity was taken by the method of D. C. voltmeter kick. The current was forced through the 34,600 volt winding and the kick noted on the secondary windings for each transformer. One ampere was forced through the primary winding and the kick induced on opening the primary circuit was read on a 600 volt D. C. voltmeter on each of the low tension circuits. The direction of the kick was positive showing that the leads were brought out to give polarity as shown in Fig. 1. All transformers were of the same polarity and, as leads were not crossed in bringing them out the windings indicated opposite polarity. From the polarity as found this first requisite for parallel operation was found to be satisfactory on all four transformers. Also, due to opposite winding and the high ratio of low tension voltage to high tension voltage, the high potential test of the transformer was determined by the sum of the high tension winding with the 12,600 volt winding.

RATIO DETERMINATION.

In determining ratio on these transformers, the ratio was taken between the full primary winding and each secondary winding, the ratio on the two being 2.78 and 5.78 for the 13,800 volt and 6,600 volt windings respectively. In taking the ratio, the voltage was impressed on the 38,100 volt winding, the impressed voltage being read on a voltmeter connected to a potential transformer having a ratio= 4.87. The voltage across the low tension terminals was

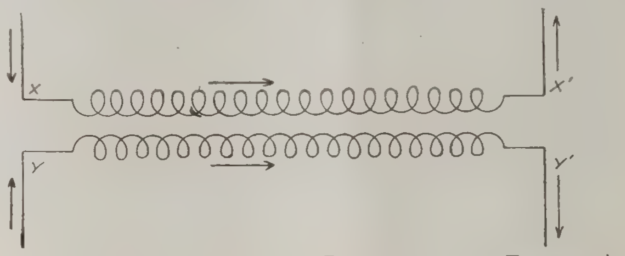


Fig. 1. Diagram Showing Relations for Proper Arrangement of Leads in Polarity Tests.

Note: In the connections X and Y and X' and Y' are the corresponding leads of the two windings. The arrows show the instantaneous direction of current in the two windings. In corresponding leads this direction is either both towards the transformer or away from the transformer.

read directly on the voltmeter. The following readings were taken: V_a being readings on high tension winding through the potential transformer and V_b being low tension readings as taken on the 13,800 volt winding.

	V_a	V_b
	50	87.8
	55	96.5
	60	105.1
	65	114.1
	70	122.8
Average	60	105.26

Correcting for comparison, V_a=60x4.87=292.20. V_b= 150.26. Then the ratio = 292.2/105.2 = 2.77. The specified ratio was 2.78.

This ratio as found is as close as errors of reading would permit and was satisfactory. If a voltmeter reading 600 volts for full scale deflection could have been available, the potential transformer would not have been required as the primary voltage could have been read directly on the 600 volt meter and still have given at least 100 volts on the secondary.

When taking the ratio on the 6600 volt winding it was necessary to use a potential transformer on the high tension side in order to impress a voltage so as to give about 120 volts on the low tension winding. In taking ratio it is not important that the frequency be exactly the operating frequency of the transformer or that the voltages used in determining ratio be near the operating voltage. Ratio was also taken between the 38100 volt winding and the 6600 volt winding by the method as given above. The ratio was taken on one transformer only leaving the ratio of the other transformers to be determined by parallel run. (See parallel run).

TAP VOLTAGE MEASUREMENT.

The tap voltages were measured on each transformer. On No. 1 transformer there were four leads from the 38100 volt winding with voltages for operating as specified:

Leads	Voltage
1 - 4	38100
1 - 3	36400
2 - 3	34600

To see if the tap leads were brought out properly a voltage was impressed across 1 and 4 while readings were taken across the other leads as follows:

Leads	Voltage
1-4	250 Volts (held)
1 - 2	11.8 Volts read
2 - 3	227.0 " "
3 - 4	11.1 " "

The above voltage table gives the data showing the proportion of the full winding which was taken between taps and when corrected on the basis of the operating voltage specified of 38100 volts, the following voltages were found:

Leads	Voltage
1 - 4	38100
1 - 2	11.8/250 × 38100 = 1800
2 - 3	227/250 × 38100 = 34600
1 - 3	= 36400 = 36400
3 - 4	11.1/250 × 38100 = 1700

This method was followed out on each transformer winding to determine if taps were brought out as specified.

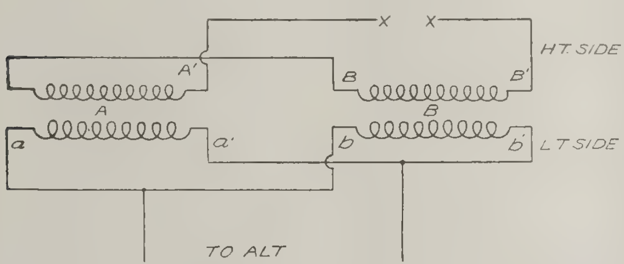


FIG. 2. ARRANGEMENT IN TESTING FOR PARALLELING TRANSFORMERS.

Note: These connections show both machines paralleled on the low tension side and tied together on one lead of the primary. The remaining two leads are brought close together to test for a spark.

PARALLEL RUN.

The test for parallel operation should always be taken under full voltage. After ratio and polarity had been taken on one transformer this one was used as a standard.

CALCULATION OF MAGNETIZING CURRENT.

When taking core loss readings, the current and watts at the given voltage should be read. This current is the total existing current of the transformer and consists of two parts—magnetizing current and core loss current. The magnetizing current is wattless in respect to the voltage while the core loss current is small and in phase with the voltage. The relation is expressed:

Magnetizing current $= \sqrt{[(\text{exciting current})^2 - (\text{Core L. Cur.})^2]}$.

Core Loss current $=$ (Core Loss)/K $\times$ voltage. Where K $= 1$ For single phase; 2 for 2-phase and 1.73 for 3-phase transformer.

From this we can see that while magnetizing current is wattless the exciting current is not wattless but, since the magnetizing current is very large compared to the core loss current, the exciting current or no load current for the transformer can be so considered.

The magnetizing current of a transformer is the current which produces the flux in the iron core which produces the counter voltage in the coil on which voltage is impressed or the induced voltage in the other windings. The current required depends, in a given transformer, on the point of saturation of the iron. If we hold frequency constant and read magnetizing current for various voltages, it will be seen that we obtain a saturation curve of the iron. A point is reached where to obtain a slight increase in voltage a very great increase in magnetizing current is required. Transformers are designed so that the normal voltage and frequency will require less than 10 per cent of rated full load current as magnetizing current. The exact per cent varies with the size of the transformer and the condition of the system on which it is used. These conditions might call for special designs. The next article will take up core loss, heat run, etc.

The Characteristics of Vapor Lamps.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN).

BY A. G. RAKESTRAW.

ALL the forms of electric light which the writer has heretofore considered in these columns have been produced by the passage of current through a solid conducting medium, raising it to the point of incandescence. These light sources have been divided into two general groups, according to whether the conductor is in the form of a solid filament, or consists of a stream of particles forming a conducting bridge between two electrodes, in which case it is termed an electric arc. These groups have been further subdivided with regard to the admission or exclusion of air, giving rise to the designations; filament in air, filament in vacuo, open arc, and enclosed arc. Further subdivisions have dealt mainly with the material used for the conductor. This general scheme of classification is shown in Table 1.

In this article we will take up that class of light sources in which the conducting medium is a gas or vapor. There is really no absolute dividing line between these two, a

Filament		Arc		Vapor		
Air Admitted	Air Excluded	Air Admitted	Air Excluded	Vapors of Solids		Gases
Filament in air	Filament in Vacuo	Open Arc	Enclosed Arc	Mercury Vapor Lamp		Moore Tube
Nernst Lamp	Carbon, Tantalum Tungsten	Carbon, Flaming Arc, Magnetite	Carbon, Enclosed Flamer	Mercury, Cadmium		Air, Nitrogen CO_2
				Glass Tube	Quartz Tube	
				Cooper Hewitt Lamp	"Silica" Lamp	

TABLE 1. CLASSIFICATION OF LIGHT SOURCES.

gas being simply such a substance as air, nitrogen, carbon dioxide, etc., which is gaseous in form under ordinary atmospheric conditions of temperature and pressure. Similarly, we term vapors those gaseous forms of substances which are usually met with in the liquid or solid state, such as the vapor of water, mercury, or iodin. As a matter of fact all gases have been liquified, and many of them solidified under the influence of great pressure and low temperature, while most liquids and some solids vaporize to some extent at all times. If we exhaust the air from a tube containing mercury, the space above the mercury will be filled with the vapor of mercury. Similarly, water exposed to the air is constantly vaporizing, and ice constantly loses weight by vaporization, even in the coldest weather.

While there are several forms of vapor lamps, the general construction is the same for all, namely a transparent non-conducting tube, filled with the vapor to be employed, and provided with two or more electrodes for the application of the current. The principal classification so far apparent in this group of illuminants, is according to the vapor employed, and further according to the material used for the enclosing tube. The commercial forms so far produced are first, those in which a rarefied gas, such as air, nitrogen, or carbon dioxide is enclosed in long tubes, and subjected to a high potential, and secondly, those in which the vapor or mercury or its alloys is enclosed in a tube of glass or quartz. The first of these goes by the name of the Moore tube, and the second is called the mercury vapor or Cooper-Hewitt lamp, or when using quartz tubes, the Silica lamp. We have also the Vogel lamp, a peculiar type, which makes use of both solid and gaseous particles, in which the light is produced by an arc between carbon electrodes surrounded by the vapor of mercury, but it is not in commercial use, at least not in this country. Vapor lamps, as a group, possess some peculiar and interesting characteristics, which we will briefly consider.

The operation of the Moore lamp depends upon the fact that gases become conductors of electricity at a high degree of rarefaction, and that if a considerable potential be applied to the terminals of a tube containing such a rarefied gas, current will flow and the gas become luminous, the efficiency of light production depending upon the pressure, and the gas used. We find that luminous gas possesses selectivity in a marked degree, for instance we find nitrogen to be about 40 times as efficient as hydrogen.

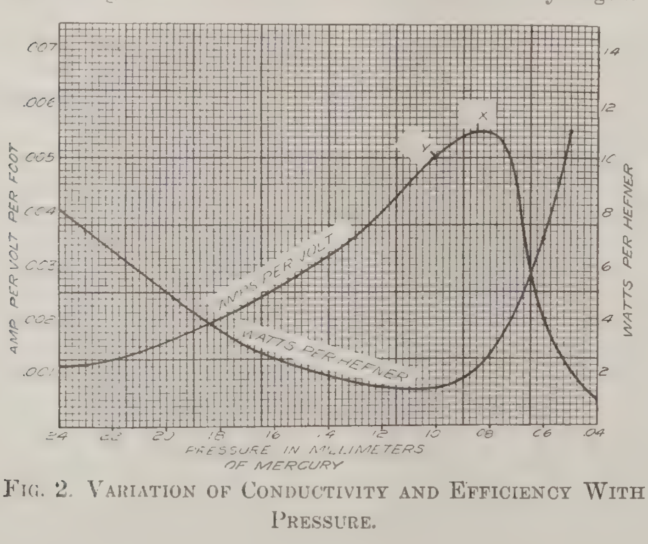
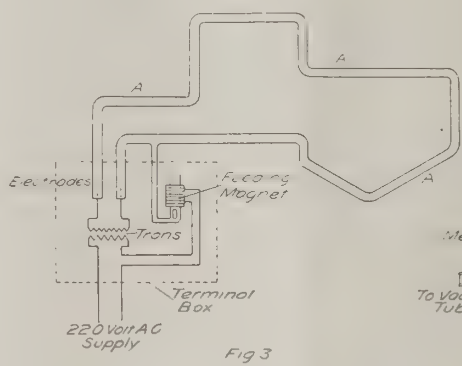


FIG. 2. VARIATION OF CONDUCTIVITY AND EFFICIENCY WITH PRESSURE.

The variation of the conductivity and the efficiency with the pressure are shown in Fig. 2 in which it is seen that the resistance of the tube filled with gas varies from 200 to 2,000 ohms per foot with a variation in pressure of from .04 to .24 millimeters of mercury, which considered in comparison with atmospheric pressure is a very small range indeed. We also note that conductivity increases with the degree of exhaustion up to a pressure of .10 mm, and then rapidly falls off.

Another interesting characteristic of this phenomonen is the fact that as the current passes through the rarefied gas, it produces a change in its physical structure, part of the gas being absorbed, that is changed to a solid state, which of course increases the vacuum. From this we see that if we were to apply voltage to a tube containing gas at a pressure of say, .11 mm. as at Y on the curve, and that no means were provided for any replenishment of the gas, that as the current continued to flow the gas would become more rarefied, and that up to the point of maximum conductivity at X, the current would increase slight-



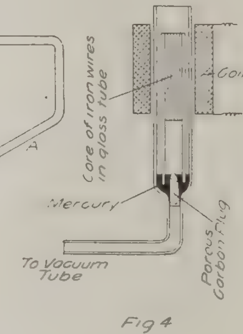


FIG. 3. CONNECTIONS FOR THE MOORE SYSTEM.
FIG. 4. FEEDING DEVICE FOR MOORE TUBE LAMPS.

ly, but that beyond this point, the resistance would rapidly increase, and the light would flicker and then go out. It is necessary therefore to provide means for the replenishment of the gas in order to secure the continuity of the light.

Since the passage of current through rarefied gas requires considerable electromotive force, the starting point of the Moore tube consists of a terminal box in which the usual potential of 100 or 220 volts A. C. is raised to that necessary to produce the desired current, and since as we have seen, the gas within the tub is slowly consumed, an automatic feeding device is used to maintain it at a constant pressure. These two features are characteristic of this form of light source.

In Fig. 3 the general connections for the system are shown. The transformer, terminals and feeding device are enclosed in a highly insulated terminal box from whence the tubes pass over any desired path up to 225 feet. It will be noted that the long glass tube can be shaped to conform to the architectural features of the building, making it possible to follow the irregular outlines of a store front, a lobby, or even the gothic arches of a cathedral. This very feature, however, while advantageous has been somewhat of a drawback as well, because the forming of this tube into shape requires the services of an expert "glass plumber," who taking the country over, cannot be considered plentiful. This has so far restricted the installation of these lamps to large cities, especially New York City and vicinity, where experienced men from the factory have been at hand to take care of this work.

While some objection might be taken to the high voltage, yet the terminal box is so well insulated and the glass such a perfect insulator that a person may grasp the tubes where they leave the box without feeling the slightest shock.

The feeding device is simple but very ingenious. Fig. 4 gives an illustration of it. It consists essentially of a porous carbon plug cemented into a glass tube as shown, and surrounded by a small quantity of mecury, the level of which is changed by the rise and fall of an inner tube containing a score of iron wires and which is acted upon by a solenoid surrounding the outer tube. The operation is as follows. Consider the tube operating at normal vacuum, which is about .10 mm of mecury, and the carbon plug covered by the mercury. As the light burns, the tube gradually becomes more nearly exhausted, the conductivity increases, and the current rises, the action of the solenoid drawing the inner glass tube upwards, lowering the level of the mercury until the tip of the porous carbon plug is exposed. This admits a small quantity of air, the pressure rises, the current falls again and the carbon tip disappears from view. Under normal working the tubes "breathes" about once a minute. In some of the tubes nitrogen is used. This is automatically obtained by passing the air taken in through a small iron cylinder containing phosphorus, a small quantity sufficing for several years' use. When carbon dioxide is used it is produced by the action of acid on a small piece of marble in a miniature automatic gas generator, and here as well, a small piece will last a long time.

Taking up the performance of this light, first from an electrical standpoint, we find that the actual voltage required per foot of tube varies from 60 to 80 for tubes from 25 to 200 feet in length, or from 2,000 to 12,000 volts total. The high tension current for the density usually employed is about .3 amperes, while the low tension current depends of course upon the length of the tube. The watts expended in the tube alone is about 15.6 per foot, while if we include the transformer losses it varies from 17 to 25 watts per foot, for lengths as given above.

The high tension voltage is not in exact proportion to the length of tube, but decreases slightly, as do also, of course, the low tension amperes, making the total power required less in proportion, and the efficiency is consequently greater with the longer tubes. We also find that the light intensity is directly proportioned to the voltage, and not as to the square or cube of the voltage, as is the case with many forms of lamps. This renders the efficiency practically independent of the voltage and makes it possible to maintain a much steadier light on fluctuating circuits. The power factor is quite low being about 65 per cent.

Taking up the illumination performance, we find that the efficiency of the Moore tube, using any certain gas, depends only upon the pressure, and referring to Fig. 2 we will see that the efficiency is the greatest at point Y on the curve, giving value of 1.4 watts per hefner at the terminals, or 1.55 watts per c. p., for a tube 220 feet long, operating at 12 hefners per foot or 10 .8 c. p.

As a source of light we find that this system has several very good points, prominent among which is its extremely low intrinsic brilliancy, which is 2 candle power per square inch or less. There is absolutely no glare, the light being soft, mild and steady. The temperature is lower than for any other form of light, in fact it is stated that the tubes have been operated with icicles hanging from them. The color depends upon the gas used. With air or with nitrogen the light is a pale yellow, while with carbon dioxide it is white, in fact it is the only light which can be depended upon for matching delicate colors, and this can be done with even more certainty than by daylight, because while daylight may vary with the conditions of exposure or

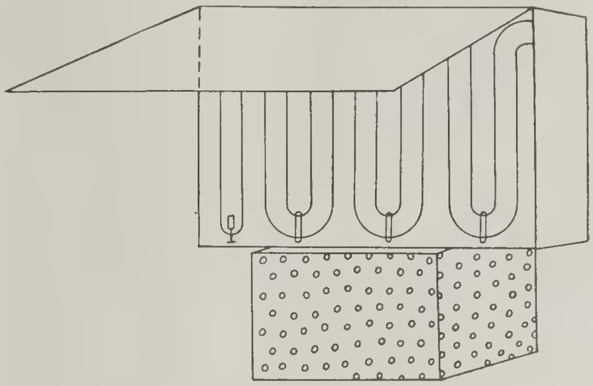


FIG. 5. THE MOORE LIGHT WINDOW.

the time of day, the light from the tube filled with carbon dioxide is unchanging in value. This has made the Moore tube of particular value in the dyeing and textile industries, and for other work requiring exact determination of color values. For this kind of work it may be made up in the form of a "light window" as shown in Fig. 5 to which the articles to be examined can be brought.

Pole Data.

The report of the pole census for 1911 shows that 3,418,020 wood poles were purchased during that year by telephone and telegraph, steam and electric railroad and electric light and power companies in the United States. Of this number 70 percent was purchased by telephone and telegraph companies, 23 per cent by electric railroad, light and power companies and 7 per cent by steam railroads. The purchase by the second-class was a substantial increase over the previous year of 19 per cent of the total number. The other classes falling off in number of poles purchased. There is a tendency shown toward the use of cheaper poles yet cedar and chestnut still are the predominating woods, together making up 82 per cent of the number of poles used. The number of chestnut was about 18 per cent, a gain of about 2 1-2 per cent over 1910. Oak and pine stand next each contributing about 5 per cent to the supply.

The pole lines in America approximate nine hundred thousand miles in length, and the number of poles in actual service is not less than thirty-five million. The annual consumption for renewals and new lines amounts to about four million poles, or nearly five poles per mile per annum. The extent of the drain on the forest which this represents may be judged from the fact that a perfectly stocked German forest produces only 250 trees per acre, so on this basis the poles now standing would represent all of the timber growing on over 130,000 acres. In this country, considerably less than one hundred poles are cut per acre, so that for the poles now in use forest areas aggregating nearly half a million acres have been cut over, and to furnish the poles for renewals some 50,000 additional acres are cut over each year, or at the rate of over one hundred acres per day.

Important Calculations for Wood Pole Transmission Lines.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN).

BY PROF. W. T. RYAN, UNIVERSITY OF MINNESOTA.

THERE are five primary considerations involved in the design of an overhead line. First, the line must be properly located in relation to the contour of the surface of the ground and neighboring obstructions; the possibility of interfering with nearby telephone lines and the probability of unusual lightning storms in the localities through which the lines passes should also receive careful consideration. The careful engineer will often abandon an otherwise satisfactory route for a high tension transmission line and select a considerably longer route but one which does not pass through regions subject to as severe electrical storms. Second, the poles, the supports and the sag to be allowed in the spans must be calculated to safely withstand the strains produced by the line itself and by atmospheric influences. Third, the size of wire, the spacing etc., must be properly calculated. Fourth, the insulators must be adapted to the voltage carried and to the atmospheric conditions to which they are subjected. Fifth, the line must finally be so constructed that uneven strains along the line are not produced even when the wind is abnormally high and the temperature varies over very wide ranges.

In what follows, the second of the above five considerations, namely, the calculations involved in the consideration of the transmission line as a mechanical structure will be discussed. Very often this part of the problem receives very much less attention from the designer than it should. Considered as a conductor of electrical energy, the question of proper proportioning of the line and its bearing on the general efficiency of the system of which it is a part, generally receive very careful consideration, whereas the difficulties which may appear on the line as the result of not properly considering the line as a mechanical structure are often given only secondary consideration.

The stresses sustained by a pole may be classified as follows: (1) Weight of wires, plus insulation, plus ice. (2) That produced by tension in the wires, (varies with the configuration of the line both as regards direction and elevation). (3) Wind upon the wires, poles, cross arms, insulators, etc. Stress (1) is a compressive force; (2) and (3) produce flexing strains. The weight of the wire, ice, etc., produces on the pole simply a compressive force which may be neglected, since poles which are strong enough to stand the bending stresses to which they are subjected are not be appreciably affected by this slight compression. If the line is properly constructed the tension in the wires will be just the same in either direction from a pole, hence does not need to be considered, except where the line changes direction or terminates, in which case the unbalanced sidewise pull is usually counteracted by guying. Hence it is seen that the most important consideration is wind.

The pole will be treated as though it were a beam rigidly fixed at one end and loaded at the other end.

The resisting moment *M* is:

$M = SI/C$ ....(1)

Where, S = Stress in section; I = moment of inertia of section; and C = distance from center to fiber under maximum stress. The amount of the force applied to the top of the pole is (Wh) where (W) is the tension in lbs. and (h) is the height of the pole in inches. For a circular pole having a diameter D, (in inches).

$I = 3.1416\ D^4/64$ ....(2)

$C = D/2$ ....(3)

Substituting equations (2) and (3) in (1).

$Wh = SI/C = 3.1416\ D^4\ S/64 \div D/2$ ....(4).

Substituting for S, $I/_n$ where T is the tensile strength in lbs. per square inch of the material of the pole and (n) is the factor of safety:

$Wh = 3.1416\ D^3\ T/32\ n$ ....(5)

D = cube root of $[32\ W\ h\ n/3.1416\ T]$ ....(6)

Where D = diameter of the pole at the ground level in inches; h = height of pole in inches; n = factor of safety; T = tensile strength in lbs. per square inch; W is yet to be determined. As pointed out above the flexing strains are ordinarily all in equilibrium except those due to the wind, therefore, $W = 1.10\ [.055\ p\ D_w\ L\ N + \frac{1}{2}\ (.055\ pD'\ h')]$ ....(7)

Where W = equevalent stress concentrated at the top of the pole due to wind; p = maximum pressure due to wind in lbs. per square foot of projected area of the wire; Dw = diameter of wire in inches L = length of span in feet; N = number of wires; D^1 = average diameter of pole (must be assumed in the first calculation;) h^1 = height of pole above ground in feet.

The stress due to wind pressure on the pole itself acts along the whole length of the pole, hence is considered as though one-half of its force were concentrated at the top. The factor 1.10 is inserted to take account of the stress due to the wind striking against the cross arms and insulators.

The wind is considered as blowing at right angles to the direction of the line, since, the maximum tension is produced by a wind which is at right angles to the direction of the line. The pressure per lineal foot on a wire Dw inches in diameter is given by the formula.

$P = .055\ j\ D_w$ ....(8)

Where, P = pressure in lbs, per lineral foot; D_w = diameter of wire in inches; p = normal pressure of the wind in lbs per sq. foot. The constant .055 is found by multiplying one-twelfth by two-thirds. According to Langley in his experiments in Aerodynamics, page 24, the wind pressure on a cylindrical surface, as for example a wire or pole, is two-thirds of that exerted upon a flat surface of equal projected area. Mr. H. W. Buck, in a paper read at the World's Fair in St. Louis in 1904, gave the results of a series of wind pressure experiments made at Niagara on a 950 foot span of 0.58 cable, erected so as to be at right angles to the usual direction of the wind. From his data the following formula was derived:

$p = .0025\ v^2$ ....(9)

Where, p = wind pressure in lbs per square foot; v = velocity of wind in miles per hour. The velocity of the wind is usually taken at a maximum of about 90 miles per hour in the open, and at 60 miles per hour where the force of the wind is broken by buildings, trees, etc. By substituting in equations (8) and (9) the effect of the wind on the wire in lbs. per lineal foot is obtained, by multiplying by the number of wires and the length of the span the first part of equation (7) is obtained. The second part of equation (7) gives the equivalent tension concentrated at the top of the pole due to the wind striking the pole. By substituting in equation (6) the necessary diameter is obtained.

It may be said, and in many cases it is true, that the experience of a superintendent of line construction in connection with the kind of poles used is worth more than any formula. It is, however, very desirable to know just what stresses may be expected and just how much of a factor of safety is actually being used. In the case of heavy wires and long spans then, of course, the strains on the supporting structures must be very carefully calculated.

The diameter of the pole given by equation (6) is, of course, the maximum diameter, or the diameter of the pole just above the ground. In order to find how this diameter should compare with the diameter at any other point, consider again that the pole is a beam rigidly fixed at one end and loaded at the other. If the pole has a round cross-section and tapers toward the top, it is a truncated cone and should have a parabolic section in order that the least material should be used for the maximum strength. The equation of the cubic parabola is:

$y = a \times x$ to $\frac{1}{3}$ power .... (10)

The exact solution of this is impractical, and approaching it most nearly is the truncated cone, its equation being:

$y = d_1 + x\ (d_2 - d_1)/L$ .... (11)

Where, y = diameter of any section; x = it's distance from the top of the pole; d_1 = diameter of pole at the top; d_2 = diameter of pole at the bottom. The first derivative of equation A is, $dy/dx = \frac{1}{3}\, a \times x$ to $-\frac{2}{3}$ power .. (12) and the first derivative of equation B is,

$dy/dx = (d_2 - d_1)/L$ .... (13)

The first derivative gives us the slope or taper of the pole; therefore if we equate the two values of (y) and dy/dx we will have two simultaneous equations from which we car obtain the taper which will give the maximum strength with the minimum material.

$a \times x$ to $\frac{1}{3}$ power $= d_1 + x\ (d_2 - d_1)\ /L$.......... (14)

$\frac{1}{3}\, a \times x$ to $-\frac{2}{3}$ power $= (d_2 - d_1)\ /L$............ (15)

Dividing equation (14) by equation (15) we get, $d_2 = 3/2\ d_1$ .... (16)

Hence we have arrived at the very interesting conclusion that the diameter at the bottom of the pole should be 3/2 the top diameter. It is a matter of observation that nearly all tall wooden poles when blown over by a storm will break a considerable distance above the ground. The above investigation shows that if the diameter at the bottom is 3/2 the diameter at the top and the pole is free from knots and other local weaknesses, the fiber stress would be the same at all points, hence the pole would be liable to break at any place.

It can be shown that if the diameter at the bottom is less than 3/2 of what it is at the top, the taper is uniform and the pole is free from local weaknesses, it will break at a point some distance above the ground, depending of course on the amount of the taper. If d_2 is greater than 3/2 d_1 then, of course, the pole will break at the ground line. The distance from the top of the pole to the section under maximum fiber stress is, $x = d_1/2s$ .... (17)

Where, d_1 = diameter of top of pole in inches; s = slope of pole in inches per inch.

As an example take a cedar pole having a top diameter of six inches and a taper of .025 inches per inch. $d_1 = 6$ and $s = .025$ Then $x = 6/.05 = 120$ inches $= 10$ feet. Hence the above pole would break 10 feet from the top, no matter how long it might be, provided of course, that it were at least 10 feet long.

Consider a pole 25 feet high a 6 inch top and a slope of .01 inches per inch. The diameter at the bottom would be $6 + (300) \times (.01) = 9$ inches. In this case $d_2 = 3/2\ d_1$. The distance from the top to the section under maximum stress would be,

$x = 6/.02 = 300$ inches $= 25$ feet. Hence the pole would break at the ground.

So far the poles have been assumed to be of equal length, a constant distance apart and on level ground. When the tops of the poles are no longer in line, and are different distances apart, unbalanced stresses will be encountered unless special precautions are observed in the erection. Consider first the case where the pole line is level, with the poles set at unequal distances. Since the tension produced in the poles by the wires varies with the sag in the wires, it is at once obvious that tension can be kept in equilibrium in case of unequal spans by varying the sag of the wires in the spans of unequal length.

Where the pole tops are no longer level, it is to be observed that since the wire in any span is everywhere in equilibrium as regards tension in the wire, it may be tied to a pole at any point intermediate between it's ends without disturbing it's equilibrium in any way. It should also be borne in mind that it is a change in grade and not the grade itself that is of importance.

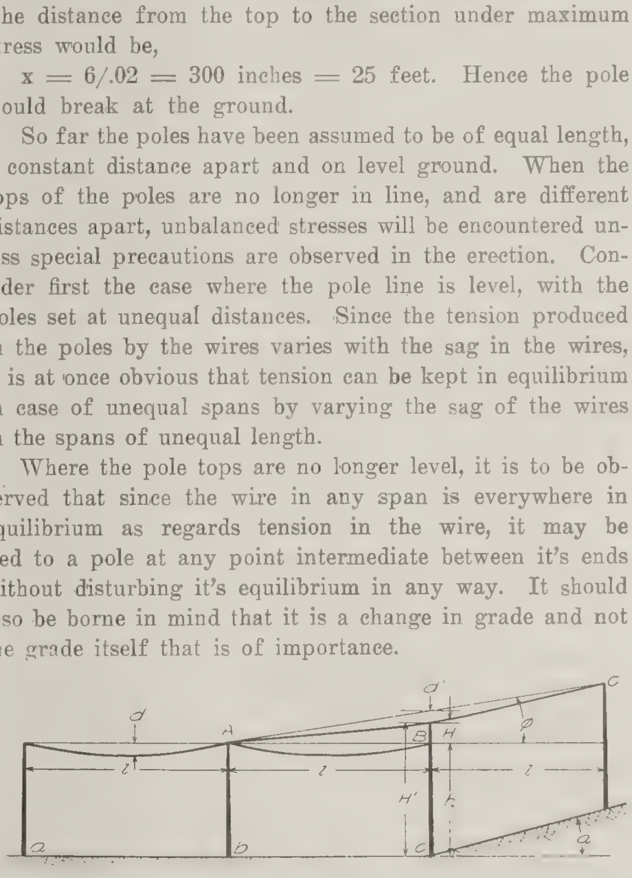


FIG. 1. FACTORS ENTERING WHEN POLES ARE NOT ON LEVEL GROUND.

In order to find an assumed span AC, in Fig. 1, with the right sag for maintaining an equilibrium of tension on the pole (b), it will be assumed that the poles (a), (b), and (c) are on level ground and that (d) is on an upgrade.

The deflection (d) in the span AB is,

$d = l^2\ W/8\ T$ .... (18)

The deflection d' in the assumed span is,

$d' = (AC)^2\ W/8\ T$ .... (19)

Since the spans are assumed to be of equal length an appreciable error will not be introduced by substituting (2 l) for AC. The equation for (d') then becomes,

$d' = (2\,l)^2\ W/8\ T = 4\ d$...................... (20)

If the pole (b) is made of such a length that the assumed span AC will be anchored to it at a point which lies upon the natural curve of the span AC between A and C, the equlibrium of the tension in the wire will not be disturbed. From Fig. 1, it is seen that,

$H = l \sin \phi - d'$ (very closely) .... (21)

It is also seen that $l \sin \phi = \frac{1}{2} l \sin a$ (very closely) and since $d' = 4 d$, it follows that,

$H = \frac{1}{2} l \sin a - 4 d$ .... (22)

Therefore the height of the pole C is,

$H' = h + \frac{1}{2} l \sin a - 4 d$ .... (23)

Where h = normal height of poles; l = length of span; d = normal deflection allowed; a = angle of change in grade.

If the spans are of unequal length the solution will be the same except that the deflection in the assumed span AC will be more or less than four times the normal deflection, and more or less than $\frac{1}{2} l \sin a$ will have to be added to (h) according as the span BC is more or less than the normal length. A general statement of equation (23) would be,

$H' = h + k l \sin a - k' d$ .... (24)

Where, k = [length of normal span (AB)] ÷ [length of assumed span (AC)].

k' = [length of assumed span (AC)] ÷ [length of normal span (AB)].

The above method of obtaining (k) and (k') is limited to cases where the length of the assumed span AC does not vary widely from twice the length of the normal span AB.

As an example of the above suppose that 40 foot poles are being placed along level ground and a 15 degree upgrade is encountered. The angle of the grade is the angle made by a line between the bottom of two adjacent poles at the point where they enter the ground with the horizontal, irrespective of the configuration of the ground between the poles. Let the poles be 200 feet apart and the normal sag 4 feet. From equation (23)

$H' = 40 + 100 \sin 15° - 16$

$= 40 + 25.9 - 16 = 49.9$ feet.

What would actually be done in practice would be to divide the 9.9 feet by two and add say 5 feet to the last pole on the level ground thus making it 45 feet high, and cut say 5 feet off of the first pole on the grade, thus making it 35 feet high.

A very important consideration especially where long spans are involved is the sag which is to be allowed in the span. The formulas involved are well known and have been quite widely discussed, therefore in this article they will simply be stated and their application illustrated.

$d = l^2 w/8 T$ .... (25)

Where d = sag to be allowed in feet; l = length of span in feet; T = allowable tension in the wire; w = weight of wire and insulation in lbs. per foot.

If we desire to calculate the sag when the wind is blowing, then the following formula is used:

$d' = l^2 W/8 T$ .... (26)

Where $W = \sqrt{(w^2 + P^2)}$ .... (27)

And where w = weight of wire in lbs. per lineal foot; P = wind pressure on wire in lbs. per lineal foot (see equation No. 8.)

The usual proceedure is to find the sag at the minimum temperature and no wind using for T a value that is sufficiently low to keep the strain in the wire below the elastic limit with a wind of say 90 miles per hour blowing at right angles to the line. Knowing the sag for minimum temperature and no wind the sag for a temperature (t) is calculated from the following formulas:

$L = l + 8 d^2/3 l$ .... (28)

Where L = actual length wire in the span; l = length of span; d = sag cold and no wind.

$L' = L [1 + B (t' - t)]$ .... (29)

Where L' = length of wire at the temperature; B = temperature coefficient of linear expansion; t = minimum temperature to which the line is exposed; t' = temperature at which it is desired to determine the sag.

$d_t = \sqrt{[3 l (L' - l)/8]}$ .... (30)

Where d_t = sag at the temperature t'. The sag will actually be somewhat less than given by equation 30 since the increased sag means less tension in the wire, hence a decrease in the elastic elongation due to the tension. This may be calculated by the following formula,

$y = [T - T_t) (l)]/EA$ .... (31)

Where y = number of feet the wire shortens due to the decrease in tension; T = tension at the lowest temperature and no wind; T_t = tension in the wire at the temperature t'; l = length of span in feet; A = area of wire in square inches; E = modulus of elasticity, about 16,000,000 for copper and 9,000,000 for aluminum.

The sag would then be d'_t instead of d_t where,

$d'_t = \sqrt{[3 l (L' - y - l)/8]}$.

A few trial solutions are required to get the sag and tension and the elastic elongation due to the decreased tension to all check each other.

ILLUSTRATIVE EXAMPLE.

Find the sag at the lowest temperature say 0° Fahr. and the sag at a temperature of 110° Fahr. in a span 800 feet long using uninsulated hard-drawn No. 00 copper wires. The weight per lineal foot is 0.403 lbs., the diameter 0.365 inches, the area .105 square inches, the ultimate breaking strength about 5,700 lbs., and the elastic limit 2,500 lbs.

$p = .0025 (v)^2 = (.0025) (90)^2 = 20.25$.

$P = .055 p D w = (.055) (20.25) (.365) = 0.41$.

Where P = wind pressure in lbs. per lineal foot due to a wind of 90 miles per hour.

$W = \sqrt{[(0.41)^2 (.403)^2]} = 0.575$ lbs.

The sag at 0° Fahr. and a wind pressure of 90 miles per hour would be

$d = [(800)^2 (.575)] \div [(8) (2500)] = 18.5$ feet.

The sag without wind at 0° Fahr., neglecting elastic shortening due to the decreased tension would be,

$d' = [(800)^2 (.403)] \div [(8) (2500)] = 12.8$ feet.

We must allow somewhat more than 12.8 feet sag at 0° Fahr., and no wind, otherwise the wire will be strained beyond its elastic limit with wind. The tension corresponding to a sag of 18.5 feet and no wind would be

$T = [(800)^2 (.403)] \div [(8) (18.5)] = 1740$ lbs.

It is evident that the actual tension should lie somewhere between 1740 lbs. and 2500 lbs. with no wind and at 0° Fahr., also that the sag should be between 12.8 feet and 18.5 feet. If we allow a maximum tension of 2000 lbs. with no wind and at 0° Fahr., we will be on the safe side. The sag would then be,

$d' = [(800)^2 (.403)] \div [(8) (2000)] = 16$ feet.

The corresponding length of wire would be,

$L = 800 + [(8) (16)^2 \div 2400] = 800.853$ feet.

The length of the above wire, neglecting elastic shortening, at a temperature of 110° Fahr. would be,

$L' = 800.853 [1 + .0000095 (110)] = 801.66$ feet.

The sag corresponding to this length of wire is,

$d_t = \sqrt{[(2400) (801.66 - 800) \div 8]} = 22.2$ feet.

The tension corresponding to a sag of 22.2 feet would be.

$T = [(800)^2 (.403)] \div [(8) (22.2)] = 1440$ lbs.

The actual tension in wire lies somewhere between 1440 lbs. and 2000 lbs. and the actual sag is somewhat less than 22.2 feet. We will assume a tension of 1550 lbs. at 110° Fahr. The corresponding sag would be,

$d'_t = [(800)^2\ (.403)] \div [(8)\ (1550)] \div 20.8$ feet.

If the tension decreases from 2000 lbs. to 1550 lbs. the elastic shortening of the wire will be,

$Y = [(2000 - 1550)\ (800)] \div [(16{,}000{,}000)\ (.105)] = 0.224$ feet.

Subtracting 0.224 from 801.66 we get 801.436 feet.

The length of wire corresponding to a sag of 20.8 feet is

$L' = 800 + [(8)\ (20.8)^2 \div 2400] = 801.44.$

This checks the value at 801.436 therefore the actual tension at 110° Fahr. is 1550 lbs and the actual sag is 208. feet. The elastic shortening of the wire decreased the sag from 22.2 feet to 20.8 feet and increased the tension from 1440 to 1550 lbs.

MINIMUM DIAMETER OF POLE.

Find the diameter of pole required for a transmission system which consists of 6-No. 00 wires on cedar poles whose cross arms are 40 feet above the ground and with poles 250 feet apart. From formula (7),

$W = 1.10\ [(.055)\ (20.25)\ (.365)\ (250)\ (6) + (.055)\ (20.25)\ (16)\ (40)\ (\tfrac{1}{2})]$

$W = 1069$ lbs.

In considering wooden poles a factor of safety at least 12 should be allowed. The ultimate breaking strength of cedar is about 11000 lbs. per square inch. The minimum diameter of pole would be,

$D = \sqrt[3]{[(32)\ (1069)\ (40)\ (12)\ (12) \div (3.1416)\ (11000)]}.$

$D = 17.9$, say 18 inches.

This means the pole should have a 12 inch top and at least an 18 inch bottom.

The moment of the force to be counteracted by guying if a turn of 120° were made in the line would be,

$W' = (1069)\ (\cos. 60°)\ (2) = 1069$ lbs.

The strain in the guy wire would, of course, depend on the angle which it makes with the horizontal. The unbalanced sidewise pull where the line terminated would also be 1069 lbs.

Alternating Current Engineering.

Contributed Exclusively to Southern Electrician

BY WILLIAM R. BOWKER.

A Discussion of the Synchronous Motor and Induction Generator.

IN connection with the operation of induction motors, it is important to remember that the output and torque varies as the square of the impressed voltage. The speed is independent of the voltage, and depends upon the frequency of the circuit and number of stator poles. Low frequency induction motors are much easier to build with a resulting higher power factor than are those of high frequency.

A three phase induction motor will give about 40 per cent of its three-phase output when used as a single-phase motor. If re-wound as a single-phase motor it would then have an output of approximately 75 per cent of its former three-phase output.

If a three-phase motor is connected to a single-phase circuit and run as a single phase motor, with a 30 per cent increase in its normal voltage, it will then have an output of approximately 75 per cent of its three-phase output. A two-phase will give 50 per cent of its two-phase output if used in a single-phase circuit. If rewound as a single-phase motor it will have an output of approximately 75 per cent of its two-phase rating. If used on a single-phase circuit with a 30 per cent increase in the impressed voltage over its normal voltage, it will give an output of about 75 per cent of its two-phase output.

SELF-STARTING OF SYNCHRONOUS MOTORS.

The chief characteristics under the headings of advantages and disadvantages, and the practical service conditions under which synchronous motors are used, have been previously mentioned in this article, an important advantage being a controllable power factor which can be regulated to equal unity, by the variation of the field excitation; a serious practical disadvantage being that it cannot start under load or only a very slight load. Secondly, that separate excitation of its field from a direct current source of supply is essential and thirdly, if considerably overloaded is liable to fall out of synchronism and stops and will not restart until a repetition of the strating method employed is gone through.

Although not self-starting as generally understood by that term, a synchonous motor can however start up with a very slight torque if supplied with a current of sufficient magnitude, by simply closing the main switch, the field switch being left open, thus switching the main line alternating current supply on to the revolving armature. This self-starting action is due to currents induced in the field pole pieces by the currents flowing in the armature. The motor will gradually increase in speed with only sufficient torque to bring it close up to synchronous speed, at which instant the direct current from the separate exciter should be switched on to the motor field circuit, and adjusted when the load may be thrown on the motor.

A serious objection and drawback to this method of starting is that it takes an excessive starting current varying from about two to five times full load current. Further this starting current being of an inductive character results in an objectionable disturbing effect of the line voltage throughout the system, which may entirely discourage it, and for that reason, means are utilized to keep the starting current as low as possible, by employing a rheostat; autotransformer, or choking reactance coil.

A starting arrangement using a reactance coil is shown in Fig. 90. This method provides for the voltage impressed at the armature terminals being reduced to 50 per cent or one-half of the impressed line voltage, which results in a starting torque of about 15 per cent of full normal load running torque, the armature taking about twice the normal full load current, and requiring only full load current from the line at the normal impressed line voltage.

To start the motor, leave the feed switch open, and throw over the double-throw triple-pole switch on the lower starting contacts. After the motor has attained its maximum speed, which very nearly approximates synchronous speed, being slightly less, throw the switch over to the top running contacts and switch the exciter current on to the feed circuit.

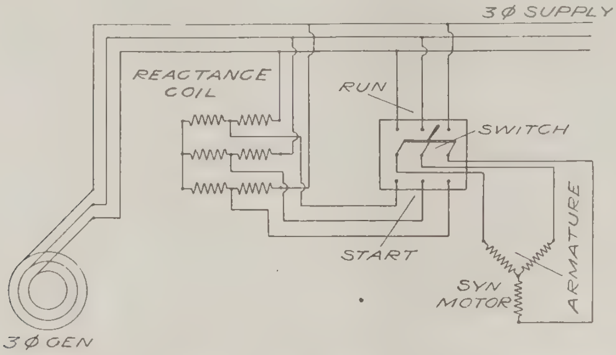


Fig. 90. Starting Arrangement for Synchronous Motor.

Compensator starters as used with induction motors of the squirrel cage rotor type previously described may be employed as starters for synchronous motors, only with this difference: Whereas the compensator or auto-transformer is placed in the stationary "stator" circuit in the case of induction motors, it is, when used for synchronous motors, inserted in the revolving armature circuit. To obtain a more gradual starting action, especially with synchronous motors of large size, the arrangement shown in Fig. 91 is frequently employed. It consists of a controller and a compensator provided with several taps, this arrangement being the method of starting a three-phase synchronous motor, the compensator being cut into circuit on only two of the phases, the "to motor" leads connected to the motor armature. It must be clearly understood that this arrangement is utilized only in the rotating armature circuit. The field magnet circuit, separately excited by a direct current is not shown here, as the exciting does not take place until the motor is fully started, the diagrams showing the starting arrangement only. By this starting method, any unbalancing that occurs is practically negligible, so far as any serious disturbance of the line voltage is concerned, for the reason that large synchronous motors are usually started up to full normal speed without load.

The synchronous motor can not be subjected to speed variation, the characteristics of the machine not providing for such variation by external controlling device, it is of necessity a constant speed machine. It remains in synchronism with the source of supply, except when affected by external disturbances or considerably overloaded when it immediately comes to rest. Reversal of the direction of rotation of the synchronous motor armature can be secured as in the case of induction motors, by reversing any pair of leads when a three-phase, and by reversing the leads of either phase if a two-phase motor.

If the field-magnet pole pieces of a synchronous motor are equipped with an additional winding, that is "damping coils," the machine runs up to speed more easily. Such windings usually consist of copper bars or rods embedded in the pole faces of the magnets, the bars having their ends short circuited by metallic rings. This constitutes a circuit winding approximating somewhat to that of a short circuited

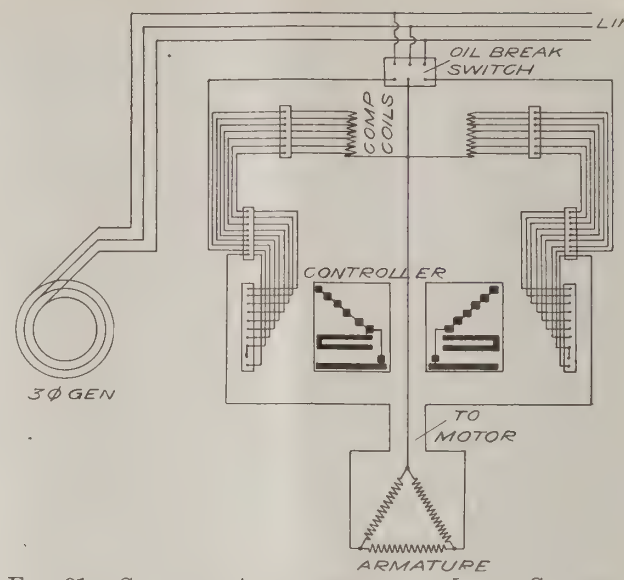


Fig. 91. Starting Arrangement for Large Synchronous Motors.

squirrel cage rotor of an "induction" motor, and machines when so built are sometimes called "synchronous induction motors," for the reason that the starting characteristics approximate those of an induction motor. A starting torque equal to about 33 per cent of the full load running torque can be obtained, the motor at starting taking about one and one-half times the full load line current.

Synchronous motors in many cases, and especially single-phase motors in nearly every instance, have to be started and run up to synchronous speed by means of power applied mechanically to the armature shaft. A very convenient method and the one usually employed in every day practice is by utilizing a polyphase induction motor. This or some similar method should always be employed when the motor has to be frequently stopped and started, or under circumstances where it is especially desirable to prevent electrical disturbances of the system, by keeping the starting current low. A starting motor with an output of about 10 or 15 per cent of the normal capacity of the synchronous motor to be started, will usually be found to fulfill the starting requirements in the majority of service conditions.

One great advantage which a synchronous motor possesses, is that of producing and controlling a displacement of phase between the current and voltage. The current can even be made leading, thus partially or wholly neutralizing any lagging current that exists in the electrical circuit due to inductive loads. This leading current is obtained by over exciting the magnetic field circuit, the motor then acting as a condenser of large capacity, and when so employed is sometimes called a "rotary condenser," and may either run light or be made to convert into useful mechanical work a proportion of the current input.

THE INDUCTION MOTOR AS A NON-SYNCHRONOUS OR INDUCTION GENERATOR.

If the rotor of an induction motor be mechanically rotated at a speed exceeding its synchronous speed, and at the same time be connected to an alternating current circuit, it will become a generator and will deliver current to the line. When so employed an induction motor is called a non-synchronous or induction generator. It must, however, be connected to a line that has current supplied it by machines of the sychronous type, because it cannot generate its own magnetizing current. The current that the non-synchronous generator gives off comes from the "stator" and not from the rotor and if connected on a line, its output is delivered to the line at a sight lag from the line current.

If an induction motor running under normal conditions be supplied with an additional mechanical power which speeds up its rotor above synchronism the stator will give off current, the amount of it depending upon and increasing with the per cent increase in speed above normal synchronous speed. The explanation of the action is as follows. When running as an induction motor with say a 10 per cent slip, the current flowing in the stator in a certain direction induces currents which flow in the rotor in such a direction that their mutual reaction cause rotation, the amount of current taken by the rotor for a motor of a given output, demanding a certain supply from the line; and this supply is delivered to and flows through the stator circuit. The greater the slip the greater the current both in the primary stator and secondary revolving rotor and conversely; the less the slip the less the current both in the rotor and stator. If while the stator is connected to the supply sources, and the rotor running at a 10 per cent slip, and external mechanical power be quickly interlocked with the revolving rotor shaft so as to cause it to rotate in the same direction, the mechanical power now assisting the rotor would gradually increase its speed. In so doing the current and likewise the stator current would gradually diminish as the slip decreased or as the rotor speed approached the stator field, the stator all this time taking a gradually diminishing current from the supply lines.

When synchronous speed was reached the rotor would have no current flowing through its circuit, and the stator would be taking no current from the line. Continuing the application of mechanical power, the motor rotor speed would gradually increase above the synchronous speed of the stator fied, and a current would now be generated in the rotor in opposite direction to what flowed when below synchronous speed, because the slip between the rotor and stator is now in the opposite or negative sense to the conditions that previously existed when the slip was positive; that is when the rotor speed was less than the stator field speed.

The current generated in the rotor when it is driven or rotated above synchronous speed and which flows in the opposite direction reacts upon the stator field in an opposite inductive sense, to what it did when the rotor required the assistance of the stator current to enable to perform its mechanical tonque, therefore the stator delivers current to the line, because the mechanical rotation of the rotor causes it to become in a sense a generator. Thus is brief, the induced current reacts upon the stator field and causes the previous incoming stator current to reverse and become an outgoing stator current delivered at a slight lag into the line, and the greater the negative slip, that is the greater the rotor speed above that of the synchronous speed of the stator field, the greater will be the current delivered by the stator to the line. It takes mechanical power to drive the rotor, with an increased per cent of slip, and since mechanical power is being converted into electrical energy, it is obvious that the greater the mechanical power to drive, the greater will be the useful current generated.

A second expanation from the standpoint of the Emf's or voltages in the primary circuits is as follows: Considering first the machine as an induction motor, the current induced in the revolving rotor so as to perform mechanical work or exert a torque, demands a watt input to be delivered to the stator from the supply lines; and the current is in phase with the impressed supply volts, but the stator winding, due to self-induction exerts an opposing or counter emf tending to prevent the flow of the watt input, with the result that whatever current does flow through the stator circuit, is in opposition to this back stator emf.

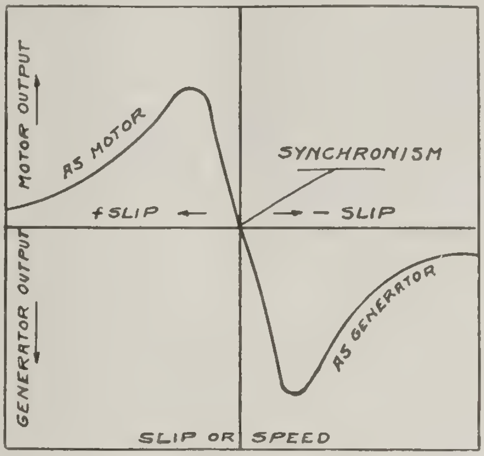


FIG. 92. OPERATING RANGE OF INDUCTION MOTOR.

When the machine is now mechanically rotated above synchronous speed, the reversed currents flowing in the rotor secondary, by their inductive action, cause a reversed primary stator current, which is now in opposition to the impressed emf or supply voltage and is therefore in phase with and assisting what was previously the stator counter or opposing emf that is, it is adding the effect of its direction or flow to that of this heretofore back emf. The machine is now a generator and the stator supplies current to the line for the reason that what was previously the counter emf of the stator, has become an active voltage working in combination with and causing the current to flow into the line.

The induction motor is obviously a reversible machine and when employed as an induction or non-synchronous generator possess similar characteristics as motor and generator as seen in Fig. 92.

A CORRECTION.

In the writer's article appearing in the January issue of Southern Electrician on, "A Review of Water Power Developments in the South During 1912," a misstatement appears on page 15, right-hand column, paragraph 2. The Augusta-Aiken Railway and Electric Corporation controls the Georgia-Carolina Power Company, and not vice-versa. The development on which the construction has already begun is located on the Savannah river about nine miles northwest of Augusta. The power will be used not only for the operation of the interurban electric lines running from Augusta to Aiken, but also for lighting properties in Augusta and furnishing power to mills in Augusta and its vicinity. The initial power installation will consist of five units of 2,700 kva. each and the ultimate power installation of ten units of 2,700 kva. each. Contrary to the statement in the article, the company does propose to enter the power business on a rather large scale.

J. A. SWITZER.

The Requirements of Power Plants in Textile Mills.

Written From an Engineering Standpoint

BY JOHN A. STEVENS.

A Discussion of Conditions and Requirements Effecting Nature and Design of Power Equipment.

THE power plant, whether it be in a cotton mill or any other industrial plant seldom receives the attention, either from the standpoints of design or maintenance, that it deserves as one of the important factors in manufacturing cost figures when taken for a period of one year. The usual and proper proportion of total cost that is chargeable to the power plant should not be more than 3 to 5 per cent. Yet through the general regard of this equipment as a continual expense such factors as efficiency and prolonged life are often neglected, thus increasing the above percentage once, twice and often three times. A study therefore of the conditions under which the power plant can best operate under different conditions, is an important one and is beginning to be so recognized by managers and superintendents of large and small plants. Where this study has been carried on its results have showed up in dividends. In what follows we present a very practical and vital discussion of the power plant design and operation in connection with cotton mills as recently presented by John A. Stevens before the American Society of Mechanical Engineers. Mr. Stevens roughly groups textile plants into classes depending upon the kind of goods produced, whether worsteds, woolens, cottons, linens, or silks; whether they produce yarns or cloth, whether their product is plain or colored; to what degree the product is finished and by what processes, that is, whether there are dye houses and bleach houses as part of the equipment, requiring large quantities of steam. He emphasizes the fact that there cannot be a standard design of power plant for any purpose but that the power equipment must be especially adapted to the conditions and requirements of the individual plant. The conditions discussed are as follows:

DIRECT AND INDIRECT SAVINGS.

The possible savings in connection with a textile power plant are at least of two kinds: (*a*) The direct savings brought about by producing through efficient apparatus a given quantity of needed power for a reduced expenditure of money after all expenses chargeable to power have been considered; and (*b*) the incidental savings realized through installing new equipment carefully arranged to meet the manufacturing needs of the plant, thus bringing about increased and more convenient and bettered production or a decreased cost of manufacture. These frequently are of greater importance than the direct savings.

CONDITIONS MET WITH IN CENTRAL STATIONS.

While the conditions and elements which make for diversity in design, or most desirable equipment of central stations for public service corporations, are everywhere admitted to be great enough to necessitate the careful working out of all features by a competent group of engineers, such equipment, when of small size, is generally much more capable of standardization than is that of the textile plant. In the great majority of cases the public service station has to do solely with the furnishing of electric energy for use by its customers in the form of power and lighting. It has, of course, no use for low-pressure steam in considerable quantities and its requirements for heating steam are usually insignificant. In fact, so far as the question of low-pressure steam enters at all into its scheme of operation, it is rather one of avoidance than otherwise. Its problem is to see that no more is produced at any time than can be made use of for the purpose of heating feedwater, and anything beyond this quantity is an absolute waste.

The influence of this condition extends so far that not infrequently it has led such plants to forego the saving from an economizer, because if such a unit were used economically, there would be so little remaining use for exhaust steam that auxiliaries, which for reasons of dependability and flexibility it has seemed best to keep as noncondensing steam units, would be exhausting to atmosphere. The public service station manager is thus prevented from the possibility of realizing in his own plant large savings from conditions which can be obtained by the manager of the textile plant, savings too, which must be thus taken advantage of if the item of total coal cost in that plant is to be kept at a minimum.

This absolute dissimilarity of conditions goes far to explain why it has sometimes happened that engineers and power sales agents who have received their training mainly in situations where there was no possible use for low pressure steam, have utterly failed to realize the extent of savings which may accompany such use. They have sometimes gone so far as to cause the abandoning of steam-using machinery and the purchase of current for power, even in plants containing dye houses, with the result that the total bill for power and manufacturing steam was thereby increased very nearly to the extent of the power bill. This, of course, represents an extreme case, and is mentioned here merely as a means of bringing out clearly the extent to which conditions may sometimes influence the proper solution of a textile power plant problem.

COMBINED POWER AND MANUFACTURING STEAM USING UNITS.

The plant which can obtain power from units properly combined with the supplying of steam for necessary manufacturing or heating processes has possibilities for securing power at costs far below those available to others not thus fortunately circumstanced. The reasons why, when conditions are suitable, such considerable savings can be realized by making the power production unit practically a reducing valve for the manufacturing steam line, or looked at from the other point of view taking the manufacturing steam from the power line as a sort of by-product, are well understood by all engineers who have had occasion to consider the matter.

Although the practice is old, dating back many years, we still find men occasionally who feel that the idea of getting the work required from an engine and from a dye tub with less coal when the latter takes its steam through the engine than when both are supplied by separate lines from the boiler is a sort of perpetual motion scheme—a producing of something for nothing. They fail to take into consideration that there is a tremendous amount of heat energy rejected through the condenser even by the most efficient engine or turbine, while the dye tub is particularly well fitted to make use of this very energy which the engine or turbine cannot use. On the other hand, the dye tub cannot as efficiently utilize the energy from the high-pressure end of the range and from which, in the combined unit, power is obtained.

When the steam turbine first began to replace the steam engine, it generally was not designed to meet this condition of furnishing low-pressure steam and the fact that it was better able to use steam efficiently through the high vacuum ranges doubtless led to the feeling that it was not so well adapted as the steam engine for supplying steam for manufacturing purposes. Later experience has shown the fallacy of such belief and now turbines are designed with special reference to such uses. It is also worth noting that at any given pressure steam leaves the turbine considerably dryer than it leaves the engine. The quantity of manufacturing steam required and the regularity of demand for it varies greatly in different mills. For best results individual conditions should receive careful study before equipment is chosen. Where demands are large and constant non-condensing units may offer the best solution. Where demands are extremely variable some system of bleeding a portion of the steam from the receiver or stage of a condensing unit is more practicable.

USE OF CONDENSING WATER DISCHARGE IN TEXTILE MILLS.

When there is a large and constant demand for warm water to be used by textile machines, the cooling water from condensers, carrying with it the rejected and otherwise waste heat from steam, can be taken to these manufacturing uses where, unless this were done, cold water would have to be used and heated by steam for which coal would be especially burned. Thus put to work, the condensing water may save a portion or all of the above-mentioned coal, depending upon the temperature of water required.

The drawbacks to this scheme which prevent its more frequent use are that the demand is apt to be for a relatively small amount of water at a considerably high temperature, while the supply from a normal and efficient working condenser would be that of a larger quantity of water at a temperature only moderately in excess of that of the cold water supply. Again the steam engine, which can better stand a rather low vacuum than can the steam turbine, under this condition requires the use of a surface condenser in order to avoid the presence of even a small quantity of oil which usually is objectionable.

CONDITIONS COMPLICATED BY USE OF WATER POWER.

It is believed that the power plant situation of a textile mill is, more frequently than with any other type of plant, complicated by the presence of water power equipment developed to such an extent that a considerable portion of it requires relaying with some form of coal consuming units. There was a time when water privileges could be more readily obtained than is the case today, and when steam power was but little developed and relatively inefficient. Water power developments of great extent and cost were made during those early days, the rights in which are still held by the original textile companies or by their successors, and which practically make financially necessary and good policy, the continued use of water power to an extent which would be prohibitive were the developments being made from the beginning today. Other industries and especially public service corporations, being of later growth, missed the opportunity to share in the rights of these early water power developments; or when they secured water privileges. have in the main because of expense, developed them less fully. Their equipment in any event is more likely to be modern and thus fit in better with present-day power-generating machinery.

THE NEW POWER PLANT DEVELOPMENT.

The problems of textile power plants can be subdivided into: (*a*) entirely new developments, and (*b*) those which have to do with changes or further developments in an existing plant. When an entirely new power plant is under consideration, the fundamental points are the same whether it be for a textile mill or any other purpose. These are accessibility to railroad or barge for handling coal and ashes, coal storage, boiler feed and condensing water supply, also convenience of and ample space for future expansion of plant.

Importance of Track Facilities.

The importance of laying out a new manufacturing plant or making additions to an old one to secure the best, or at least workable, track facilities cannot be too strongly emphasized. The manufacturer who builds an important mill group without first having his track connections definitely laid out to the approval of railroad engineers, is apt to find that intended connections are impossible, or at least awkward and unduly expensive.

Providing Room for Future Development.

The importance of locating a new power house to have ample room for growth, is another point which ought not to require mention, but rapidly growing plants are frequently found with this important portion of their equipment needlessly built into a hole. Sometimes such building is forced upon a concern by the circumstances of location and business conditions, and it is then of course justifiable as it has been done with full recognition of the fact that it is going to prove expensive later on. The greater portion, however, of such building seems to have come about through a lack of conception that there were possibilities of greater things in the future and throu an unwisely directed effort to economize in the first cost of power equipment.

OLD POWER PLANT DEVELOPMENTS REQUIRING ADDITIONS.

The subject of the second subdivisions, viz, problems which have to do with changes or further development in an existing plant, of necessity make up the greater portion of the work of a power plant engineer.

Power Plant in Old Mill an Adaptation to Existing Condition. The power plant problem in an old textile mill is always one of adaptation not only to the requirements for power in all its phases, but more especially to the more difficult requirements of having the new equipment fit in with that already in the plant and thus form a satisfactory working unit at least expense, while still conserving as far as possible the money already expended.

The special lines along which adaptation has to be secured in any individual textile plant of course depend to a great degree upon the complexity of its power plant equipment and power uses, differing all the way between the comparatively simple condition of an all-steam using plant burning coal for power uses only, and the plant making large use both of manufacturing steam taken from power producing units and of water wheel equipment requiring extensive relaying by steam.

The question of power plant location will of course be affected by the presence of one or all of these factors, for the grouping of this equipment, so that it can be handled with the fewest possible men, has a considerable effect on the final cost of power. If steam is to be used through engines or turbines for manufacturing purposes, it is very desirable that the location of the power house should be near that of these manufacturing uses, both to avoid drop of pressure in the large steam mains, and to keep the costs as low as possible.

Electric Transmission as an Aid to Adaptation. The development of electric transmission makes possible the gathering together of all steam power-producing machinery in a single station under the charge of a comparatively small group of men and leaves the designer free to locate that station where it will have room for further development, be convenient for coal handling, and out of the way of manufacturing processes. It sets free for manufacturing use a considerable portion of space which was formerly taken up by belt towers and belt ways, main lineshafting, bevel gears, quarter turn and rope drives, all of which were heavy and extremely expensive both as to first cost and maintenance. Above all it enables manufacturing buildings to be placed in any manner best suited to location and manufacturing conditions, and renders easy the changing and regrouping of machinery which in some departments of textile work is constantly going on owing to changed demands for production.

Electric Transmission in Connection with Water Power. By the installing of generators on waterwheels it gives this portion of power a flexibility which it has never before had and it thus somewhat simplifies the serious problem of relaying this power. In many instances it is found possible to gain the necessary flexibility and prolong for a considerable time the useful life of old waterwheel equipment by means of installing belted generators connected to the main shaft of these old wheel. While this is not an efficient means of generating and transmitting power, the relatively small cost at which the necessary added equipment can frequently be installed, compared with that of an entire new equipment of waterwheels and direct-connected generators, makes the real cost of power thus secured for the time being very attractive and retards the otherwise necessary expenditure of large sums of money.

The next section of this article will discuss plants illustrating principles discussed here.

Electric Rates and Classification of Central Station Customers.

Abstract of Report of N. E. L. A. *Rate Research Committee.*

Why Electric Companies Should Adjust Rates So as to Get All Possible Business.

When a business is subject to unlimited competition, all its rates automatically seek a level wreer they give the owner barely a minimum return, or possibly provide no profit at all, since, when they rise above this level, more competition develops, and when they fall below the competition ceases until they rise again. In the case of a monopoly, and particularly of various public service monopolies, the rates are not entirely controlled by competition, and in the case of public service monoplies, it is expected that either public sentiment, the courts, or commissions, shall regulate the rates to a point at least as low as they would have been in the long run, if subject to competition.

The degree of monoply of public service corporations is greatly overestimated, since most of their monopoly is in form only. An electric company may have exclusive rights to supply electricity for light, power, heat, etc., but it has no monopoly in the supply of light, power or heat as such on account of active competitors. Below a certain point in its prices, the electric company may have a monopoly, and public sentiment requires that its prices shall, in the long run, be lower than if the competition were unlimited.

The question of division of cost among different customers or classes, is an entirely separate question from the question of total costs or fair return. Having decided finally, or for the time being, what is a fair return on the investment in a given electric or other public service company, the separate question is still open—how shall the rates that are to produce this income be adjusted as between the different classes of customers? The first answer (and a theoretically correct one) is that each individual customer should be charged at least what it costs to serve him. The trouble is that this only distributes a small portion of the costs as between customers. If an electric light is burned, or motor used, the electric company uses perhaps a little more coal, costing perhaps 1-2 cent per kilowatt hour for each kilowatt hour used, but the rest of the expenses are not immediately affected. They are joint costs which may belong to any of the lights or any of the motors, or to some other part of the business.

In many businesses—and especially such a business as electric light and power service—most of the expenses are the same whether any particular customer uses the service or not, and it is only certain small expenses that are necessarily part of the cost of each customer. These latter are sometimes grouped under the general term the "increment cost," the cost incurred by adding that customer to the system, or saved if he is disconnected. The remaining and greater portion are joint costs, which may belong to all of the customers or the customers as a whole. Increment costs must be, or rather should be, apportioned to individuals, or special classes that cause them. Joint costs must be divided in some way as between all the customers.

One method is for the owner or manager to make arbitrary prices to each customer, but it is clearly of no advantage to the owner to charge different amounts under like conditions, and such discriminations are forbidden by law on the ground that they are either due to some improper influence on the manager against the interest of the owner and public, or else an error of judgment. The simplest method is to select some unit, as ton-miles or kilowatt hours or number of telephone instruments served, and divide all costs in proportion to this unit. Here there is no difference of interests as between owner and public, in choosing the unit, but there will naturally be a difference as between portions of the public. A charge for hotel service by the European plan, helps one class of travelers as compared with a class that prefers the American plan, and so on. Whether an electric company charges per lamp connected, or per kilowatt hour, makes a great difference as between stores and residences, even if the rates are such that the owners of the electric company get the same return on their whole investment.

Further, it is perfectly possible to select more than one unit, or, if using a single unit, to make the rate for such unit different for different classes, as one rate for residences and another for business, as one rate for letters and another for merchandise.

At the moment there is a call for electric companies to adopt prices as developed from a certain formula, sometimes known as the demand theory. Costs = number of customers × a + kilowatt hours × b + kilowatts of demand × C, and it is well to understand why this, as well as any other formula, would be to the public's disadvantage unless by the merest chance it worked out right for all cases.

No matter which formula we use for analyzing costs. it is still true that most of the costs are joint costs not necessarily incurred by any particular customer or customers. If these joint costs are divided in one way according to some formula, there may still be another division which may give better results for the public. The best result is when the burden on customers is least; *i. e.*, when we get as much business as possible among which to divide the joint costs so that the burden on each customer shall be least.

Take existing rates. They produce an income which is either less than a fair return, a fair return, or more than a fair return. Now, if the return is less than fair, a new rate applicable only to new business that could not otherwise be obtained, should return something towards joint costs, and will be of no harm to existing business and will be an improvement. If the return is just a fair one, a new rate that produces new business over which to distribute joint costs will not hurt existing business, but will make possible a reduction of rates. If existing rates show more than a fair return, a reduction should be made, but again, if a reduction so as to produce new business is made, further reduction becomes possible. In any of the cases, it is obvious that the new rate should take as much of the joint costs as it will stand, and this is clearly no injury to the new business, because it need not take the supply unless it wants to, and will not unless it gets some advantage. On the other hand, if new business is asked to share the same proportion of joint costs that is being paid by the old business, it may not be secured at all, and then will not pay anything towards joints costs, instead of paying something.

The costs for the central station are the average costs, made up of all sorts of expenses, and because they may average 9½ cents it does not mean that each new customer will also cost 9½ cents. Each new customer may add something to the total costs, but this addition will have no relation to the average cost of serving the old customers. If a rate can be established for a single customer, and a different rate for the next one, then the increment cost can be figured for each. If, however, a rate is established for a class, we must figure what is going to be the whole result for years ahead, when not one but many customers of the class are added.

A new customer should contribute as much as possible to joint costs; *i. e.*, should be made to pay, in unpopular phraseology, all his traffic will bear, even if we do not charge him as much as we charge the others. Now, in order to determine what he can actually afford to contribute towards joint costs, it is necessary to figure what it will cost him to make it himself, and in most cases of customers, the things which determine his costs are his demand, his consumption, and his size; in other words, using as a basis to figure his costs, the demand formula above referred to. Hence, in publishing a rate to attract these customers, it is natural to make it on a demand basis, so that each shall pay as much as possible of the joint charges and reduce their burden on others.

While the demand system furnishes a measure of the total station costs it is not for that reason that we use it in making prices. We use it in making prices because it furnishes a measure of the value of the service to the customer and if in any particular case the demand system did not furnish this measure we might use some other measure in order to apportion to him as much as possible of the joint costs, so that the supply to him should be of the greatest benefit to the other customers. This explains in part, at least, the popularity of the so-called demand theory. Everybody uses the analysis of costs into demand and output charges, and finds it extremely useful, first, when applied to the central station costs to determine the effect of changes upon those costs, and, second, when applied to the customers to determine the price which will make the supply to them result in the greatest benefit to the customers as a whole.

The demand theory is very apt to give prices that will be best for all, but this is purely because it happens to fit certain classes of customers. The fact that in some cases the best prices can be figured from a particular cost formula, does not prove that the same figuring will give a correct result when conditions are changed.

Returning to the case of the large customer, there is always difficulty in undertsanding why it is that a large customer can be supplied at so much less than the average price, but here is another analysis which may make it clear. The central station could build a new small station for a customer close to his mill, and a duplicate of his plant, and by running it exactly as he would run his plant could meet his costs exactly. In such a case it is clear that the old station costs would be 7 cents and a proper price to old customers 7 cents; cost at new station 1-6/10 cents. and the proper price to the new customer 1-6/10 cents. Then when we combine them and run them as a unified proposition, the situation is still the same, and the cost of each does not become the average, any more than a short man could become taller by enlisting in a company of soldiers whose height averaged more than his.

This point about building a small station close to a customer is a very essential one to remember. The central station can *always* meet the price of the isolated plant because it can build an exact duplicate of the isolated plant and run it as the customer would run it and meet the price.

and then, as a next step, the central station by combining the loads can effect a saving and make a profit. In any case it cannot lose by selling to the customer at what it would really cost the customer to supply himself, because in the worst case it operates exactly as the customer would have operated.

We contend that there should be no isolated plants from the standpoint of economics. Why, then, are there any isolated plants? The reasons are as follows. Sometimes the central station does not know its business. The costs of the isolated plant may be said to be 3 cents, but the central station may refuse to supply the service at less than 5 cents. Sometimes the isolated plant does not know its business. The real costs of the isolated plant may be 3 cents, and the central station may offer a supply at 2.9 cents, but the engineer may report that the plant cost would be only one-half cent, and he secures a commission, or at least a job.

Occasionally the case may present itself where it is really economical to generate part of the electricity at the customer's premises and part at the central station, as when the customer may have water power available. If this amount at any given time corresponded exactly to the customer's requirements, then for this time there would be no advantage from the central station connection, but practically always some of the electricity could be economically supplied from the central station, or else the water power plant could sell some to the central station.

Any saving or contribution to the net revenue of the central station are ultimately for public advantage, because whatever increases the profit of the central station brings earlier reduction of rates to its customers as a whole. Hence, a central station should make rates that will get all the business, and while making the rates just low enough to get the business, that could not otherwise be secured, should make them no lower than necessary and in no case below increment cost.

Whenever the return on investment is higher than is reasonable and equitable, competition will naturally spring up, and the authority that grants the monopoly requires that there shall be a reduction of rates, applicable to those classes whose price would have been reduced by means of such competition. Subject to this exception, each price should be such as to produce the greatest amount of business and make the burden of joint costs least; and the final result will be obtained by basing all rates either on actual value of service, or on what this value would be under free competition. This results in practice, in a simple general rate such as obtains in most of our cities, with special classifications for power use, and for large customers, etc.

It will be for the interest of owners, as well as of the public, to adjust rates along these lines, and if rates are made public and open to all alike under like conditions, and so long as these conditions are made in good faith and without ulterior motive, any such proper discrimination in rates is justified and should inure to the advantage of the public as a whole. In practice the method here advocated of determining rates works simply, even if it means that the final figure is determined more by the business judgment of the manager, than by the reports of the accountants.

The change in rates may apparently produce some new business, but the business on the new rate may be business that was formerly on the old rate. In such case it is merely a transfer from the old rate, and there is no increase in business, but instead, a decrease in contribution to joint costs, and in such case the new rate does not stand the test. This will often be the case when the customers on the new rate are competitors of those on the old rate.

One rate for residences and one rate for stores would never transfer business and would seldom be open to criticism. On the other hand, one rate for two family houses, and another for single houses, might transfer business from one to the other, and in general might be undesirable. One rate for ice-making, and another rate for water pumping would almost never transfer business, hence is fully justified. One rate for drug stores and another for saloons, would be apt to transfer business, and would have to be closely scrutinized. One rate for theatres and another for other amusement places, would be apt to be discriminating, because it would be apt to transfer business, and a rate for newspaper offices different from ordinary printing offices, would again be subject to suspicion. On the other hand, a rate for hotels might be different from a rate for factories, without much chance of any transfer of business.

The following rules will show how the foregoing methods can and should be applied.

For the company—adjust the rate to the various classes so as to get the greatest volume of business among which to divide joint costs, and in order to do this, first make sure that no class is supplied at a loss, and that each class bears as much as it can contribute (or would have paid under free competition) of the joint costs. This means make the rates proportional to the value of the service, less the savings due to monopoly.

This should result in a single general rate for the general public, at least as low as would have obtained under free competition. It should result in class rates for power, street lighting, charging of batteries, cooking, etc., lower in many cases than the general rate, and should result in differentials for large customers, all of these class rates and differentials being only as low as necessary in order to get the business. The differentials for large customers should be low enough to get the business now done by isolated plants.

For the public—allow the company to make any change it likes as between customers or classes who do not compete with each other. When a change is proposed that makes a difference between customers or classes that do compete with each other, allow the change only when it is clear that the result will really produce new business, and not merely transfer business as between competitors. When the rates produce more than a fair return, provide for reducing the rates to those classes which would have obtained a reduction if competition had been free.

This is the line along which companies are now developing. The only weak point in their present situation is that they are not making the differentials in favor of large customers (and of certain uses, such as cooking, etc.), enough to get the business, and this requires the small customers to pay more towards joint costs than would be necessary if the rates for big customers were made low enough to shut down every isolated plant, where the owner knew his costs and was not running it for his pride or his amusement.

Explanation of How Field of Induction Motor Revolves.

By A. G. LANGWORTHY.

A Mechanical Illustration of the Action of 3-Phase Currents in the Induction Motor.

THE Current'o Scope is the name given to a device recently designed by a manufacturer of electrical apparatus to show in a simple and correct manner how the so-called revolving field is produced in a three phase induction motor by the action of alternating currents. In investigating the operation of this device, remember that an alternating current is one whose direction of flow is reversed periodically so that it flows first in one direction for a brief period and then gradually decreases in strength, reaches zero, starts to flow in the opposite direction and gradually increases in strength until it has the same value as before in the opposite direction and then these processes are repeated. In a 60-cycle current the reversals occur at the rate of 120 per second; in a 25-cycle current they occur at the rate of 50 per second; two reversals for each cycle.

A three phase alternating current is really three alternating currents usually flowing in three wires, the reversals following each other in the three wires at equal intervals of time, always in the same order. The usual graphical representation of the currents in a three-phase circuit is shown in Fig. 1 with the polar scheme of vectors shown at the left, in the same relative position as shown in the center of the Current'o Scope in Fig. 2. The full lines of the sine curves indicates one half cycle operation while the current in the black or leading phase passes from zero through its positive values to zero again in the negative direction. The dotted lines show the second half cycle of operation when the current in the black phase passes through its negative values. It will be seen from the diagram that for any instant such as (A) the current in the black phase leads that in the red by 120 degrees and that in the green by 240 degrees as shown clearly in the polar scheme as the left. It is also to be noted that at any instance the algebraic sum of the currents in all three phases is zero. By comparing this graphical scheme with the explanation that follows, the action in a three-phase circuit becomes plain.

DESCRIPTION OF CURRENT 'O SCOPE.

The outer part of the diagram shows the frame, core and windings of a two-pole three phase induction motor; the slotted ring represents the stator core and the red, green and black spots represent the wires in the stator slots; the red, green and black lines running around the core from the left hand foot of the motor indicates the lead wires through which the current flows to these windings and the other ends of the three windings may be assume to be all together at the back of the motor. In a "star" wound motor they actually are joined.

The arrows which appear through the slots in the motor foot indicate the direction of the currents in the lead wires, while the spots and crosses which appear through the round holes in the stator frame indicate the direction of the currents in the phase windings opposite which they appear, the crosses indicating a current flowing downward or away from the observer and the points indicating currents flowing upward or toward the observer. Where a zero appears in these holes, it indicates no current in that phase. The red and black shaded portions of the disc which show through the inner rectangular slots indicate the strength and direction of the magnetic field produced by the combination of the currents flowing in the different phases, the red indicating a north pole and the black a south pole. The deeper shaded portions where the letters N and S appear, indicate the points of maximum field strength, and the lighter shaded portions indicate the gradual weakening of the field on either of these points.

ILLUSTRATION OF CHANGING CURRENT VALUES.

In the center of the Current'o Scope, Fig. 2, there will be seen through the two circular openings, three radial lines which represent the relative direction and flow of the electric currents in phases 1, 2 and 3 of a three phase generator, or transmission line, or motor. For convenience, we will refer to them as black, green and red currents in black, green and red phases. When a line appears in the upper circle it indicates a current in the positive direction in that phase and a line in the lower circle indicates a current in the negative direction. The length of the lines as they show through the circular holes indicates the strength of the current in amperes, which it must be remembered isconstantly changing.

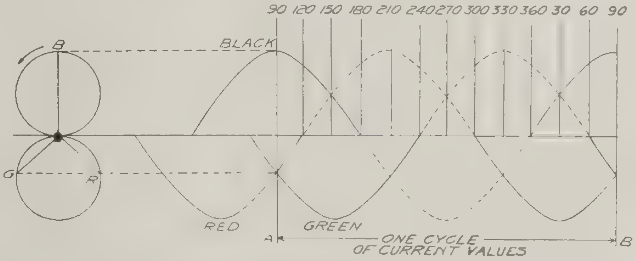


FIG. 1 GRAPHICAL REPRESENTATION OF 3-PHASE CURRENTS.

Imagine the disc at the center, with notched edges at the side thumb places, turned until the black line points vertically upward in the upper circle as shown. This represents a current of maximum value flowing in the positive direction in the black phase as shown in Fig. 1 at the point A. Turn the disc left handed, or opposite to the motions of the hands of a clock, and notice that the black current decreases gradually, becomes zero, then reverses and starts in the negative direction, as shown by the appearance of the black line in the lower circle, gradually increases to its maximum negative value when the black line is vertical, decreases again to zero, changes to positive and gradually increases until it reaches its maximum positive value again when the black line is vertical. The red and green lines will be seen to pass through similar changes, following each other one-third of a revolution apart.

Again turn the disc until the black line points vertically upward in the upper circle; the black current is now at its maximum value in the positive direction and the green and red currents are exactly half of the black current, in the negative direction. This may be looked upon as a current flowing inward through the black phase and dividing into two equal parts which return outward through the green and red phases. Turn the disc in a direction opposite to the movement of the hands of a clock and note that the black current decreases, the green current increases and the red current decreases. After moving the disc 30 degrees, see Fig. 1, it will be noticed that the decreasing black current and the increasing green current have reached the same value and the red current has disappeared. At this time there is no current in the red phase and all the current is flowing in through the black phase and out through the green.

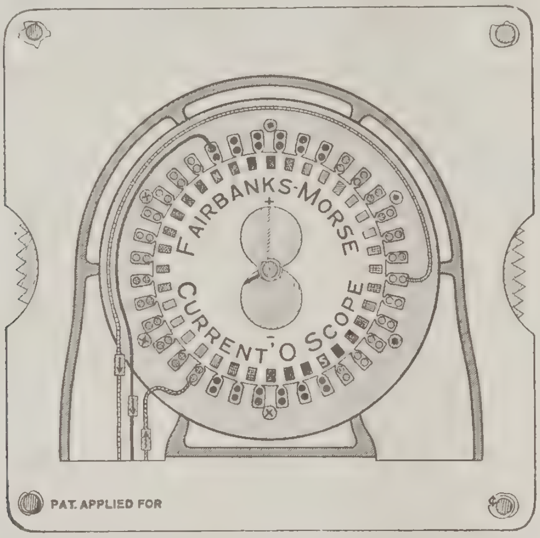


FIG. 2 THE CURRENT 'O SCOPE, ILLUSTRATING REVOLVING FIELD OF INDUCTION MOTOR.

Turn the disc still farther in the same direction and the black current will go on decreasing while the green current increases until after moving 30 degrees the green line extends vertically downward indicating that the green current has reached its maximum value in the negative direction, while the red current has reversed and is now flowing in the positive direction, as shown by the red line in the upper circle, and both the red and black positive currents are each equal to one-half of the green negative current. This condition may be looked upon as two equal currents flowing in through the red and black phases and joining together to flow out through the green phase. Turn a little farther; the black and green currents decrease and the red current increase until after turning 30 degrees more the green negative current and the red positive current are equal and the black current has disappeared. Turn a little farther; the black current has reversed and is now flowing in the negative direction and after moving 30 degrees the red current has reached its maximum positive value and the black and green are both negative and each equal to one-half of the red.

Turning 30 degrees more, it will be seen that the green current has disappeared, the black negative current is equal to the red positive current. 30 degrees farther on, the black current has reached its maximum value in the negative direction while the green and red are positive and equal to one-half of the black. This is exactly opposite to the condition with which we started when the black line was vertical.

Turning farther by steps of 30 degrees, we observe the following changes in order: First, red current zero, black and green currents equal; second, green current maximum in the positive direction, red and black currents each equal to one-half the green in the negative direction; third, black current zero, red and green currents equal; fourth, maximum negative value of red current, black and green positive currents each equal to one-half of the red; fifth, green current zero, black and red currents equal; sixth, maximum positive value of black current, red and green negative currents each equal to one-half the black.

This brings us back to the same position with which we started, completes one cycle and represents the changes which the three currents pass through sixty times a second in the case of a sixty cycle current. If the disc is turned again watching one line at a time, it will be seen that each current in turn decreases from a positive maximum to zero and increases from zero to a negative maximum, the decreases to a positive maximum.

EXPLANATION OF REVOLVING FIELD.

Placing the disc with one line No. 1, extending vertically upward through the opening at the center of the diagram and looking at the arrows through the openings in the motor foot, we see that current No. 1 in right hand lead is flowing inward to the lower part of No. 1 phase windings and from there downward to the back of the motor where it passes through the end connections of the coils to the opposite windings of No. 1 phase at the top and right of the diagram. After passing through all the windings of this phase to the point where the three phase windings are joined together, it then splits into two equal currents which flow outward through No. 2 and No. 3 phases, passing downward through that part of these windings which lies at the left of a line drawn between the points marked N and S and upward through the parts lying at the right as shown by the crosses and points in the small round openings.

In all the wires above a line through N and S of the diagram, the points that show through the openings in the stator core indicate that the current is coming upward toward the observer, and below this line the crosses indicate that the current is going downward away from the observer. This is equivalent to right hand rotation of the current about the central part of the right hand inner surface of the stator core and consequently produces a south pole at that point marked S while looking at the opposite or left hand surface the direction of rotation of the current would be left hand and consequently a north pole would be produced at that point marked N. The strength of the current in the No. 1 phase is at its maximum value and the strength of the current in the No. 2 and No. 3 windings is equal, therefore, the total current strength above and below the line is the same and the poles or points of maximum field strength are located at the ends of the line between N and S.

Turning the disc in the left hand direction until the next series of marks appear through the openings, we see that the currents are all in the same direction as before, but No. 2 (middle lead) current has increased in strength a little and No. 3 current has decreased in strength a little, so that the total current strength is no longer symmetrical about the line N-S but the No. 2 current in the windings below the line have strengthened and the No. 3 currents have weakened and above the line the No. 3 windings at the right have awakened while the No. 2 windings have strengthened, thus shifting the poles downward at the left and upward at the right.

It will be noted that whenever the current in one phase winding is at its maximum value the currents in the other two phases co-operate with it to produce a magnetic flux along its axis and when the currents in the two phases is equal with zero current in the third phase it fluxes along the combined axis of the two current carrying phases. At intermediate points the action of the current is such as to produce a great shifting of the flux from one axis to the other.

As the disc is farther turned step by step, it will be noticed that these changes are repeated and that the poles are shifted continuously in the same direction, until when the No. 1 line is projecting vertically downward showing that the No. 1 current has reached its maximum value in the negative direction, the poles have made one-half of a revolution and the north pole is now at the right where the south pole was located when we started, and upon turning the disc until the No. 1 line projects vertically upward again completing one cycle for the current, it will be found that the poles have made one complete revolution, that is, for a two pole machine the revolving field makes one complete revolution for each cycle. For four pole machine there would be four poles about the circumference of the core instead of two and the revolving field would advance from the initial position of one north pole to the initial position of another north pole or one-half of a revolution. For a six pole machine there would be one-third of a revolution for each cycle and so on, the number of revolutions being equal to the number of cycles divided by one-half the number of poles. As the frequency of an alternating current is given in cycles per second and the speed of the motor in revolutions per minute, it follows that the number of revolutions per minute is equal to 60 times the number of cycles divided by one-half the number of poles. This is the synchronous or no-load speed of the motor.

The rotor or revolving part of an induction motor although made up of iron core and a number of copper bars or groups of coils, is dragged around by the revolving field exactly as a two pole magnet mounted upon the shaft would be, except it lags slightly behind the speed of the revolving field by an amount correspondiny to the load on the motor. This device was designed by the Fairbanks-Morse and Company of Chicago.

Present Practice in Grounding Secondaries on Low Tension Systems.

BY W. J. CANADA.

The Experience of Operators With Grounded Secondaries.

THE grounding of secondaries is now a subject of interest and importance to central stations in connection with low tension distribution and is required by the Underwriters to prevent life and fire hazard. What follows is an abstract of a paper on the subject, presented at the January meeting of the Western Association of Electrical Inspectors, by W. J. Canada, Electrical Engineer for the Rocky Mountain Fire Underwriters' Association, Denver, Col.

Apparently theory strongly indicates thorough grounding for safety. For if a secondary neutral has a normal low-resistance ground, no capacity to ground exists and no voltage to ground from this source can appear; no contact to ungrounded primary can raise secondary potential, for the same reason. A contact with one primary wire through transformer when another primary is grounded will cause current enough to pass through secondary winding of transformer to quickly blow primary fuse. If a primary wire makes contact to secondary outside the transformer, the same will occur, although the blowing of station or section primary fuse may then be necessitated. The effect of resistance in secondary ground will be later considered. In every case theory would tend to prove absolute immunity of well grounded secondaries to high voltage entrance.

We naturally turn to practice to support theory or to locate its flaws, and will usually admit the engineering judgment of observing operators to have considerable weight in any investigation. It might be stated briefly that to obtain such a consensus of practice throughout this country, 140 service companies, representing every state and Canada, were written a series of questions and from the one hundred odd replies received, the following give proof of the general satisfaction in all sections following adoption of grounding.

TABLE 1.

Companies using grounding	86 or 87 per cent
Expressing belief in grounding	92 or 96 per cent
Experience with grounding	average 5 years.
Companies reporting advantages in grounding	69 or 85 per cent
Companies grounding above 110 volts	Six
Companies' experience with grounding good	86 or 99 per cent
Companies utilizing mains	34 or 31 per cent
Companies utilizing driven pipes	52 or 48 per cent
Companies utilizing cones	6 or 6 per cent
Companies utilizing plates	13 or 12 per cent
Companies utilizing tracks	3 or 3 per cent
Companies which prefer water mains	71 or 92 per cent
Companies interconnecting secondaries	33 or 49 per cent

That many companies recognize the ungrounded secondary as a fire and life hazard is proven by their own statements of experience with injuries and fires from high voltage on their secondaries, which for obvious reasons, cannot be given here. Of 49 cities from which deaths were reported, 41 are now partially or entirely grounded.

In the midst of this argument for grounding, which, if not logically opposed, should demand our unanimous and active support for such protection, it is necessary before arriving at our final decision to inquire where opposition has developed to grounding. The strongest, and initially the sole, opposition has been that of the underwriters, and this may be said to have now changed to a decided preference. The later opposition has come more particularly from those lighting companies which either have suits pending, or the moral necessity for supporting their former defense of such suits.

Fortunately, later improvements in line and transformer construction have been made the basis of a revised recommendation by the grounding committee of the National Electric Light Association through its chairman, W. H. Blood, that grounding be made a mandatory requirement in the National Electrical Code where secondary voltage above ground cannot exceed 150 volts, leaving the grounding optional above that voltage. As the slight ground is an ever-present hazard even with the secondaries above 150 volts, the reliance on its absence creates a false sense of security. In the case where by grounding we have insured that only normal low voltages may enter buildings, isolation from such low voltages whether 110 or 500, may be easily secured to prevent personal hazard, and insulation, for the property hazard. It is also readily seen that the fire hazard grows with the voltage, as well as does the life hazard, and it thus develops that an arbitrary limitation of grounding to 110-volt circuits would have removed any weight which such Code rule could be given by fire insurance men as a fire safeguard, and would have left in much question the justification for demanding grounding as a life-hazard protection. As a matter of fact, many companies are finding the grounding advisable on their 440-volt, 3-phase circuits and are so installing them.

SIZE OF GROUND WIRE.

The thoroughness of the ground is a prime necessity, and it should be of such size as neither to burn loose in case of dead ground on opposite primary, nor to deteriorate from the passage of such amounts of current as the blowing of the largest primary fuse may necessitate. Failure to blow the fuse must, of course, subject the secondary to some voltage rise. If 200 amperes be taken as about the largest primary fuse in any given system, the ground on that feeder should easily accommodate that current.

Since the grounding should be permanently good enough to prevent more than say 125 per cent voltage rise on secondary it is evident that with 200 amperes flowing from a primary-secondary contact to one ground 500 feet away at least No. 4 ground wire and neutral would be necessary. A No. 6 wire would cause a 40-volt rise. A resistance in ground connection, even so small as one ohm, would cause a 200-volt rise, which might readily be dangerous, and certainly does not accomplish the full purpose of grounding.

It seems quite evident that for real protection primaries must, then, be generally much smaller than 200-ampere capacity, or far better, that grounds on secondaries to this primary should be in such numbers and thoroughness as to give much less than one ohm resistance. The large proportion of companies using driven-pipe grounds would appear to indicate that such had given absolute satisfaction in the above respects were it not that a majority of these very companies state their distinct preference for the ground to water mains as much more thorough and rugged.

One engineer representing a large number of important operating companies writes, "Ground plates are better than nothing, but the ordinary connection to water mains, if properly made, are entirely satisfactory, and driven pipes can be made satisfactory where soil is moist and where enough pipes are driven."

It generally appears that in very wet places the driven-pipe ground in sufficient numbers and well spaced will give the necessary low resistance and fair life. In all other cases, and especially where few grounds must be depended on for protection against crosses with heavy primaries, the water-main ground is without a rival. Such cities as Denver or Los Angeles could not get any effective service from other forms of ground. Only the best available grounds should be made, since the neutral may by a direct cross with primary be raised to a sufficient potential above water or gas pipes in buildings to cause fire and indirectly life hazard by breakdown to such piping systems, or by high-resistance contacts with them.

Another difficulty, rare, but still occurring, is that caused by small grounds, such as pipes, cones or plates, even where reasonably numerous in locations, where soil freezes to a considerable depth. In this case, the earth surrounding the "ground" becomes practically an insulator. The grounding loses its nature as such, and in event of surface thaw severe shocks have been given between this poor ground and the better conducting top surface.

All this seems to demand that secondaries should be not only grounded, but very well grounded, and further appears to indicate that water-main grounds should be insisted on unless they bring about difficulties of more seriousness than their popularity would indicate.

CONDUIT GROUNDING AND SECONDARY GROUNDING.

Contacts of direct-current wires within conduit may be expected to utilize conduit to some degree as portion of the circuit. If contact be with the neutral, current path is through conduit to its water pipe ground to help balance any uneven loading in the building. If contact be with the outer wire, current path will be through conduit pipe to same neutral and may be expected to quickly blow circuit or feeder fuse, according to location and severity of ground. With a very poor ground in the latter case the fuse might not blow, and with very little unbalancing in the former case current would be very small, in either case not enough to harm conduit, since any large amount of current could only result from such unbalancing as to mean a large proportion of load on one side cutout by open fuse or broken wire, a condition readily seen and quickly corrected. Aside from possible damage in those cases where conduit should be buried in damp concrete, such moderate amounts of direct currents would certainly not injure the conduit itself in any way.

The evidence at hand seems to give a very decided preference to the use, in addition to outside grounding on water pipes, of inside grounds, and particularly the ground to conduit at point near the conduit ground itself.

Comments on Electrical Contracting Business.

Letters Discussing the Subject as Presented in January Issue.

Several letters have been received referring to the article in the January issue on, "Southern Contracting and Electrical Supply Business." In each case a confirmation of the opinions expressed by the letters presented in that articl eis expressed and emphasis laid on the need of a closer organization and more co-operation. The following letters treat circumstances that represent average conditions. The first by a large Southern contractor in a fast growing city of 25,000, gives in no uncertain terms a serious aspect of electrical contracting as now carried on in the average large and small town. The letters follow:

"To further emphasize the fact that in the contracting business credit can easily be obtained for promoting cut-throat competition, the writer will outline a sample of cut-throat competition in its worst form that for the past eight months we have had to pass through.

"The competitor to whom the writer has reference, started business with $250.00 borrowed from a friend. He obtained credit from first one and then another jobber, exhausted his credit with each, and then moved on to the next. This credit was obtained in spite of the fact that the fellow had failed in the electrical contracting field in a city less than one hundred miles from ours a little over a year ago. One of the concerns who had lost in the first failure was paid a few dollars on the old account and credit was again extended. This concern stands to lose now about two hundred and fifty dollars, as we have been informed. We are told that the business owes now over two thousand dollars between four jobbers, with assets of about five hundred dollars. On one large job money was collected for material which was out on the job and afterwards removed from same. On several other jobs money was collected and the work was not completed.

"Cut-throat competition does the electrical industry more harm generally, than possibly any individual member. The public think that you are making money, regardless of what price is being obtained, and when this competition is put to an end and legitimate prices are being asked, the impression is that they are being robbed.

"The above is only written to emphasize conditions through a practical illustration which is worth more than any theory which could be advanced. There are no doubt a great many contractors who have had experiences like the one referred to above, and this is one of the main reasons why the credit of the average electrical contractor is not of the best. It is due to the jobbers as much if not more than the contractors themselves. Incidents like this compel the legitimate contractor to figure work at cost, if he desires to do any, or remain idle and pay those men having a steady job, which would be impossible for any length of time. We have tried doing just enough work to keep our regular men busy, feeling that our competitor could not last always. This, however, has been exceedingly hard to do, as we have lost the electrical work on four of the largest jobs that have ever been built in this city.

"The conditions in this case are in no way exaggerated, as the writer can furnish the names of all parties referred to, from contractor to jobbers.

J. F. Pierce, President Pierce Bros., Tampa, Fla., Discusses Conditions in His Territory and Mentions Unfair Transportation Rates.

"The writer refers in what follows to your discussion of the Electrical Contracting and Supply Business, believing that the questions taken up in Southern Electrician are of great interest to the trade.

"In the writer's territory, within 100 miles of Tampa, there is no organization of contractors and competition is active. The only organization of importance that exists is through about twelve concerns holding memberships in the National Electrical Contractors' Association, the writer's company being one of the twelve.

"For the competition, which is sufficiently active to maintain very low prices, I see no immediate remedy in sight. The credit of the average contractor is not good for two reasons: First, the collection laws in Florida are about as bad for the collector as they could possibly be, and second, too many contractors are inclined to work their credit overtime rather than themselves, probably placing too low a valuation on both their credit and their time.

"We are not, in what is said here, stating that these conditions are necessarily general, for we have some good, straightforward and active men in the business, and believe that these are receiving due consideration, as a rule, by manufacturers and jobbers. Personally, we have no particular complaint to make against the manufacturers, but feel that we have one with transportation companies or the rate-makers governing same. The classification on electrical products is, in our opinion, unjust in general in the South, and in Florida in particular. We have paid one and one-half the first-class rate on goods that should rate about fourth class in the state, and in some instances a first-class rate generally, where a lower rate should apply. These conditions need a remedy, not only for the good of the contractor, but for the promotion of the electrical industry."

F. C. Myers, Managing Editor of Southern Machinery, Offers a Solution for Conditions in Electrical Supply Business Through Publicity.

There is some confusion in the South in regard to the electrical contracting business, and several plans have been proposed as remedies. These plans include high license, strict inspection, supervision of contracting firms by central station managements, giving of bonds to guarantee the quality of work done and other rather impracticable methods. In what follows I shall attempt to give what I consider the most reasonable and practicable way of overcoming the difficulties, discussing principally selling methods.

The trouble lies with the manufacturer of supplies, the jobber, and also with the contractor. I might have added the purchaser, but his reason for aiding in the confusion is due to ignorance. In no line of business is there any limitation as to who shall or who shall not enter the field and endeavor to outdo those already established. There are no restrictions as to who shall open a corner grocery, drug store, meat market, clothing house, or what-not. In fact, they are springing up every day, and also closing out every day. The condition in regard to the supplying of foodstuffs, hardware, or clothing to the ultimate consumer is highly competitive. Occasionally a cut-throat enters the field, but he does not remain, because the people have been educated to demand certain standardized products that are sold the country over at a standard price, which price permits of a living profit to the retailer.

For instance, go into a grocery to get crackers; you do not say, "Give me a nickle's worth of crackers." The chances are that you will say, "Give me a package of Uneeda Biscuits." If you want an axe, most likely you say, "I want a 'Keen-Kutter' axe." The same condition holds if you are buying clothes, meats, you doubtless are well acquainted with the "Ham That Am," "Style Plus" clothes, "Have you a little fairy in your home?" soap, etc. The list is almost without end. The conditions in these fields have been brought about by advertising, not only to the dealers, but advertising directly to the consumer by manufacturers. The unscrupulous manufacturer did not dare to enter the field of publicity. The legitimate manufacturer had nothing to cover, and said so, he told the truth, he called attention to the reasons for the superiority of his goods and the reasons were sound, else the advertising could not have continued and the results would have been disappointing. Let the manufacturers of electrical apparatus start a publicity campaign that will reach the consumer of their wares as well as the jobber, contractor or retailer. To attempt to reach the consumer without proper distribution makes advertising ineffective, and the same condition holds with the dealer. Both links of the chain must be brought to a realization of the "quality" feature of goods and a means established for designating the goods desired.

As soon as the public is brought to a realization that various brands of "wire" may or may not be insulated alike, and that a certain brand can be relied upon for long service under all conditions or that a certain brand is best suited for use under certain conditions and another under other conditions, the unscrupulous contractor and dealer will be driven from the field and the whole business elevated to the position it should hold.

Manufacturers may say, "This plan is not tenable. Usually a customer only wires and fits up one house in a lifetime." Many companies under the same condition find advertising to the consumer profitable. For instance, the furnace manufacturers, roofing manufacturers, manufacturers of fancy brands of facing brick, mantel manufacturers, and manufacturers of lumber especially fitted to certain purposes. Others could be named. The sole purpose of this advertising is to tell why certain brands should be called for and named in specifications and to educate the consumer to call for goods with a name which is known to signify quality and reliability.

Calling for goods by a trade name rather than by simply naming the material wanted, is a growing habit with the American people. Advantage of this is now being taken by many of the largest producers of practically all lines of manufacture. There is no reason why the manufacturers of electrical supplies should not reap the same benefits, and until they do, the cut-throat electrical contractor will prosper and grow fat, while the electrical business as a whole may be expected to fall deeper into disrepute with each job that does not meet expectations.

Briefly, then, the solution I offer is for the manufacturers to get suitable names for their products and then educate the public to call for their goods by name. The advance work has been done by manufacturers in other lines, people buy by name more and more each year and the same methods that have created this condition can be used for electrical supplies.

R. M. Eames, President of the Salisbury Supply and Commission Co., (Electrical Contractors), Writes on Conditions In the Contracting Business.

How many people in the electrical contracting business are making unusual profits? I venture to say few can boast of this. It should be the reverse for many are using electricity in some way, and as a general rule, that for which there is a great demand, enjoys fair profits. In the electrical contracting field this is decidedly not true for in some towns plumbers charge more for their time than can possibly be secured for that of a wireman. Electrical work is just as important if not more important than plumbing, yet very few people stop to consider this view point.

Where lighting companies are operating in a new town or taking over an old one, they invariably push the use of electricity to the limit, which of course reduces the price of wiring. This being the case people feel that to have their house wired is an accommodation not only to the lighting company but to the contractor. The electrical equipment is looked upon as a luxury and something new, and no high or scarcely fair prices would be considered. Where lighting plants are owned by the city, wiring at cost is usually the result. This gives the people an insight as to the cost of work and impresses the idea upon them that the city will do most anything to get them to use electricity. This is in fact nearly true and as a consequence the price of wiring is reduced to such an extent that an independent concern in the wiring business can scarcely make a living. When some "sky scraper" is erected in the town some large outside contractor walks in and does the work. The local lighting company and local contractors look on with astonishment, wondering how these people can do work cheaper than they can. The result is the local people determine to secure all such work in their own town, and slash! the prices are cut. The next large job falls to a local man through his determination to get the business. He bid on this job to get the work, it resulted in a loss, and on the next job that falls his way he makes up with a small profit by "making it pass inspection" with no room to spare, and the chances are that additions or changes may be required.

In many towns this wiring game, for it truly is a real game, is carried to the limit by people who "want the business" and do not plan on making enough on their work to take care of them should any trouble arise. This practice is most often found the policy of the small contractor, who is a good wireman but no business man. The consequence is, small shops start up and then fail, a course in the history of any town that any careful observer will see. In a section of the country where a union prevails the conditions are often better as the best prices for work are charged. This keeps a large number from going into the contracting business for the wireman makes more than he could in business for himself.

Further, fairly good profits can be made on wiring if contractors are friendly and pull together. In these towns where the opposite spirit prevails and the contractors are fighting each other to get all the work and cutting the price of work so they can realize their desire, one man is the loser in the long run and he is the one who has the work done. The job is in good condition for a few years, and then trouble arises. The customer looks for the contractor but to his disappointment finds his shop has been closed for some time. Such work as this customer complains of was the cause of his failure. Part of the responsibility can be contributed however to the customer for giving the work to the lowest bidder and part to the inspector for not being more strict in his requirements. Where small jobs are being done without proper inspection the lowest bidder always gets the work. It is the most expensive in the end.

Now, Brother Contractor, I am located in a town where we all are friendly and a fairly good price is charged for work. The conditions I have cited have attracted my attention for some time in other towns, and I bring them before you for your consideration, suggesting that if fighting and low prices prevail in your town, you should get to work, cooperate and watch your profits increase.

Electrical Plant for South Africa.

The British Trade Commissioner for South Africa has reported that the municipal council at Paarl has been authorized by the rate-payers to apply for a loan for the lighting of the town by electricity. The proposal is to obtain power from a reservoir having a capacity of 121,000,000 gallons, and the whole scheme is estimated to cost $167,700.

Meeting of Society for Electrical Development.

An important meeting is planned for the Society for Electrical Development on March 4 and 5 in the Engineering Societies Building, 29 West 39th St., New York City. The entire electrical fraternity has been invited for the purpose of discussing from all angles tentative plans of the Society for co-operation and general educational work through the electrical and allied industries that will effect practically every individual interest in the electrical business. A complete program of the conference will be published in the near future. Since the policy and plans of the Society are now concrete and of importance to electrical interests in general, a large attendance of the influential men of the industry is expected at this meeting.

Southern Power Company Purchases Power.

The Southern Power Company has recently closed a contract with the Georgia Railroad and Power Company whereby it will take over 14,000 horsepower of hydroelectric energy generated at the Tallulah Falls station beginning September 1, next. This is the margin between the capacity of the plant and the probable market consumption of the developing corporation. Short-term contract was made and can be a terminated at will after the time designated in the bond.

The Southern Power Company will construct its transmission line from Easley, S. C., the present terminus about 15 miles southwest of Greenville, through Liberty, Central and other South Carolina points to Tallulah Falls, the site of the power generating plant. It will there tie-in with the new development and the current thus secured will be thrown into the South Carolina end of the transmission field. It will thus reinforce that side just as the tie-in with the Blewett Falls' power now reinforces the nothern end of the transmission area.

The transmission field covered by the Southern Power Company lines extends approximately 370 miles in length. When this extension is made 50 miles to Talluah Falls, it will there connect with the lines that supply power for Atlanta, Macon and the other great Georgia centers. This will provide a transmission field that covers three States, the two Carolinas and Georgia. The Southern Power Company has a similar contract for short-term power from the Blewett Falls power station described in this issue and the transmission line extends from the power site near Rockingham to Durham, a distance of approximately 110 miles.

Macon, (Ga.), Gas & Electric Club.

The employes of the Macon Railway & Light Company, Central Georgia Power Company and the Macon Gas Company have formed a Gas-Electric Club. The main object of the organization is to get the employes of the three corporations better acquainted with each other and to have discussions every meeting night on different matters pertaining to their work. In this way new ideas are gained that will prove beneficial to every man in his particular line of work. Traveling representatives of electric and gas corporations will be called on by the club when they visit Macon for demonstrations. The gas meter salesmen will be expected to do likewise for the club.

Judge W. H. Felton was elected honorary president, J. W. McLarty, chairman; G. M. Camel, vice chairman, and Emory W. Cabaniss, secretary and treasurer. It was decided that the club should meet every two weeks, the dates to be decided on later. There are about 75 members.

Mississippi Electrical Association Question Box.

Under this heading will appear each month questions and answers to questions from members of the Mississippi Electrical Association. All readers are invited to discuss any question or topic presented. Address all correspondence, including questions and answers, to Clarence E. Reid, Question Box Editor, Agricultural College, Miss.

Questions Unanswered.

QUESTION No. 9. On some series transformers recently received, I find the terminals which are to be connected to the meters short-circuited, with a copper wire, and the instruction tag sent with them states that these terminals should always be short-circuited when the meter is not connected. Why is this?

QUESTION NO. 10. About how many times normal full load current will a modern 3-phase, 2,300-volt, 60-cycle, 40 kw. alternator give on short circuit with normal full load field current?

QUESTION NO. 11. Why is the air-gap between pole-face and armature so much larger in the case of turbine-driven alternators than in the case of other generators of corresponding dimensions?

QUESTION NO. 12. Where may auto-transformers be used instead of two-coil transformers to advantage, and in general, where may they not be used?

QUESTION NO. 13. Kindly explain how an alternating current motor with no brushes or external connections to the armature, is caused to rotate.

QUESTION NO. 14. The common impression is that the older a carbon incandescent lamp gets, the more current it takes. I have been informed by an electrician that this is not so, but I have noticed that an older lamp gets hotter than a new one. Why is this, if it is getting less power?

QUESTION NO. 15. Why re the manufacturers of some modern direct current generators putting slots between the commutator segments instead of mica? Is not there some danger of carbon and other dirt short-circuiting the commutator?

QUESTION NO. 18. In the armature of a 3-phase, 110-volt, 60-cycle, 3-h.p. induction motor, I notice that the conductors are not well insulated from the iron core. The motor is in operation, and seems to be all right. How will the above effect the operation of the motor?

See Questions Unanswered—Nos. 2, and 3, in January issue.

Production of Tungsten Ore In 1912.

The quantity of tungsten ore mined and marketed in the United States during 1912, according to preliminary figures collected by Frank L. Hess, of the United States Geological Survey, was equivalent to about 1,290 tons, carrying 60 per cent of tungsten trioxide and was valued at $492,000, besides which a smaller quantity was mined but not marketed. This is an increase over the output of 1911, which was equivalent to 1,139 tons of 60 per cent ore and was valued at $407,985. The average price paid per unit (the unit is 1 per cent of a short ton, or 20 pounds, of tungsten trioxide) was about $6.35 in 1912, compared with $4.89 in 1911, but the extreme variation seems to have been less in 1912 than in the previous year.

As usual, the largest production from any single district was made from the unique feberite deposits of Boulder county, Colorado. About 1,200 tons of ore of various grades were shipped out, equivalent to 775 tons of 60 per cent ore.

Corrections. On page 68 of the February issue, the word "underground" in Fig. 7 should be "ungrounded." The word "constant" in Fig. 8 should be "continuous." In Fig. 9 the booster connections are not correct, the plus and minus signs for the booster terminals should be interchanged. With the connections as shown and the plus bus the trolley wire feeder, the effect of a series booster would be to lower the voltage. A booster connection for the case referred to would be one connecting the positive bus to the negative terminals of the booster, making the voltage between the booster positive as feeder and the trolley rail the sum of the generator voltage and the booster voltage.

Editor.

New Business Methods and Results.

Representing Interests of Central Station, Electrical Jobbers, Dealers and Contractors.

Treatment of Complaints and Delinquencies.

This is an important and equally extensive subject. If we were to discuss it in all of its aspects, and to describe various methods of handling complaints that have been adopted by various public service corporations, the material could not be contained within the limits of a single issue of this publication. We will therefore give a few hints only and hope to have them elaborated and commented on by our readers.

There are several ways in which a complaint may be regarded and handled accordingly. One way, which has been very common in the past, but which we are glad to note is rapidly disappearing, is to take the stand that the company is always in the right; that its meters never go wrong; its readers never make a mistake; the service is perfection itself; the customer is a chronic kicker and if he doesn't like the way he is treated, he can do otherwise.

Another way, which is almost as bad, is to regard complaints as a bore, as a disagreeable but necessary duty. In such a case the idea seems to be, not to shirk the duty, exactly, but to grudgingly give the customer the least attention that will in a "half-hearted sort" of a way satisfy him, and smooth the whole thing over as quickly as possible. The idea is maintained, if not openly so that it may be inferred, that the general manager is far too busy to devote his attention to such trifling things as complaints. The complaints are handled in such cases by the office boy or some minor clerk, whose assurances to the irate customer that the matter will be well taken care of, are anything but satisying.

Fortunately, as we ascend the scale of common sense, we note a far better way of treating complaints, which is to welcome them as showing weak spots in the service or the organization that are open to improvement. Then follow the remedy as promptly and as effectually as possible, and take steps to prevent the recurrence of the same sort of complaint. In case of disputes, such policy advises treating the customer with courtesy, admitting that he is as likely to be right as the company, and in every way giving him a square deal.

While this is an admirable policy, we believe that there is a better one for we consider that every complaint has a still greater significance then yet mentioned. As we have already stated in these columns, public service corporations on account of their democratic nature are more dependent upon public favor for their existence and prosperity, than any other class of business. It is therefore essential that they should have not only the passive good-will, but the active favor and confidence of their customers. They secure this only to the degree that they get into personal touch with them. Now a complaint offers an opportunity, *par excellence* for coming into a close personal touch with the customer, and the treatment he gets at such a time will do more to create an active sentiment of friendship or hostility than months of ordinary dealings. A complaint courteously and well attended to, is often the means of changing a dissatisfied customer into a boosting friend, while a few neglected complaints will very easily turn friends into "knockers." In fact, it is hardly stating it too strong to say that the consensus of public opinion regarding a corporation, depends largely upon treatment of complaints. And why should it not be so? The customer who has never had occasion to call upon the central station for anything in the way of adjustment, but has each month used his light and paid his bill, with no circumstances arising which required special communications, has not and cannot have the crystalized opinion of the company that a man has who has had two or three complaints to settle up.

Perhaps the one single thing of greatest importance in the treatment of complaints, is to refer them to and see that they are attended by some person of even temperament, good judgment, and of sufficient authority to make adjustments on the spot if the nature of the case permits. The capability of handling complaints so that every one adds to the company's stock of good will, is a rare qualification, and a public service corporation is fortunate when it can find a man of this caliber for this important duty. In small concerns it would be best, no doubt, for the general manager himself to personally take care of complaints. The larger companies nearly all have complaint bureaus with a department head of more or less responsibility. For the company of moderate size the contract agent, or commercial manager is perhaps the most logical party, as he is in closer touch with commercial conditions than anyone else. Whoever is selected, however, should be supported with the iron-clad rule that all complaints should come to his attention. This does not mean that nothing can be attended to without waiting his approval, for this would often bring a hardship to a customer, but the complaint adjuster should be advised as to the nature of the complaint and what was done. A classified record of these complaints and the steps taken to prevent a recurrence, is a valuable file for the complaint adjuster.

DELINQUENCIES.

Delinquencies are delicate matters to handle in any line of business. The problem is, of course, to collect the bills without offending the customer. Public service corporations have not had as serious losses from delinquencies as many other lines of business, because the great majority of them have such iron-clad rules in regard to settlements that nearly every customer knows that failure to pay the bill means prompt termination of service.

No one therefore expects a public service company to continue to furnish service without payment, altho there are a few persons to whom every request to pay up is an insult. It is, however, universally recognized as bad business to allow debts to accumulate, both from standpoints of creditors and debtors. Prompt settlements are best for everyone concerned, and an enforcement of rules for prompt payment, in the right way, is really a blessing in disguise.

However, the position of advantage possessed by public service companies in the matter of collections, has led a great many to become so harsh and arbitrary in enforcing their rules, that without gaining anything in the w of results, they have seriously offended many otherwise good customers. Some instances of this have been admirably set forth by a contemporary in an article on "Go-To-Hell Correspondence." Such statements made that "The current will be positively shut off within three days unless immediate payment is made" and that "Positively no discount will be allowed after the expiration of the discount period" can not be calculated to create feelings of peace and good will, especially when they are flaunted in the face of the customer at the wrong psychological moment, when perhaps something has happened to justly create the delinquency or a delay of payment entirely beyond his control.

We are not urging that the rules made by a compa·· should not be enforced, but we do urge that courtesy and politeness characterize the correspondence necessary in such cases, and that no arbitrary rulings be summarily enforced but that sufficient investigation be given to show whether or not such action is necessary. Almost any fair minded man will appreciate the necessity of rules regarding the matter of payments and discounts, and it is not necessary for the company to apologize in regard to them. What he does expect however, is a treatment with consideration and common sense.

Of course there are public service customers who will take advantage of the company whenever they can, and it may frequently be necessary to enforce the rulings to the letter. Even then every effort should be made to refrain from unnecessarily arousing the anger even of these, and they should be left without the shadow of an excuse to make any claim that they were ill-treated.

The collection of delinquent bills is rather a distinct matter. We may briefly say that persons owing the company may be divided as follows: First, those who dispute the bill, and would pay if the matter could be adjusted to their satisfaction. In such a case there is but one adequate solution and that is to make the adjustment satisfactory. This does not necessarily mean that the company must be "easy" and give in to every claim made by a customer, but it means this. The customer honestly thinks that he is right. He has no intention of evading payment, but he does not want to pay a charge which he thinks is unjust. There are practically no cases which, when both parties are anxious to do the square thing, cannot be satisfactorily adjusted. The second case is where the former customer would like to pay the bill but is not able. If he is not able to pay for electric services at present, there is practically nothing that can be done. If he is able to use service, there is a good chance to collect the old account by taking him on as a customer, and collect a small amount of the old bill each month together with the current bill. This method may be the means of saving many a customer.

The third and last class consists of those who do not dispute the bill, are able to pay it, but refuse to do so. In this class, we think it would be well to collect by legal process or at least bring strong pressure to bear upon them. Deliberate dead beats are a menace to any community, and should not be allowed to operate any longer than to find them guilty.

In the ordinary course of business, the monthly bill is rendered bearing on its face a statement of the period during which discount will be allowed. If not paid shortly after the expiration of the discount period, it is the usual practice to send either a collector or a second notice. The written notice is perhaps the better method for collectors employed for this purpose by public service corporations tend to develop an arbitrary attitude towards the customer, and in such cases do more harm than good. The second notice, while it should be courteously worded, should plainly indicate the necessity of immediate action, either by payment, or in cases where there is any dispute as to the bill, by making a claim for adjustment. If this does not bring results, of course a final notice becomes necessary. Before sending this notice, however, the matter should be reported to the contract department, and a solicitor sent to investigate the case and see whether or not the cut-out can be prevented. It is surprising how many contemplated cut-offs can be avoided by skillful handling. The solicitor being primarily a business getter looks more at the customer's point of view than any employe of the auditing department or treasurer's office, and can usually get better results in cases of this kind.

If this method is followed, the first class of delinquents will be entirely eliminated. The second class will be partly lost, but left in such a way that they can be approached for reconnection if their circumstances improve. The last class, which, fortunately, is a small one, the company is much better off without.

If the disconnection actually occurs, it goes without saying that the solicitor in that district should be notified, and if immediate reconnection cannot be effected, the party kept in mind for future business. A. G. Rakestraw.

R. B. Mateer, Manager Agricultural Sales, Great Western Power Co., San Francisco, Cal., Comments on the Subject of Complaints.

Complaints are comparatively few where current is used for industrial and agricultural purposes, by reason of the care exercised when the motor-operated apparatus is installed, securing a high over-all efficiency.

The greater number of complaints originating in residential sections, are primarily due to two causes: First, the tendency to use a cheap and inefficient lamp, resulting in a high current consumption and a minimum of light; second, the tendency to plug onto the circuits, the small electrically heated appliances, little or no consideration being given to the consumption of the appliances.

Most of the complaints originating in residential sections can be satisfactorily adjusted when a little patience is used by the representative of the company in explaining the cause.

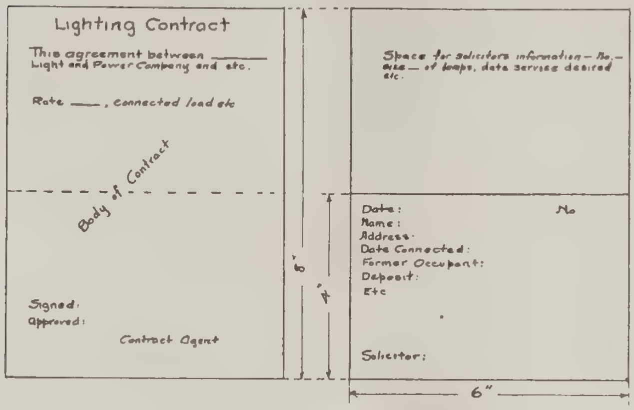
Contracts and Service—A Discussion of Material in Last Issue.

We are glad to note several comments on the nature of contracts in the February number, and that the contributors agree fairly well with the editorial views, expressed in the same issue. The similarity of opinions seems to indicate that the practice of different companies while varying somewhat is largely built up on the same general principles.

The policy of the Chattanooga company is admirable. We question only the optional method of determining whether or not late remittances are subject to discount. This might very easily lead to discrimination or else cause this provision to become a dead letter.

In the case of Salt Lake City, it would seem that the deposit is rather high, as $5 will usually cover two months' bill for the majority of residences, and even for some small stores. We would be glad to have Mr. Mendenhall give his opinion as to whether this ruling has shut out any business that could otherwise be obtained. We also appreciate Mr. Mateer's statement of the conditions in California, and heartily agree with his remarks concerning the wording of contracts.

As to the form of contract, aside from the wording, we illustrate herewith a form, which, as far as we know has never received unfavorable comment, but on the contrary



A USEFUL CONTRACT FORM.

has proved admirable in handling. We would be glad to have readers' opinion of it. The form is 6 by 8 inches, and is printed on a stiff and tough but not heavy bond paper. It folds in the middle and just fits a 4 by 6 inch card index box, displaying on the side facing the front of the box, all of the essential information required for filing and handling. The wording, which but seldom need be referred to, is on the inside.

A. G. Rakestraw.

Athens Railway & Electric Company Establishes New Commercial Department and Celebrates Opening of an Electric Shop.

The history of the Athens Railway & Electric Company, of Athens, Ga., has, since its organization in 1894 with a plant capacity of 80 kw., been a series of successes causing the construction of one new plant after another and at the same time necessitating additions to those in operation. The company now has a plant capacity of 6,700 kw., in three waterpower plants and one steam turbine auxiliary station with a capacity of 1,500 kw., in which will soon be installed a new 2,000 kw. turbine. The connected load includes 4,000 horsepower in motors, over 35,000 fifty-watt equivalents in lighting (two to every inhabitant) besides 227 arc lamps and some 500 flat irons and smaller devices. In addition to this service, the company operates a street car system.

During the latter part of 1912 the H. L. Doherty organization of New York City, was interested in the Athens Railway & Electric Company, and its future development from a financial standpoint is now assured, backed by an organization of great financial strength and stability and of more than national reputation for engineering, constructive and administrative ability. The Greek letter emblem, "Delta" of the former organization has been adopted by the Athens company, as shown in Fig. 1, since it carries with it a significance of progress in electrical affairs through its past associations in this respect.

The most recent development and the one toward which the management feels most optimistic, is the establishment of a new business department in charge of Mr. A. H. Sikes, a new business expert who has had a varied experience and been connected with the H. L. Doherty Company, of New York, for a number of years, and sent by them to Athens as new business manager. Mr. Sikes came South in November of last year, and before assuming any of the duties of his office, first met every business man of the city and talked over in detail his plans and theirs for the future of Athens. Through this evidence of his first and main desire to work for the betterment of the city's interests, Mr. Sikes at once made friends of all the business men, who now one and all express the hope that Athens has touched his heart and made him a permanent citizen of this classic city.

THE ATHENS NEW ELECTRIC SHOP.

On account of the location of the main and executive offices of the Athens Railway & Electric Company at some distance from the business thoroughfares of the city, it has

A. H. SIKES, SALES MANAGER ATHENS RAILWAY & ELECTRIC COMPANY.

seemed advisable in order to facilitate the carrying out of commercial campaigns to open an electric shop for the display of electrical devices and as a central headquarters for the sales organization.

The entrance to the electric shop and its electric sign is shown in Fig. 1. In its size, fittings and arrangements, it is equal to and surpasses in many respects the display rooms of a much larger city. The front of the electric shop was designed with particular reference to the needs of an electric office. The door is on one side and is very heavy and massive and fitted with beveled plate glass, leaving a clear window space of nineteen feet. Over the window on the small panes is painted in transparent letters the words, "If It's Modern, It's Electrical." Hanging from the transom bar is a cream-colored silk curtain. Practically all the stores in the city are painted green or red, and for that reason and to make the electric shop distinctive, it was decided to paint the front a light cream color and finish it in French enamel. This color scheme brings the location into great prominence. There is no bench in the window, it being on the floor level with the glass extending to the floor.

A movable background is made of screens to match the interior finish so that any size display can be made. It is an easy matter with this layout to install model kitchens, living rooms, machine shops or any other large displays.

The interior woodwork and furniture is all of a very dark oak. The cushions on the furniture are of red Spanish leather, and the wainscoting is finished to match. Several ferns and palms add to the appearance of the room. The cashier's cage is in the rear and the display tables are so arranged that every one wishing to pay bills or exchange lamps must pass the entire display. No desks are used, it being thought best to depend on plain writing tables and a good filing cabinet so that all company business is easily accessible in case of absence of any employe. A small ladies desk is installed for the convenience of customers and stationery is supplied.

The wiring and lighting of the office is exceptionally complete. The main lighting of the room is furnished by seven 500 watt Mazda lamps in Veluria, Urnolite fixtures. The window is lighted with twenty 100 watt Mazda lamps in X-Ray scoop reflectors installed along the transom bar. The connected load is 5,500 watts in 1,300 square feet. Two G. E. 16-inch oscillating fans are permanently attached to each side wall, the connection being made under the base, and openings are available for other fans in various parts of the room. Along each side wall above the wainscoting are flush receptacles spaced five feet apart so that electric devices can be plugged in anywhere. Five more receptacles are in the baseboard in the windows for connecting window displays. In the ceiling above the window are four outlets for connecting up fixture displays. The cashier's office is lighted from a bowl fixture set in the ceiling with a No. 700 X-Ray shade equipped with a 60 watt Mazda lamp above it. The wiring is so laid out that it is believed it will never be necessary to run any exposed or temporary wiring for any purpose. A fifteen kilowatt transformer supplies the store and decorative lighting.

The electric sign, shown in Fig. 1, consists of the delta and trifoil emblem of the Doherty Company, surmounting the roof, with an electric fountain effect radiating therefrom for a height of twenty feet above the roof and eighty feet across. Under this display is the name of the "Athens Railway & Electric Company" in electric letters. In the center of the building is a vertical sign reading "The Electric Shop," on either side of which is an electric arrow four lamps wide and thirty feet high pointing downward to the store front. The lamps in the arrows and in the fountain are in constant motion. Several colors of lamp caps are used to enhance the effect. It was generally conceded on the night of the opening that the display ranked high with any in the South.

Fig. 1. Electric Sign Over Entrance to Athens Electric Shop.

On one side of the company's sign is an electric soda fountain and on the other a sign of the Buick Sales Company. All the signs, with the exception of the company sign in Fig. 1, were furnished by the Greenwood Advertising Company.

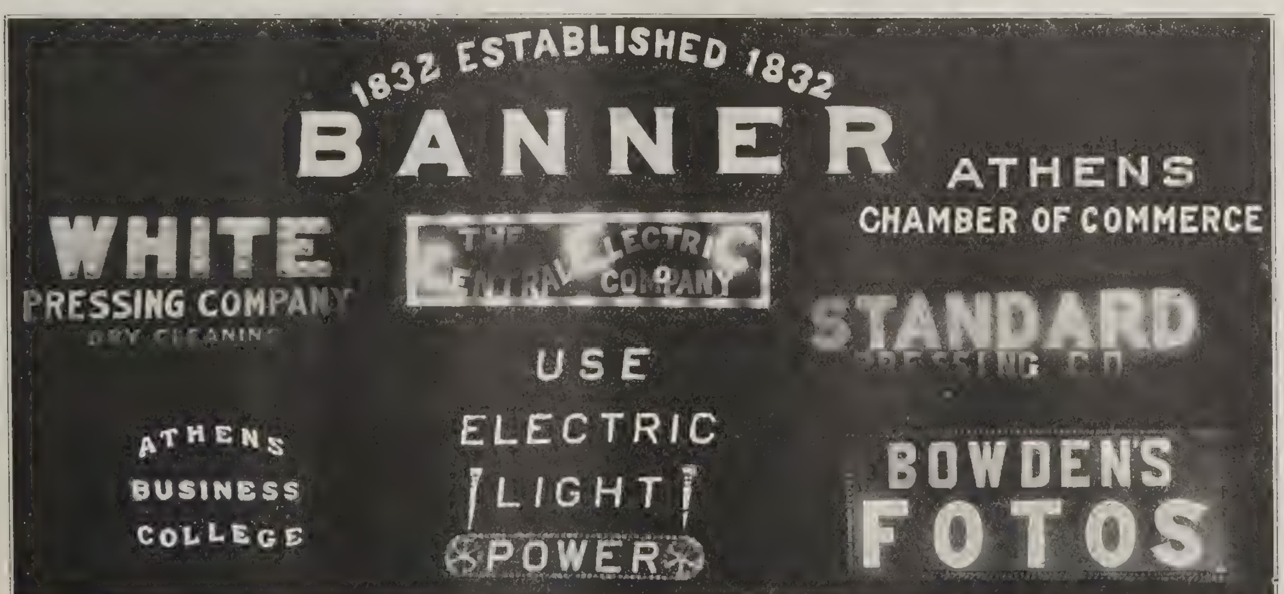


Fig. 2. Some of the Signs Recently Installed at Athens, Ga.

OPENING OF ELECTRIC SHOP FEBRUARY 15.

The opening of the electric shop took place on Saturday night, February 15, a date set some thirty days in advance for the sale and erection of twelve electric signs containing 5,000 five watt lamps. A few of these signs are shown in Figs. 1 and 2. Although it was thought by all who had watched the construction of the large signs that it was impossible to complete all of them by the night of February 15, by working night and day the entire work was completed as planned.

The selling of the electric signs was carried on jointly by the members of the sales department of the company, and the representatives of the Greenwood Advertising Company. Mr. H. O. Bourkard, assistant manager of the latter organization, was on the grounds and through personal visits on merchants and a series of letters mailed to the prospective purchasers of signs discussing the importance of sign advertising and the boosting power they have for a city and its business establishments, the signs were placed in the quickest and most satisfactory manner. Arrangements were made by the Athens Railway & Electric Company with the local contractors, the Taylor Electric Company, the Central Electric Company and the Athens Engineering Company to install the signs, the customer being allowed to pay for them in convenient monthly payments with their monthly curent bills.

At 7 o'clock on the night of the 15th, all the electric signs of the city flashed their greetings with the opening of the door of the electric shop to the public for a reception. The interest shown in the activity of the newly created department was most strikingly evidenced by the throng of people that crowded the electric shop to congratulate Manager Sikes for his successful work against all odds. Music was furnished by an orchestra and carnations given the ladies. It was evident that considerable admiration was felt for his ability in pushing forward the work with apparent ease and his assurance that time was plenty for the work he had planned. In fact, a few of the older electrical men familiar with construction work, were not a little worried when at 4:30 on Saturday afternoon one whole sign, 20 x 30 feet in size, except for the frame, was not completed. However, when 7 o'clock, the appointed time, came, the letters and flashing details were in place and this sign with the rest was ready, wired and lighted. Such is the result of accuracy in judging the ability of men, born of experience and possessed by Manager Sikes.

Certainly on the night of February 15 Athens was one if not the brightest, of cities in Georgia, and there was every assurance that the sales department is well organized and has before it a fertile field in which to push its work. Those who were present from neighboring cities commented on the interest shown by the local people, who from the inquiries they have made in regard to cost and operation of electric ranges, vacuum cleaners, electric irons, percolators, toasters, grills and other devices, made it plain that a number of these devices will be connected to the lines of the company with little effort.

When an observer asked for an explanation of how such interest was created in the brief period of a few weeks, everyone responded, "Mr. Sikes did it. He knows the advertising business and in and through his plans creates the respect and admiration of all who come in contact with him." The spirit of the Athens people is plainly appreciative of the activity of the Athens Railway & Electric Company in boosting their city. Mr. H. J. Rowe, mayor of Athens and editor of the Athens Banner, voices this feeling and has the following to say in the main editorial of an electric issue of his publication on the Sunday following the celebration of Electric Night:

"The Athens Railway & Electric Company has always been a progressive concern, but within the past few weeks under the direction of the new sales manager, Mr. A. H. Sikes, it has been demonstrated that it is here to serve the people in the highest capacity.

"The new office of the company on Clayton street is an ocular demonstration of what has been done and what is to be done. It is all well and good to know what can be done by electricity, but it is better to have these things amply demonstrated before your eyes. That is what the people of Athens will be enabled to see and understand at the new office on Clayton street. After a visit there you will fully realize what you have been missing by not having on hand in your houses and places of business the latest electrical contrivances.

"Manager Sikes is here to demonstrate what an agency for development of a city electricity can be made. He is full of energy and ability and has already shown the people that the Athens Railway & Electric Company is at their service in every possible way when it comes to working for the upbuilding of the city.

"The success of 'Electric Night' served to show to all the merchants of the city the need for better illumination. It ought not to be difficult now to launch the movement for a Great White Way and carry it to success."

The electric issue above referred to is no small indication of the progressiveness of the city and the way it takes advantage of its opportunities. It consisted of three sections of twenty pages, and besides containing the regular Sunday features, gave a full account of the electrical activity of Athens, presenting historical reviews of developments, plans for the future, and full page displays of the plant equipment of the Athens Railway & Electric Company, together with the electric sign displays erected by the merchants. In making possible such an edition, credit is given to Sales Manager Sikes for his hearty co-operation.

Eugene Creed, New Business Manager of the Lexington Utilities Company, Writes of Electrical Activities In Lexington, Ky.

Undoubtedly the busiest little city in the United States is Lexington, the capitol of the Kentucky blue grass country. While strictly an agricultural center, it teems with life; the business men are wide awake, the people prosperous, and as has always been known, the women beautiful. This city has the distinction further of being the largest loose leaf tobacco market in the world, the center of the thoroughbred horse trade and not least in importance, falls not far from if it is not, a city with more electric signs illuminating its business center, than any other of equal population on the North American continent.

The Kentucky Traction & Terminal Company, which controls the Lexington Utilities Company, the City Ice Company and the Lexington Gas Company, operates interurban lines extending to Georgetown on the north, Versailles on the south, Paris on the east, and Frankfort on the west, thus covering practically the entire blue grass country.

The Lexington Utilities Company serves Lexington with electrical energy for light, heat and power. A modern power plant has lately been installed as described in the electrical press. A new business department has only recently been instituted with the writer in charge, and the prospects

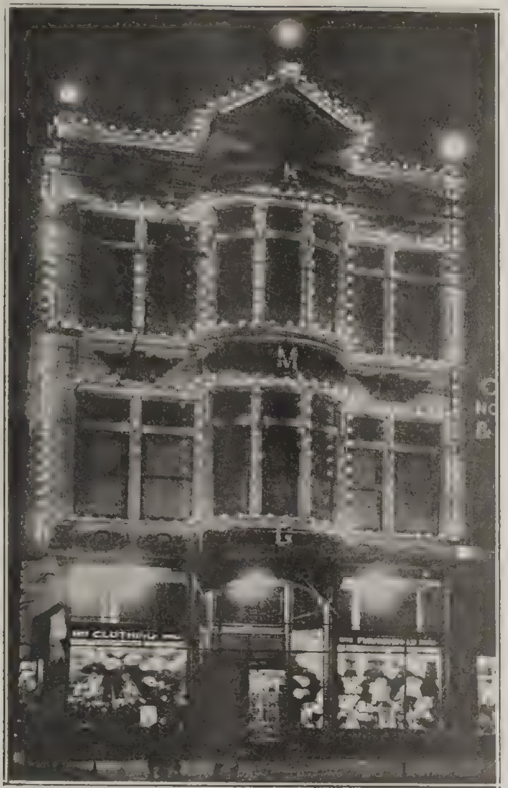


Fig. 1. Outline Lighting of Clothing Store.

look especially bright for extensive work in this direction. A systematic campaign for new business is being conducted and results secured in the face of the sale of natural gas at 35 cents per thousand cubic feet.

As already mentioned, electric signs predominate in Lexington. As the visitor who enters the city by night, leaves the beautiful Union Station at the east end of town, an immense electric sign, 38 x 25 feet, presents a burning greeting. Up and down Main street are other numerous electric displays, a few of which are shown in the accompanying illustrations. The Federal Sign System (Electric) has a branch office located in Lexington under the management of Kenneth P. Crouse, at one time the new business

Fig. 3. Showing a Number of Lexington Signs and White Way Posts.

Fig. 2. Dancing Girl Sign at Colonial Theater.

manager of the Licking Light and Power Company, of Newark, Ohio, and many of the signs shown were furnished through his office.

The location of some of the important displays are as follows: At the corner of Main street and Broadway, one of the busiest spots in the city, two large buildings are outlined with Mazda lamps. Looking west on Main street, one sees the "Old Elk" whiskey sign. One of the principal banks in the city has shown a faith in the pulling power of electrical advertising by operating a "Drop a Dime" sign as shown. The "Dancing Girl" attracts thousands nightly to the Colonial Theater. Another, the "$15 Suits," attracts the younger or more economical purchaser. The garage proprietors find electric signs a necessity in Lexington, while the Seelbachs Hotel, through a sign of this name, attracts the traveler.

It is often now said that prior to the launching of the electrical advertising campaign in Lexington, few promenaders were found on Main street after dark. At the present time quite the contrary is the rule, for thousands pass and repass along this street at night. Brilliant boulevards also bring business as has not only been found true in Lexington, but in other Southern cities. These are all being worked to bring Lexington into its own.

Central Station Co-Operative Advertising.

The cost of preparing a complete advertising campaign is almost prohibitive except for a few of the largest companies. A good advertising drawing costs from twenty to fifty dollars. Add to this the cost of preparing copy, obtaining cuts, etc., and the total for a year's campaign of 125 to 150 advertisements is enormous. Yet the progressive manager is realizing that good newspaper advertising will bring him new customers and will also greatly increase the consumption of current by his present subscribers.

The problem therefore of obtaining good advertisements at a moderate cost has been solved by co-operation. The advertisements used by the Commonwealth Edison Company, of Chicago are widely known and are prepared by the Wm. D. McJunkin Advertising Agency of Chicago and New York. This company has now perfected a co-operative scheme where the companies co-operating are using the same advertisements in their various cities. They receive a reserve supply of 25 advertisements when commencing the campaign and thereafter receive ten advertisements monthly which are prepared on timely subjects. A matrix is supplied for each advertisement so there is no further cost for cuts. A valuable feature of the service is the fact that while the matrix is furnished for the illustration only, the proof submitted shows both drawing and copy. Thus the proof may be followed for style of type, set-up, etc. and the copy may be revised or entirely re-written if wished. Many of the large companies having advertising departments prefer to do this and these companies find the service a great economy for the illustrations supplied and for the suggestions contained in the copy. The expense of preparing the advertisements is divided among the companies participating, making the cost very moderate for the individual company.

Why Electric Light Bills Vary.

An ingenious arrangement has been worked up in the form of a chart by the Commonwealth Edison Company of Chicago and used in newspaper advertising to explain why the amount of electric light bills varies during the months of the year. This chart is shown in the illustration herewith. As will be seen at the top of the chart, its length

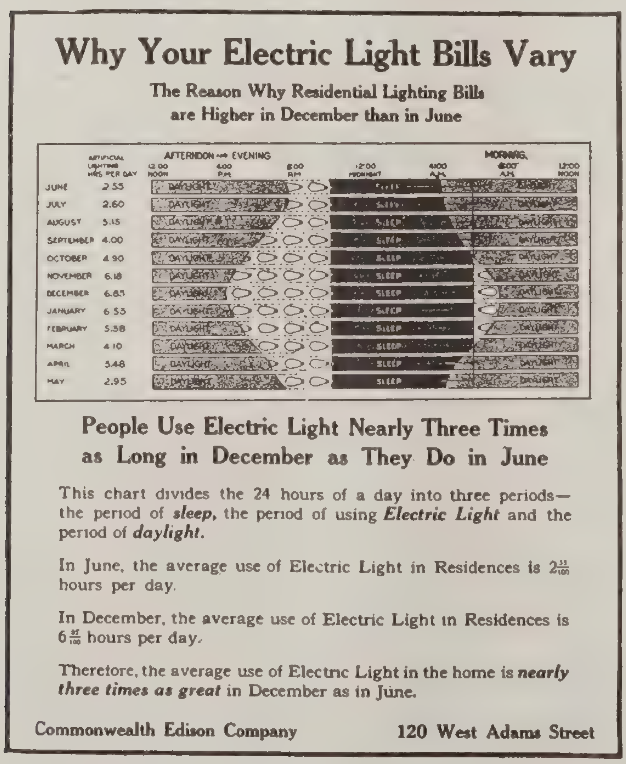


CHART SHOWING HOURS USE OF ELECTRIC LIGHTS DURING 12 MONTHS.

represents 24 hours, from 12 o'clock noon. The 12 horizontal strips represent the months of the year with the division lines between daylight and darkness indicated so as to present a graphic representation of the actual hours use of electric lights pe rday when retiring at ten in the evening and rising at 6 in the morning.

C. A. Knight, of Meridian Light and Railway Company, Describes a Unique Window Display.

The photograph of a show window shown here was recently used to advantage in a house wiring campaign.

The object of the window display is plain and convincing. The houses were made from ordinary lamp boxes, with the aid of a jar of paste and a pair of scissors, the windows being covered with tracing paper. The entire window was lined with a sky blue cloth, the ground was represented by a green paper, the background being ordin-

A UNIQUE WINDOW DISPLAY.

ary wall paper border of a forest design. The fences were made from small strips of wood, the road of ordinary sand and the trees were the tops cut from small ordinary pine trees. Taken as a whole, the window was very inexpensive, one that attracted quite a little attention and we believe did some good.

Progress of Electricity in China.

The report of the electrical engineer of the Shanghai International Settlement, just published, contains matter which should be of interest generally to American manufacturers of electrical supplies. Chinese merchants in Shanghai have taken up electric advertising during the past summer to a surprising extent, and now the large stores on Nanking Road vie with one another in the splendor of their shop fronts.

It has always been the custom among the Chinese to drape the store on opening day in red hangings of silk coverered with pictures of fairies and genii and inscriptions of good omen. When coming of evening lanters would be suspended among the hangings and illuminated by candles. This has all changed onw. First the Japanese brought in electric advertisements for their patent medicines, and now the Chinese merchant sprinkles a galaxy of electric lights all through the hangings that cover the front of his newly opened store.

It is also interesting to note from the report that the Chinese cotton mills are beginning to use electricity for power in the mills. It all goes to prove that they are quickly adopting conveniences furnished by electricity, although such things usually begin as fads. One of the most interesting parts of the engineer's report refers to the suitability of the electric motor car to the needs of Shanghai.

Questions and Answers from Readers.

We invite our readers to make liberal use of this department for the discussion of questions as well as for obtaining information, opinions and experiences from other readers. Answers to questions or letters need not conform to any particular style. All material is properly edited before publishing it. Discussions on the answers to any question or on letters are solicited, however, the editors do not hold themselves responsible for correctness of statements of opinion or fact in discussions. All published matter is paid for. This department is open to all.

MOTOR CIRCUIT WITH GROUND RETURN.

Editor Southern Electrician:

(356) When a 110-volt D.C. motor has one side of its armature grounded through a rheostat about 55 volts is registered between the ground and the other side of circuit. What are the reasons for this method of speed control? Please show by a formula how the speed is reduced and how the voltage of the 110-volt circuit is reduced to 55. Is it practicable to run one wire any distance to a compound motor using the ground for return? Can a single-phase motor be connected as mentioned above? When one side of a single or three-phase circuit is grounded, what is the voltage between any other wires and the ground? H. A. R.

GROUNDING SECONDARIES.

Editor Southern Electrician:

(357.) Please publish information on grounding transformer secondaries and the case, giving the proper point to attach ground wire on the secondary coils and the case. What sizes of wire should be used relative to capacity of the transformer? A Reader.

WHY DIFFERENT SPACING OF WIRES ON TRANSMISSION LINES OF SAME VOLTAGE.

Editor Southern Electrician:

(358.) It is known that the spacing of high tension line conductors varies for different systems of approximately the same voltage. The writer desires to know if there are definite conditions that determine the spacing, that have been formulated so that the spacing for any voltage can be calculated. It is known that the closer the wires, the reactance of the circuit is reduced, this having a favorable effect on line drop. It is further known that as the wires come closer together the capacity increases. Is the spacing therefore a happy medium between these two conditions or are there other mechanical or electrical reasons? Referring to cases of variation in voltage, in your September issue it was stated that the 110,000 volt system of the Georgia Railway and Power Company from Tallulah Falls has a spacing of 9 feet, 4-0 and 2-0 copper being used. In your January issue, it was stated that the 110,000 volt system of the Mississippi River Power Co., from their plant at Keokuk, use a spacing of 10 feet. This system uses, however, 300,000 c. m. cable, but spaced in a vertical plane, the tower being practically the same design as the ones used by the Georgia Railway and Power Co. It has occurred to the writer that the use of the cable may introduce factors. W. E. C.

Coal vs. Wood As Fuel.

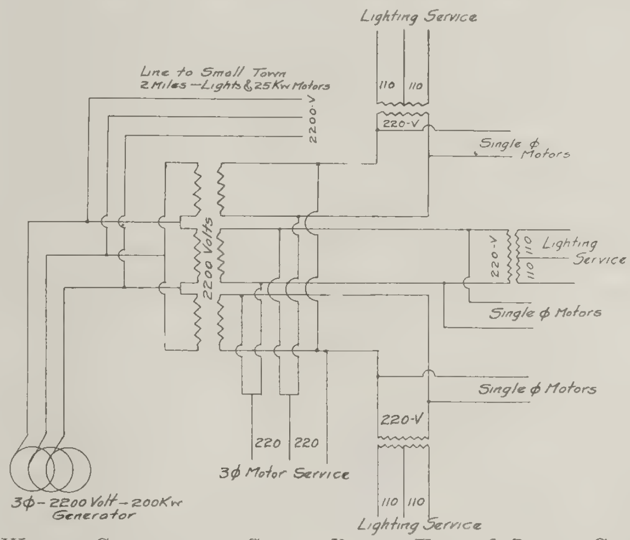
Editor Southern Electrician:

(359.) The writer desires to know how to figure a comparison of coal and wood as fuel in the boilers of a small station. How much long-leaf dry pine wood 4 feet long and green slabs of the same length equal a ton of soft coal. The slabs can be secured for $2.25 per cord and the dry wood for $3.00, while soft coal is $3.75 per ton. The wood is plenty and most of it is what is known as "fat pine," rich in pitch and turpentine. H. E. S.

3-WIRE SYSTEM FROM 3-PHASE GENERATOR.

Editor Southern Electrician:

I would like to know the objections to the wiring arrangements shown here if all secondary lines are loaded so as to maintain a balanced load on the three step-up transformers. Would not this scheme be more economical than single phase generators and single-phase motors for the



Wiring Scheme for Single-Phase From 3-Phase Generator.

power load? The day motor load is about 175 kw. and night load about 195 kw. Would it be more economical to install one single phase and one 3-phase machine arranged to belt to the same engine, operating the single phase at night and the 3-phase during day time? H. W. Wallis.

TRANSFORMERS FOR DIFFERENT SIZE MOTORS.

Editor Southern Electrician:

In an industrial plant where there are to be installed four three-phase 220 volt motors, one 50 hp., one 25 hp. and three 5-hp. induction motors is it advisable to install a separate transformer for the 25 and 50-hp. motors? Will the starting of the large motors seriously effect the voltage and operation of the smaller motors? Would it not be advisable in this case and cheaper to install the 3 small motors as single phase, one across each phase of the secondary of the three transformers feeding the two large motors?

H. H. Williams.

Questions Unanswered in 1912 Issues.

DESIGN OF STEEL TRANSMISSION TOWERS.

Editor Southern Electrician:

(322.) There seems to be a variety of designs of transmission towers used by the high tension hydro-electric companies. What are the advantages claimed for the two and three-legged types, a combination of two three-legged towers for a double circuit, and the four-legged tower of wind mill type, for double circuit? What are the factors that determine the arrangement of conductors whether in a vertical plane or equilateral triangle? W. C. T.

SIZE OF UNITS FOR 25,000 KW CENTRAL STATION.

Editor Southern Electrician:

(328.) In a well developed city of from 40,000 to 60,000 inhabitants where it has become necessary to redesign or install a new steam generating station, what are the conditions that determine the suitable capacity of boilers and generators to take care of the natural increase in future demands upon the plant? What is now considered present practice in the capacity of boiler units with economizers for a turbine plant of 25,000 kw generator capacity? Assume a case giving load curve under average operating conditions and show how to select sizes of units. W. C. D.

COST OF STEEL TOWER TRANSMISSION LINES.

Editor Southern Electrician:

(324.) I would like to ask through your question and answer department that some reader give data on the cost of a complete steel tower transmission line of single and double circuit design. I would like such data to include cost of towers, insulators and clamps and the labor necessary to assemble and erect towers and lay foundations. The part of the total cost per installed tower or per mile of line is desired for each item in the construction of lines of over 66,000 volts. If possible data on any special structures should be given separately. G. S. M.

RATING OF SWITCHBOARD PANELS.

Editor Southern Electrician:

(333.) Kindly advise through SOUTHERN ELECTRICIAN by publishing a formula or other directions, how to determine the ampere ratings of switchboard generator, feeder and induction motor panels for A. C. plants. What instruments are required on the generator and feeder panels? How is ampere capacity of buses for the switchboard computed? Determine the above conditions for a plant having one 100, and one 200 kva. generators, giving sizes of panels and number for street and residence lighting and for factory motor service. The largest A. C. motor is 50-hp. and the motor load is about 150 kw., the lighting load at peak 250 kw. Voltage of generators is 480, at 60 cycles. G. D. W.

USE OF SHUNT RESISTANCE MULTIGAP LIGHTENING ARRESTERS.

Editor Southern Electrician:

(334.) Can the same shunt resistance multigap lightning arrester be used on a grounded *Y* system and on a delta and ungrounded *Y* systems without changes? If not, what changes must be made? Give skeleton diagram, and explain. H. H. T.

FUSING SECONDARY CIRCUITS OF DISTRIBUTING TRANSFORMERS.

Editor Southern Electrician:

(339.) We have several banks of transformers on our residential system but not all in any bank are of the same size. After reading the answer to question 317 on banking transformers by Mr. Seidell, I would like to know if there is any condition which would interfere with using fuses to divide the secondaries into sections so as to locate any trouble due to short-circuits? If so, please explain. H. W. W.

Poles of an Induction Motor. Ans. Ques. No. 329.

Editor Southern Electrician:

Properly speaking, an induction motor has no poles in the sense that a direct current motor has, that is they are not located so that we can point out where one leaves off and the other begins. The field of the induction motor is not stationary but rotates. If a coil be wrapped continuously about a ring shaped core, and connect at three equidistant points to a three phase circuit, we would have a rotating field, and yet could not designate any certain poles. If for instance at a certain instant the resultant field would be in a horizontal position it could be seen by a simple consideration of the change in current values that at a succeeding instant that it would be at some angle from the horizontal and so on, rotating in a certain direction either clock wise or counter-clock wise.

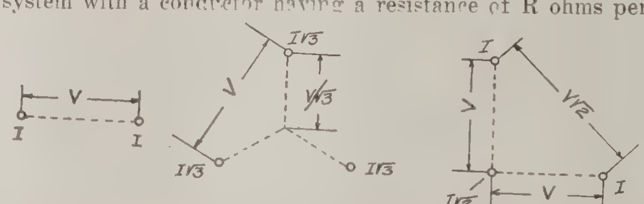
The reference to poles of an induction motor is in this way: a motor having a field which completely rotates once every cycle is said to have one pair of poles, if twice, two pair, etc. We can then determine the poles by dividing the frequency of the circuit in cycles per minute, by the synchronous speed. For instance, a motor runs at 1750 r. p. m. (synchronous speed 1800) on a 60 cycle circuit, we have $3600 \div 1800 = 2$. The motor has therefore 2 pairs or 4 poles. Similarly a six pole motor would have 1200 r. p. m. as synchronous speed (actual about 1150). The winding begins at any point and progresses symmetrically around the stator to the starting point.

A Lightning Arrester Scheme. Ans. Ques. No. 331.

The writer sees no reason why the device mentioned by Mr. Havenhill in question No. 331, should not work perfectly, subject only to the draw-back of being non-automatic. It would be quite likely to provide a very interesting occupation for the station attendants during a lively thunderstorm. As a means of providing a low resistance path to ground for high tension discharges, and of keeping the generator current from following, it seems to be adequate.

Amount of Copper for Various Systems. Ans. Ques. No. 335.

Consider the three systems as shown in the figure, with voltage V equal, transmitting the same power, and with the same loss. With unit current as I, the power will be $V \times I$ (neglecting the power factor). In the single phase system with a conductor having a resistance of R ohms per



VOLTAGE AND CURRENT RELATIONS IN DIFFERENT SYSTEMS.

mile, the loss will be I^2R per mile for each conductor or $2\ I^2R$ for both. In the 3-phase system the current in each conductor will be $I \div \sqrt{3}$, and the voltage from each conductor to neutral will be $V \div \sqrt{3}$. The power therefore will be $3 \times (V \div \sqrt{3}) \times (I \div \sqrt{3})$ or $V \times I$, equal to that of the single phase. With a resistance of R_2 ohms per mile, the loss will be $3 \times (I/\sqrt{3})^2\ R_2$ or I^2R_2 per mile.

Equating this with the loss in the single-phase system we have $R_2 = 2R$, that is the conductors in the 3 phase are just one-half the size as in the single phase, so that clearly there is but ¾ of the copper used.

The next figure shows the 2-phase, 3-wire, with voltage V from middle to each outer wire. If we take a two-phase, 4-wire system and combine one wire of each phase together, using the same size of wire, we will easily see that since the current in the middle wire is $I\sqrt{2}$, that $2\,I^2R$ is equal to $(I\sqrt{2})^2 R$. That is, we can do away with one wire altogether, and without using any more copper in the other three, we will have exactly the same loss. This, however, will result in unequal current density in the three conductors. By using more copper in the middle wire, we can reduce the weight a trifle more for the same loss, getting a value of 72.85%.

If however, we take the voltage V across the outers, we find that we have to use just twice the amount of copper as before or 145.7 per cent in excess of that used for the single phase. As regards the last system mentioned, I am not familiar with it and have never come across any instances of its use.

Aluminum vs. Copper Wire. Ans. Ques. No. 336.

Editor Southern Electrician:

Answering this question, in part, I would say that having decided the proper size of copper wire to use for any line, that aluminum wire of the same resistance can be used with safety, but it may be necessary to decrease the span or increase the height of the poles somewhat because the aluminum wire sags considerably more. This may be the reason why aluminum wire is not used more for this purpose. I know that where the cost of the line construction does not enter into the calculation, as in the case of trolley feeders, that there is quite a saving in the use of aluminum.

Inductance and Capacity in D. C. Circuits. Ans. Ques. No. 337.

Capacity and inductance are usually neglected in figuring direct current systems. There is an inductive effect in every case where the value of the current changes, even so slightly, but on straight wiring, incandescent lamps, and most other apparatus it is so small as to give no trouble. In some cases, like that of a field circuit, it may be necessary to make special provisions to take care of it. The problem of inductive emf. also enters intothe operation of every D. C. motor or generator, because while the delivered current is direct, yet in the individual conductors it reverses every time the wire passes under a pole piece. This introduces an inductive voltage which opposes and delays the reversal of the current, and this has to be taken into account in designing coils, brushes, commutators and the like.

Series Multiple Wiring. Ans. Ques. No. 338.

The principal objection to the use of any series lighting system appears to be that any break in the line, or the failure of any lighting unit, concentrates the whole potential of the circuit at that point, which might cause an arc capable of setting fire to inflammable material, and yet not drawing a current which would open a fuse or other protective device. In street cars, car barns, etc., this is often the only available means of lighting, and is hence permitted because it is necessary. Series-multiple and multiple-series systems appear to be especially prohibited because they have all the hazardous features of the series systems, are not at all necessary, and cause complications in the wiring. In straight multiple wiring any trouble with any lighting fixture will blow the fuses and protect the building.

A. G. Rakestraw.

Relative Amounts of Copper Required for Various Systems. Ans. Ques. No. 335.

Editor Southern Electrician:

The amounts of copper required for various systems may be calculated as follows:

In each system let,

E = volts pressure between wires,
I = amperes per wire,
Kw = total power to be transmitted,
p = per cent loss due to resistance of wires,
R = resistance per mil foot of material.
l = distance from generator to receiver, in feet,
A = area of conductor, in circular mils.
W = total weight of wire for the system.
w = weight per mil foot of material.

CASE I. THE 2-WIRE SINGLE-PHASE SYSTEM.

$$I = (Kw \times 10^3)/E \quad \ldots (1)$$

$$p = (2.l.R.I^2)/10Kw'A' \quad \ldots (2)$$

$$W' = 2\,l\,A'\,w \quad \ldots (3)$$

From equations (1), (2), and (3)

$$W' = 4.l^2.R.w.Kw. \times 10^5)/p.E^2 \quad \ldots (4)$$

CASE II. TWO-PHASE, THREE-WIRE SYSTEM, with equal current densities in all wires. E' is the pressure between the common wire and either outer conductor.

$$I = (Kw \times 10^3)/2\,E \quad \ldots (5)$$

$$p = [2.l.R.I^2/A'' + l\,(1.41\,I)^2\,R/(1.41\,A'')]/10\,Kw$$

$$= (3.41.l.I^2\,R)/10.A''\,Kw \quad \ldots (6)$$

$$W'' = 3.41^2.l^2..Kw.10^5.R)/4.p.E^2 \quad \ldots (7)$$

Comparing the weight of copper in the 2-phase, 3-wire system with that of the single-phase 2-wire system

$$W''/W' = 3.41^2/4 = 0.729$$

CASE II. THE THREE-PHASE, THREE-WIRE SYSTEM.

$$I = (Kw \times 10^3)/\sqrt{3}.E \quad \ldots (8)$$

$$p = (3.l.R\,I^2)/A''' \times 10Kw \quad \ldots (9)$$

$$W''' = 3\,l\,A'''\,w = (3\,l^2.R.Kw.w.10^5)/E^2.p \quad \ldots (10)$$

Comparing this weight with that for the single-phase system

$$W'''/W' = 3/4 = 0.75.$$

Comparisons with other systems may be made in the same way.

Attention should be directed to the apparent advantage of the two-phase, three-wire system over the single-phase or the three-phase system. This advantage arises from the fact that the pressure between common wire and outside wires was taken equal to the value between any two wires in the three-phase system. This means a pressure between the two outside wires 40 per cent greater than in the two other systems. If the maximum pressure between any two wires of the 2-phase, 3-wire system is the same as for the other systems the comparison gives a ratio of 1.46 instead of 0.729, as above, between the weights of copper for the two-phase, three-wire system and the single-phase system.

B. C. Dennison.

Amounts of Copper for Various Systems. Ans. Ques. No. 335.

Editor Southern Electrician:

In comparing the relative amounts of copper required by different systems to transmit the same amount of power at equal voltages and losses, the single-phase, 2-wire system will be taken as the standard of comparison. The following table gives the relations which exist between the various systems and gives values for transmitting 10,000 watts at 100 volts maximum voltage and a constant loss of 200 watts assuming a non-inductive load or a power factor of 100 per cent.

System		Loss per Wire	Current per Wire	Volts between Wires	Wires % Single-Phase
Single-phase, 2-wire		100	100	100	100
Two-phase, 4-wire		50	50	100	100
	Outside	58.6	70.7-50	141-100	
Two-phase, 3-wire					145.7-72.9
	Middle	82.8	100-100	100-70.7	
Three-phase, 3-wire		200/3	$100/\sqrt{3}$	100	75
				To Neutral	
Three-phase, 4-wire		200/3	100/3	100	33.3

The losses in a system vary directly as the square of the current and indirectly as the volume (or weight) of the conducting material. Remembering this relation, the weights of copper are determined thus:

The relative amounts of copper required for a single-phase system and for a two-phase, four-wire system is as follows: Single phase current, per wire, $I_1 = 100$ amperes, loss per wire, $L_1 = 100$ watts; and weight per wire, $W_1 =$ 50 per cent. For the 2-phase, four wire system, the power $= 2 E_2 \times I_2 = 10000$ watts; $E_2 = 100$ volts. Then $I_2 = 10000/2 \times 100 = 50$ amperes. Since the total loss $= 200$ watts, the loss per wire, $L_2 = 200/4 = 50$ watts. Expressing in a proportion the relationship already mentioned of losses to current and weight of copper we have,

$$L_1 : L_2 = \begin{cases} I_1^2 : I_2^2 \\ W_2 : W_1 \end{cases}$$

Then $W_2 =$ weight per wire in percent for a two-phase, four-wire system is,

$W_2 = (I_2^2 \times L_1 \times W_1)/(I_1^2 \times L_2) = (50^2 \times 100 \times 50)/(100^2 \times 50) = 25$ per cent.

Then the total weight for the 4 wires is $4 \times 25 = 100$ per cent.

Following the same reasoning, the amount of copper for a 2-phase, 3-wire system is as follows: The current in the middle wire is $\sqrt{2} \times 70.7 = 100$. For the same drop in voltage in each wire, the losses are divided as shown in the table, the sum of the losses being 200 watts. Then with current for outside wire $= I_3 = 70.8$ and loss for outside wire $= L_3 = 58.6$; current for middle wire $= I_4 = 100$ and loss for middle wire $= L_4 = 82.8$.

$W_3 =$ weight of one outside wire,

$= (I_3^2 \times L_1 \times W_1)/(I_1^2 \times L_3) = (70.8^2 \times 100 \times 50)/100^2 \times 58.6) = 42.7.$

Then weight for two outside wires $= 2 \times 42.7 = 85.4$.

$W_4 =$ Weight of middle wire

$= (100^2 \times 100 \times 50)/(100^2 \times 82.8) = 60.3.$

Total weight of conductors $= W_3 + W_4 = 85.4 + 60.3 = 145.7$ per cent.

The other systems can be analyzed in the same way.

R. E. Hendricks.

Inductance and Capacity in D. C. Circuits. Ans. Ques. No. 337.

Editor Southern Electrician:

Inductance and capacity are inherent characteristics of the electric circuit, just as ohmic resistance is, and are entirely independent of the character of the current. The peculiarity of these characteristics is that they effect an electric current only while that current is changing in strength. An alternating current is constantly changing in strength, from zero to positive maximum, and back again to zero, and so on continuously, 60 times a second in a 60 cycle current. Inductance and capacity are constantly manifesting themselves therefore in an alternating current circuit. Their effect is just the same in a direct current whenever the strength of that current is changing. When a direct current potential is impressed on a circuit, the current begins at zero and raises rapidly to its normal value where it remains practically constant until the circuit is interrupted when it drops to zero again. While the current strength is constant, capacity and inductance have no effect on it, but during the periods of change at beginning and end, or during any change of current strength whatever, however small, they are present. The direct current is immune only in so far as it is rigidly constant in strength. This condition is so nearly approached in all ordinary direct current circuits, however, that capacity and inductance can in general be ignored. In the design of direct current apparatus they must be considered to a greater or less extent. In a D. C. generator, for instance, the armature current is alternating, just as in the A. C. generator, so capacity and inductance must be considered there. A field discharge resistance is found necessary to absorb the inductive "kick" of a generator shunt field when the circuit is opened. These characteristics play an important part also in battery systems of gas engine ignition where a mechanical vibrator is used to constantly vary the current strength by making and breaking the circuit. They also require serious consideration in telephone work where the currents, tho nominally direct, are constantly pulsating by reason of the sound vibrations they transmit. Floyd S. Lorentz.

Wiring for Starting and Running of Induction Motors. Ans. Ques. No. 342.

Editor Southern Electrician:

In answer to question No. 342 of your January issue, the writer offers the following: Rule No. 24b of the National Electric Code states that double throw knife switches may be mounted either vertical or horizontal as preferred.

It would seem, however, that it is good practice to mount them horizontal, but if conditions are such that this cannot be done and the switch must be mounted vertical, the fuses or running side should be at the bottom, thus either blowing the fuses or at least offering the motor some protection should the switch blades drop in contact. L. C. Wilkinson.

Rheostat and Ammeter Connections. Ans. Ques. No. 343.

Editor Southern Electrician:

With reference to the connection of the field rheostat mentioned in Question 343, I should say that it is immaterial which way it is connected unless there is a possibility of the rheostat becoming grounded. In this case it might be well to have the shunt field connected between it and the armature in such a manner that the rheostat will be connected to the grounded bus, if it be a railway generator with one side grounded. In this case a ground on the rheostat would do very little damage whereas if it were on the ungrounded bus it might become badly burned. Also if it were on the grounded bus there would be less danger of shocks.

The current through an ammeter is the same in any part of the circuit without reference to the polarity. The terms positive and negative are merely conventional and must not be understood to mean that the electricity st at the positive pole and that there is no electricity at other points until it has passed through the positive side of the switch. Electricity is supposed to travel at the velocity of light, about 186,000 miles per second, and therefore the position of the ammeter would be of little moment in any event. The current at the sending end of a long submarine cable may be considerably greater than at the other end because of the distributed capacity of the cable, but the phenomena is equally apparent with either pole. T. G. Seidell.

Connections for Compound Machine. Ans. Ques. No. 343.

Editor Southern Electrician:

The connection of the field rheostat is more or less a matter of convenience. As a rule, one terminal of the shunt field is connected to one pole of the generator at the machine, the other carried to the switchboard to the field rheostat and from the rheostat to the lead connecting to the other pole of the generator. This also saves copper, especially if the machine is some distance from the switchboard. In the diagram submitted with question 343, the field connections in solid lines would be the easiest to install and would call for the least amount of wire.

The ammeter of a 2-wire, direct current, compound wound generator, also the circuit-breaker, if single pole, should be placed in the lead opposite to that in which the series field is placed, whether in the positive or negative. For a machine, operating alone, the position of the ammeter makes no difference, but if the machine is to run in multiple with other generators, unless the ammeter is in the opposite lead from the series field the instrument will not register the total current output of the machine under all operating conditions as can be seen by making a sketch of two machines operating in parallel and inserting the ammeters in the same lead as the series field. Under the latter condition, the ammeter would not indicate any circulating current in the equalizer.

Shunt Motor and Watthour Meter Operation. Ans. Ques. No. 344.

The commutating type of watthour meter is similar to a shunt motor in a general way only. There are more dissimilar than similar points. In the motor, the field is in parallel whereas in the meter the field element is in series with the line. In the motor, the field winding is of comparatively high resistance and the armature of low resistance, while in the meter, the field winding is of low resistance and the armature circuit of high resistance.

The watthour meter is not a shunt motor in the ordinary sense of the term, any more than it is like any other type of motor. It is true that one of the elements is in shunt with the circuit but it is built altogether different to a shunt motor and operates differently, so to state that it is similar to a shunt motor is apt to be misleading.

The magnetic circuits contain no iron so that the magnetic fields due to the field and armature coils will be strictly proportional to the current flowing in them. In the armature circuit, the current is practically a constant value due to the voltage of the circuit while in the field coils it varies with the load, thus making the rotary effect proportional to the voltage of the circuit and the current flowing through the meter at all times.

Transformers Siphoning Oil. Ans. Ques. No. 346.

If A. R. H. will fill the transformer leads with solder where they leave the oil, in addition to stripping off the insulation, I think it will stop the siphoning. The oil works up the stranded wire by capillary action but will not work up when the wires have been sweated together.

Wattmeter Constant. Ans. Ques. No. 349.

There are several constants used with integrating meters. One is the dial constant, a value by which the reading is to be multiplied to give the correct amount of energy passing through the meter. This constant is usually stamped on the dial. The great majority of meters put on the market now are direct reading and no dial constant is needed.

The constant referred to by Davis B. is probably the calibrating constant and is usually the value in watthours, watt-minutes or watt-seconds of one revolution of the rotor. However the calibrating constant may not be any of the above values but some arbitrary value assumed by the meter manufacturer. It is usually marked on the rotating element, in the cover, or is indicated in the instruction book that usually accompanies the meter. It is usually designateded by C or K.

As far as testing is concerned, it depends on the instruments available for the work. If Davis B. would write the meter manufacturer he would receive printed instructions covering tests with ammeter and voltmeter, indicating wattmeters, rotating standards, etc., together with diagrams of connections, as all meter manufacturers are glad to send out such literature. To go into the matter fully in the question box would take up considerable valuable space. A. C. Kerr.

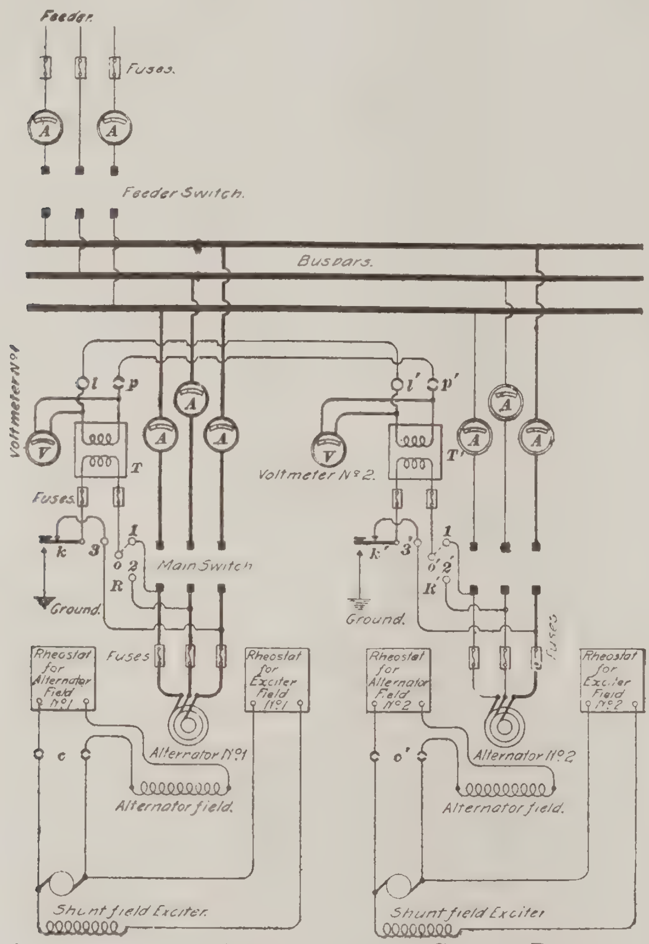
A Ground Detector Arrangement for 3-Phase System.

Editor Southern Electrician:

The diagram shown here gives the connection for two three-phase alternators and the connection for a ground detector for the system. It will be noticed that the primary of the pressure transformer T has one terminal connected through a switch (k) to one of the line wires, while the other terminals may be connected to either of the other two line wires. In this way one terminal of the pressure transformers may be connected to any one of the line wires, and the other terminal may be connected to the ground if desired. If one terminal of the transformer is connected to the ground and there is a ground on the line to which the other terminal is connected, the voltmeter will not give an indication, while if the insulation is good and the system is grounded only at its neutral point, the voltmeter will indicate the pressure between each line wire and the neutral point which will be equal to the total pressure between lines divided by 1.732. A ground on any piece of apparatus will be indicated, as described above, by a ground detector such as is illustrated.

After a ground is detected, the usual method should be employed for definitely locating it, that is, each branch circuit should be opened to see if the ground is on any of the branches. If the ground is on any of the branches in the station, it is possible to locate it by cutting out one piece of apparatus at a time. For example, one transformer could be cut out at a time until the grounded transformer is located.

If the transformer is found to be grounded, it may be possible to locate the grounded coil by carefully inspecting the windings after the case has been removed. It may, however, be necessary to disconnect the various layers of coil and test each one separately in order to definitely locate the fault. The same method must be used if the fault is found to be in armature windings of one of the generators. The fault usually can be located within certain limits by opening the armature circuits at some point and testing each part. The same method must be continued until the damaged coil has been found. The test may be made by means of a magneto or by means of a pair of test lines from a direct current circuit which have an incandescent lamp connected in series. A short circuited coil can be located by measuring the resistance of the various coils by means of an ammeter and voltmeter and direct current, or by means of a Wheatstone bridge. As the resistance of transformer coils is very small, special care must be used in making these tests.



Connections for Alternators and Ground Detectors.

If it is desired to dry out the windings of an alternator, the terminals of the armature may be connected together and a special high resistance placed in series with the field so the exciting current can be controlled. The exciting current should then be adjusted, as the current flowing through the armature windings will be approximately equal to the full load current of the machine. Under these conditions, the pressure generated by the machine will be very small so there will be practically no danger of breaking down the insulation which may be weakened by the presence of moisture. J. W. Nance.

Dimensions of Porcelain Knobs.

Editor Southern Electrician:

In electrical work the knobs or small porcelain insulators used for supporting interior conductors, are of two general types, the solid (Fig. 1), and the split, (Fig. 2). The solid knob is required by the underwriters for certain work and is the cheaper of the two. All wiremen do not agree as to whether screws or nails should be used to support split knobs. In some kinds of soft wood nails hold

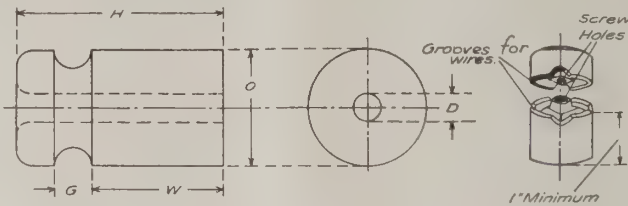


Fig. 1. Standard Porcelain Solid Knob.
Fig. 2. The Split Knob.

better than do screws, but in spite of this, screws appear to be the most popular. One of the disadvantages of screws is that where they are used, knobs are often broken during erection, due to the screw being set up too tightly. Not only do the knobs break at the time they are being placed, but frequently an invisible crack is started in the knob when the screw is set up, but the knob does not break until after it has been installed some time, and probably within plastered walls.

Dimensions of Standard Porcelain Knobs. All Dimensions in Inches.

Trade Number	H Height	O Outside Diameter	D Hole Diameter	G Width Groove	W Height of Wire
0	2¼	3	1¼	1	9/16
1	3	2⅛	7/16	¾	1¾
2	2	2	½	½	1
3WG	1¾	2	7/16	¾	9/16
3	1¾	2	7/16	7/16	¾
3½	2	2	7/16	7/16	1
4	1 11/16	1½	⅜	⅜	⅞
Midway	1⅞	1⅜	⅜	⅜	1
4½	1⅞	1½	⅜	7/16	1
5	1¼	1	¼	5/16	11/16
5½	1 9/16	1	¼	5/16	1
6	⅞	13/16	7/32	¼	½
7	⅜	⅞	¼	7/16	⅛
8	15/16	1	¼	5/16	7/16
9	1⅛	⅝	3/16	3/16	¾
10	1¾	1⅝	⅜	⅜	15/16
10½	1⅞	1½	⅜	⅜	1

Some wiremen in putting up knobs with screws, drive the screw in with a hammer for the greater part of its length, and then give it a few turns with his screwdriver. This practice is very objectionable, as knobs erected in this way are apt to be readily pulled off of the supporting surface. One point that is really in favor of the use of the nail, is that the nail can be driven much more rapidly than can a screw, which, of course, results in considerable saving of the wireman's time.

As far as insulation is concerned, a knob held with a screw provides as good insulation as one held with a nail. A split knob which clamps the conductor between its two halves, is shown in Fig. 2. Split knobs must be used for conductors smaller than No. 8, B. & S. gauge.

George Braden.

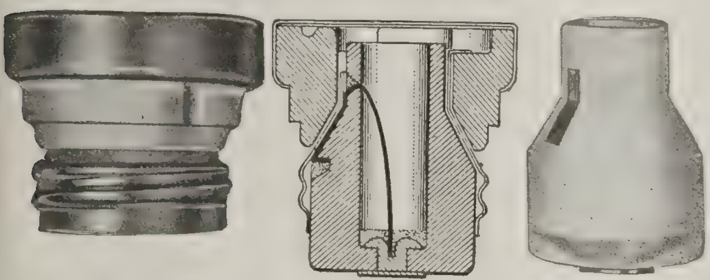
Carbon and metalized lamps often fall off in candle power 20 per cent., while the Tungsten lamp does not lose more than one-fourth this amount in the same period.

The Tungsten filament being pure metal does not deteriorate and change in character as do the carbon and metalized filament.

New Apparatus and Appliances.

Improvement in Fuse Plugs.

A new fuse plug now made by the H. T. Paiste Co., Philadelphia, marks a forward step in fuse plug manufacture. With old style fuse plugs the entire plug must be thrown away when the fuse blows. With these new fuse plugs only the fuse core, of "fusette" is destroyed thus a large item in fuse plug expense is saved. The Paiste fuse plug is in two separate parts, a permanent mica cap holder with brass screw shell and a removable porcelain core, the fusette, containing the fuse. When the fuse blows, the old fusette is taken out and a new one slipped into the holder. In the fusette, one end of the fuse strip is soldered to the bottom contact rivet; it is then carried up through the hollow center of the porcelain out through the side, bent over, and the outside end cemented fast. When the fusette is slipped into the holder and screwed into a cut-out the outside part of the fuse strip is forced tight against the brass sleeve of holder and completes the circuit, the wide fuse strip insuring a good contact.



The Paiste Fuse Plugs and Fusette.

No care is needed when inserting the fusette into holder as the contact is made in any position, and the entire construction is so simple that special instruction in handling is unnecessary. They are of standard size so that no additional expense is required in changing from the plugs now in use, the new style plugs being substituted as quickly as the old style are blown out. These plugs are approved for all circuits up to 125 volts and laboratory tests give a splendid record for safety and accuracy.

A New Sewing Machine Motor.

A new patented sewing machine motor is being manufactured by the Fidelity Electric Company, of Lancaster, Pa., which has features of interest in speed control. The motor is so constructed that as soon as the foot is taken off the treadle, the motor stops automatically by means of switch located in the base. The speed variation is produced mechanically and so arranged that the harder the treadle is pressed the faster the motor and sewing machine runs.

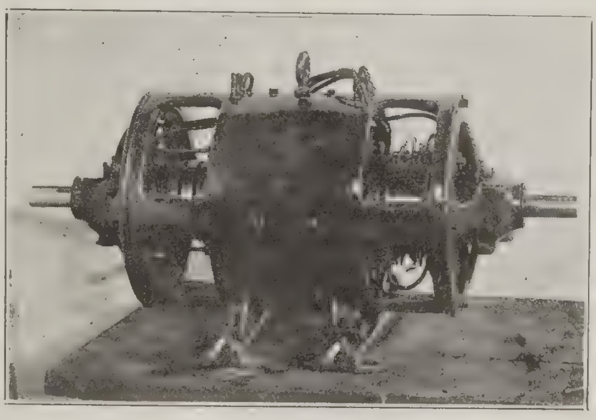
This motor has now been adopted to the use of running watchmakers' lathes for which there has been a great demand owing to the fact that motors previously on the market for this work have been very expensive and the speed variation has been limited either to one direction or to a given number of speeds produced by a rheostat. The Fidelity watchmaker lathe motor is made for both alternating and direct current and on account of the fact of its speed variation being produced mechanically, the operator can get any speed he may desire either forward or backward simply by pressure of the foot upon the treadle.

In addition to the above articles that have just been put upon the market, a complete line of small alternating current motors for running all classes of light machinery, a complete line of direct current motors from 1/40 H. P. to 30 H. P. inclusive and a complete line of alternating and direct current fans, generators, rotary converters, are products of the Fidelity Electric Co.

A Small Interpole Inverted Converter.

The Diehl Manufacturing Company, of Elizabethport, N. J., has developed an interpole inverted converter with special characteristics which commend it for use in laboratories. The machine will develop alternating current, single or three-phase, 60 cycles, and may be run as a shunt or compound direct current generator, or shunt or compound direct current motor of the commutating pole type.

It is designed to operate as a motor from the direct current end, having a capacity of ten horse-power on a circuit of 220 volts. When operating as a 10 H. P. motor the machine develops alternating current at 155 volts, single phase, 60 cycle, from two rings on the alternating current end or three phase, 60 cycle current from additional rings. When operating as a rotary converter the machine is connected shunt wound.



An Interpole Inverted Converter.

For further testing purposes the machine is equipped with a compound winding on the fields so that it may be operated as a compound direct current generator. When operating as a direct current generator at a speed of approximately 2200 R. P. M. the machine is flat compounded from no load to 50% overload. This machine can also be utilized as a shunt wound interpole motor and the flat speed regulation, high efficiency and other characteristics of this type of apparatus may be noted.

Thordarson's Improved Sign Lighting Transformer.

The Thordarson Electric Manufacturing Company, of 507 S. Jefferson street, Chicago, announce the production of an improved sign lighting transformer. Like all their electrical apparatus, this transformer was designed and made with a complete and experienced knowledge of exact service conditions and the materials and workmanship are the best obtainable. The radical improvements incorporated in these transformers by the Thordarson experts are strongly endorsed by the National Board of Fire Underwriters. The new model is very compact and neat in appearance and is claimed to be the smallest transformer on the market, weighing less than any other type. At the same time the highest efficiency is attained and it is guaranteed to withstand a breakdown test of 2,500 volts between the primary, secondary and core. Some of the largest sign manufacturers of the country have already given the new transformer an exacting trial and reprot every claim fully sustained in use. Eight sizes, 100 to 2,000 watts, inclusive, are manufactured.

A NEW SIGN LIGHTING TRANSFORMER.

A New General Utility Battery.

The Western Electric Company has recently placed upon the market a new dry battery to be known as the "Red Label Blue Bell Battery." It is encased in a bright red carton, and is designed for intermittent service requiring high efficiency and rapid recuperation. The battery is of the high initial amperage and low internal resistance type, having an initial amperage of 25 amperes on short circuit. These characteristics, together with its powers of rapid recuperation after use, insure its long life and usefulness wherever this general type of battery is required.

THE NEW WESTERN ELECTRIC BATTERY.

A few of the most important uses to which this dry battery is adapted are, the operation of call bells, annunciators and electrical toys; for operating telephone pole changers; for railway telephones in furnishing transmitter current on train dispatching circuits, as selective signaling battery or in operating interrupters. It is also suitable for ignition service in general.

Pole Top Disconnecting Switches.

Pole top switches are an essential feature of every well designed transmission system and are coming into more general use as the sole switch equipment of the high voltage side of outdoor sub-stations. Such switches should be made so as to open all poles at once from the ground, in order to insure the safety of the operator. They can be obtained in single, double, triple or four-pole types of either the single or double break feature per pole, as well as the combination of these features for use in connection with fuses. A single pole of a 30,000-volt, 150 ampere, pole top switch of the double break type is shown in Fig. 1. The contacts are of the flexible, self-aligning type. The switch is furnished so that it can be locked in either the open or closed position as desired. This style of switch when equipped with discharging horns has been found capable of breaking considerable loads.

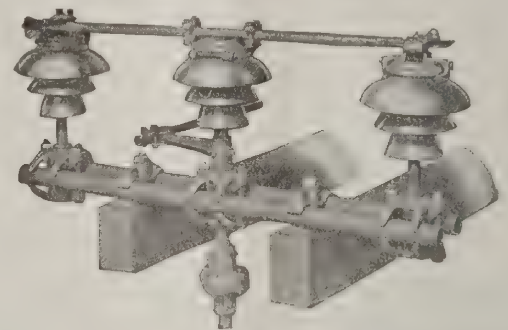


FIG. 1. DOUBLE BREAK TYPE POLE TOP SWITCH.

FIG. 2. TRIPLE POLE, 22,000-VOLT POLE TOP SWITCH.

A triple pole 22,000-volt, 100 ampere pole top switch of the single break type is shown in Fig. 2. This style of switch can readily be mounted either vertically or horizontally, the control handle adapting itself to either mounting, as well as at either the center or the end of the switch as desired. The switch as illustrated is not equipped with fuse tubes or fittings, but can be so furnished if required.

In Fig. 3 is shown a triple pole 15,000-volt, 100 ampere combined switch and fuse, the usual switch blade in this type being supplanted by a hickory tube boiled in linseed oil, dried and then varnished. The hickory tube contains the fuse, which is readily renewable. The switch and con-

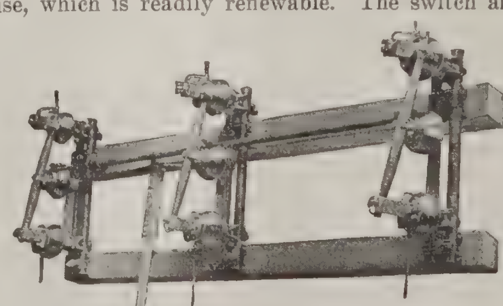


FIG. 3. TRIPLE POLE, 15,000-VOLT SWITCH AND FUSE.

trol handle can be mounted in a similar manner to that described above.

All three types of pole top switches have been so designed that the work required for installing them is of the simplest and most elementary nature, consisting of bolting the switch units, which are shipped completely assembled, to the arms and attaching the control. The switches are built with clamped pipe arms, and are capable of adjustment in every way, thus affording a rigid construction readily adaptable to standard pole line framing. It is only necessary for the user to furnish the required pole and cross-arm work. Of the many uses to which switches of the type described above have been put, the most usual are: Opening branch lines, disconnecting transformer banks, diverting energy past sub-stations, when installed upon the roof, disconnecting portable sub-stations from high tension lines of electric railways, and as line sectionalizing switches.

These switches are manufactured by the Electrical Engineers' Equipment Company, 10-12 N. Desplaines street, Chicago, Ill.

The Western Electric Company in 1912.

On account of the world wide ramifications of the Western Electric Company the final figures as to the results of the year 1912 will not be completed much before April 1st. The sales will be between 71 and 72 millions, which is sightly more than in 1906, the previous largest year in the company's business. The increase has been in American sales outside of the Bell System, which have increased about 100% over 1906, and in European sales, which were the largest in the company's history. The results have been accomplished by an energetic selling campaign in the face of increased and increasing competition.

The company is now selling to upwards of 30,000 customers in the United tSates alone. It is expected that the profits will be satisfactory considering the wider distribution and increased competition. The board of directors has established two additional vice presidents in the company's organization, and has appointed to these newly created positions Gerard Swope, general sales manager, and A. L. Salt, general purchasing agent.

Southern Construction News.

This department is maintained for the contractor, dealer, jobber, manufacturer and consulting engineer. The material is obtained from various sources and includes the latest information on new Southern engineering and industrial enterprises. We ask the co-operation of new companies by furnishing authentic information in regard to organization and any undertakings. We also invite all those who desire new machinery or prices on electrical apparatus to make liberal use of this section. No charge is made for the services of this department. Every effort is made to avoid errors in any item, and if such occur, we want to know about them.

ALABAMA.

BESSEMER. It is understood that the Republic Iron & Steel Company is to install electrical driven machinery, replacing steam equipment, in a number of mines.

HUNTSVILLE. The city will vote on March 11 on a proposiiton to sell the Huntsville Electric Light & Power Co. to Charles H. Dameron and associates.

TUSCALOOSA. The Tuscaloosa Ice & Light Co. has been reorganized and increased the capital stock from $50,000 to $100,000. It is rumored that extensions to the property will be made and additional properties acquired.

FLORIDA.

GAINESVILLE. The board of public works will make improvements to the electric lighting system and water works. J. B. McCrary Company, of Atlanta, are the engineers, and bids will be received until March 17.

JACKSONVILLE. It is understood that underground conduit for an electric light system will be constructed by the city.

ST. CLOUD. A franchise has been granted to the St. Cloud Public Utilities Company to construct an electric lighting system.

ST. PETERSBURG. The St. Petersburg Electric Light & Power Company plans the construction of a plant on the bank of Booker Creek, equipped with two 1,200 kw. generators. The cost of this plant will be $100,000.

TAMPA. The Tampa Electric Company is to increase its capital stock from $1,870,000 to $2,244,000, and improvements to the plant will be made. This company will consolidate with the Tampa & Sulphur Springs Traction Company.

WILLISTON. A franchise has been granted the Williston Manufacturing Company to install an electric light plant.

KENTUCKY.

DANVILLE. The Dix River Power Company is planning the construction of a plant on the Dix river, eight miles from Danville. This plant will cost about $1,400,000 and supply electrical energy to Lexington, Nicholasville, Danville, Lancaster, Richmond and Harrodsburg.

EMINENCE. The Kentucky Utilities Company, of Lexington, has purchased the Eminence Electric Light Company, and improvements will be made to the plant so as to furnish a 24-hour service. It is further understood that the purchasing company will extend its service to Pleasureville and Newcastle.

FERGUSON. A franchise to supply electrical energy has been purchased by the Kentucky Utilities Company. The service will be supplied through the United Water, Light & Traction Company, of Somerset, a subsidiary of the Kentucky Utilities Company. Their plant is located at Somerset.

KNOXVILLE. An ornamental street lighting system is to be installed in the business district. The Merchants Power Company are to erect standards and supply electrical energy under contract with the city.

LOUISVILLE. Webster Gazley, of Louisville, engineer in charge of the new power plant to be installed by the Seelbach Realty Company, will open bids about March 1 for the erection and equipment of the power station which will cost about $75,000.

PADUCAH. The Kentucky Southwestern Railway, Light & Power Company is to issue $1,500,000 in bonds to be used for the construction of the first division from Paducah southwest to Murray, a distance of 40 miles, work to begin in the early summer. H. C. Rhodes is president and F. M. Smith is general manager, both of Paducah.

PERRY. The United States Utilities Company has been incorporated, with a capital stock of $10,000,000. The purpose of the company will be to take over the electric plant at Paris and Danville, Ky., and a gas plant at Paris. The main offices of the above company are at St. Louis, Mo.

RICHMOND. The Middle West Utilities Company, of Lexington, has purchased the property of the Richmond Electric & Power Company. The Middle West Utilities Company is controlled by the Tusrell interests, of Chicago.

MISSISSIPPI.

JACKSON. The Jackson Railway & Light Company is planning the installation of an ornamental street lighting system.

NORTH CAROLINA.

BURLINGTON. The Piedmont Railway & Electric Company has purchased the Municipal Electric Light plant and proposed to construct a central plant to transmit electricity to Burlington, Graham, Haw River, Simpsonville and Elon College. The initial installation will consist of 100-horsepower capacity.

CHARLOTTE. The Southern Power Company has contracted with the Georgia Railway & Power Company for 14,000 horsepower, to be taken from the Tallulah Falls Hydro-Electric station of the latter company. The Southern Power Company will construct a transmission line from Easley, S. C., southwest to Greenville, through Liberty, Central and other South Carolina towns to Tallulah Falls.

CLAYTON. The city plans the construction of a water works, electric light and sewer system.

SOUTH CAROLIA.

RAEFORD. It is understood that T. C. Upchurch, N. B. Thomas and others will construct a hydro-electric plant of 500 horsepower and transmit electrical energy to the cotton mill which they are to build.

SPARTANBURG. The South Carolina Light, Power & Railway Company proposes to make improvements to their system, increasing the Gadsden Shoals Hydro-Electric plant to 1,200 horsepower, and Spartanburg steam plant to 5,000 horsepower. A future development is contemplated at a power site on the Broad river above Gadsden, where 18,000 horsepower is available.

SPARTANBURG. Permission has been granted the manufacturers' Power Company to supply electrical energy for lighting and power in Spartanburg. All wiring will be placed underground and the energy furnished from a hydro-electric plant on Green river, near Saluda, N. C. W. S. Montgomery, of Spartanburg, is president of the company.

WALTERBORO. The Walterboro Ice & Light Company has been incorporated with a capital stock of $12,000. An ice plant will be established and also equipment to generate electric light and power. G. C. Brown is the secretary and J. D. Grover, manager.

TENNESSEE.

JOHNSON CITY. The city is planning to petition the legislature for authority to issue $200,000 in bonds for the purpose of constructing an electric light plant and water works system.

CHATTANOOGA. The Chattanooga Tennessee River Power Company is planning to build a $1,000,000 steam power plant with a capacity of from 20,000 to 25,000 horsepower to operate in connection with the Hales Bar Hydro-Electric plant now being constructed.

GREENSBORO. It is understood that the city commissioners are to install an ornamental street lighting system on Elm street from Lee street to Church street. It is further understood that five-light standards will be used.

HICKORY. The Thornton Light & Power Company has been purchased by the Southern Power Company, of Charlotte.

SALISBURY. The North Carolina Public Service Company, of Salisbury, has the matter of installing a new street lighting system before the city council. At the present time the city pays $75 per arc lamp per year, and the company offers to furnish under a new contract 112 lamps at $65 each per year.

VIRGINIA.

COVINGTON. The committee on street lighting has been directed to prepare an ordinance providing for soliciting bids on a franchise for electric lighting and power purposes. This action was taken at the request of a committee representing the Covington Light and Power Company, whose franchise will expire on May 20, 1918.

BOOK REVIEWS.

STEAM POWER PLANTS, by Henry C. Meyer, Jr., consulting and mechanical engineer. Published by McGraw-Hill Book Co., New York. 24 pages and a number of 9 x 10 layouts inserted as illustrations. Price $2.00.

The third edition of this work has recently been issued entirely rewritten and enlarged. From standpoints of design and construction it stands by itself as a work pointing out the necessary characteristics of a steam power plant and besides giving enough information so that any reader will know how to go about the ordering and specifying of certain apparatus either for a new plant or for an addition so that the desired characteristics may be the result of the operation of the equipment. The design of plants, selection of boilers, engines and turbines, the arrangement of apparatus and piping, a discussion of condensers, pumps, feed water heaters and economizers, chimneys and coal handling, are some of the subjects taken up in much detail. Every engineer in charge of a steam plant and others interested in the design will find the work valuable.

HEAT-POWER ENGINEERING by C. F. Hirshfeld, Professor of Power Engineering, Cornell University and Wm. N. Barnard, Professor of Steam Enginering, Cornell University. Published by John Wiley and Sons, New York. 793 pages. Price $5.00.

This work from the mechanical engineering department of Cornell University harks back to the days and circumstances that gave birth to Thurston's works on the steam engine and the steam boiler and Carpenter's work on experimental engineering; three works which have done much in placing Sibley College not only in a high position among technical schools but equally as high a position among the sources of technical information on engineering subjects. Heat-Power Engineering has sprung from mature minds, its contents reflect extensive experience and sound engineering judgment as regards the practical needs in fundamentals and in the interpretation of the vital phases of mechanical and power engineering. Since the work was primarily designed as a text-book, the authors are to be all the more complimented by the members of the engineering fraternity, on the nature of the material that is being fed through them to the young recruits of a profession and on the further assurance that the products of Sibley College, Cornell University, at least can be expected to have a thorough grounding in one of the essential branches of engineering. Whatever may be the name under which it is known in brief it treats the economical use of our fuels and the perfection of those devices that stand between the fuel and the application of the energy derived and help to spell a total efficiency closer and closer to 100 per cent.

Let no one be lead to believe that this work is a text book only, for it may equally well be considered a hand-book and find a useful place in the library of evrey student whether he be in a University or has been seasoned by years of practical work. This book can properly be regarded as the last word up to now on the fundamentals now considered important in the discussion of the subject.. Every engineer who keeps up with the best in engineering literature must possess material of this sort and the writer of this review, since he personally knows what both these men have contributed in energy to Sibley College and what they are capable of contributing to the engineering world at large, feels justified in making the unqualified statement to all interested in a work of this character, that this one measures up to the most rigid requirements of any work on the subject that he has had the pleasure of investigating. It is strictly an engineering treatise, written by thorough students of engineering and themselves practical engineers, from an engineering standpoint. It is written with a distinct purpose, that of formulating the principles underlying the transformation of latent heat in fuel into available heat and the available heat into mechanical energy together with a discussion of the devices by which the transformations are effected—all this being apropriately expressed by the authors through the term "Heat-Power Engineering."

The headings of the chapters of the work give a definite idea of the treatment and are as follows: Heat; Elementary Laws of Heat Energy; The Heat Power Plant; The Laws of Gases; Expansions and Compressions of Gases; Reversibility; Entropy; Gas Cycles; Vapors; Properties of Steam; Volume Changes of Vapors; Vapor Cycles; Power, Efficiency and Performance; The Theoretical Steam Engine; Action of Steam in Real Engines; Steam Engine Governors; The Valve Gears of Steam Engines; Conventional Indicator Diagrams; Performance of Engines; Steam Turbines; Internal Combustion Gas Engines; Internal Combustion Engines—Methods of Operation; Internal Combustion Engines—Mechanical Features; Internal Combustion Engines—Efficiency, Performance and Power; Fuels; Combustion; Actual Combustion of Fuels—Furnaces and Stokers—Oil Burners; Boilers; Superheaters; Draft and Draft Apparatus; Gas Producers and Producer Gas; Utilization of Waste Heat—Financial Considerations; Heat Transfer; Apparatus for Heating Feed Water; Condensers and Related Apparatus; Water Purification; Power Plants; Continuous Flow of Gases and Vapors through Orifices and Nozzles; Compressed Air; Refrigeration. In all there are 42 chapters.

STEAM BOILERS, by E. M. Shealy, assistant professor of steam engineering, the University of Wisconsin. Published by McGraw-Hill Book Company, 239 West 39th St., New York City. 350 pages. Price $2.50 net.

This work is written in a practical way and will interest men in practical work, although it was the purpose of the author to produce a book on steam boilers and accessories for correspondence students in the extension division of the Univeristiy of Wisconsin. The purpose of the author has therefore developed into a work that treats operation in detail and design only in so far as essential and discussing operation. Every chief engineer of a steam plant and the firemen as well will find something of every day use in chapters on fuels, firing and smokeless combustion of coal. Here not only causes of smoke are treated but how to prevent smoke and get all possible use out of the heat of combustion. Another chapter which should interest the practical man is the one on Feed-Water Heaters and Economizers. Examples of conditions and savings for certain cases make this material simple and plain. Boiler testing and the necessary calculations offer another source of information always necessary in every steam plant.

The following contents by chapters gives the scope of the work. Types of Boilers; Water-Tube Boilers; Boiler Calculations; Stays and Staying; Heat and Work; Effects of Heat; Properties of Steam; Actual and Equivalent Evaporation; Fuels; Chemistry of Combustion; Methods of Firing; The Smokeless Combustion of Coal; Fittings; Piping and Boiler Fittings; Boiler Accessories; Chimneys and Draft; Boiler Feed-Waters; Feed-Water Heaters; Inspection and Care of Boilers; Boiler Testing.

ESSENTIALS OF ELECTRICITY, by W. H. Timbie, author of Elements of Electricity and head of the department of applied science, Wentworth Institute, Boston, Mass. Published by John Wiley & Sons, New York. 271 pages, 224 illustrations. Price $1.25 net.

This work is one of the Wiley Technical Series designed to furnish elementary texts on applied science in mechanical arts, electricity, and other fields. It is clearly written with numerous examples so that the reader can use and refer to his experience in taking up any of the subjects discussed. The work will, we believe, appeal to those who desire to know more about the technical features of the work they are doing but have little training in technical subjects. The following statements from the author's preface of the book gives his aim when prepairing it. "It attempts to explain the underlying facts and laws of good electrical practice, which the really well-informed and efficient workman must understand, rather than to provide book descriptions of the mechanical operations of the electrical trades, which can be really learned only through continued practice in their performance. It is designed to be a systematized text for class and self-instruction, and, also, a book of electrical information to which frequent reference may be made during the day's work. For convenience in the latter purpose, it is bound in a pocket size and with semi-flexible covers."

WIRELESS TELEGRAPHY AND TELEPHONY SIMPLY EXPLAINED, by Alfred P. Morgan. Published by the Norman W. Henley Publishing Co., New York City. 154 pages and 156 illustrations. Price $1.00.

This work is a practical treatise embracing complete and detailed explanations of the theory and practice of modern radio apparatus and its present day applications, together with a chapter on the possibilities of its future developments. The text is simply written, yet takes up all the details of theory, construction and operation of wireless systems and apparatus. Some space is given to the wireless telephone and the difficulties involved. Considered from all standpoints the work is an important contribution to the literature on the subject.

THE MODERN GASOLINE AUTOMOBILE, by Victor W. Page. Published by The Norman W. Henley Publishing Company, 132 Nassau St., New York City. 700 pages, 500 illustrations. Price $2.50.

This work is one of the latest and most complete on the design, construction, operation, maintenance and repair of gasoline automobiles. It is written in a thoroughly practical style, it treats actual mechanisms used in domestic and foreign cars and contains no technical discussions, historical reviews or descriptions of freak constructions. Without a question this is a book for the owner, operator or automobile repair man who desires to know something about the make-up of a car without disecting it. To such as these and all others interested in an authoritative work on the automobile we strongly recommend this one. The author of this book has also compiled a chart showing a sectional view of a gasoline engine. It outlines all parts liable to give trouble and also details the derangements apt to interfere with smooth engine operation. It is a complete review of all motor troubles and will be found of considerable interest and value. The price of this chart is twenty-five cents.

OPERA STORIES. Published by H. L. Mason, 188 Bay State Road, Boston, Mass. Price 50 cents.

This book takes up in a few words the stories of 164 operas, 6 ballets and one mystery play, and gives that part of the opera desired by most persons in as far as the play goes before hearing it. Each abstract is divided into acts and recites the features of most importance as well as in many cases commenting upon the chief character. Portraits of the leading singers are also given.

PROPER LAMP VOLTAGE is the title of bulletin 102 recently issued by the engineering department of the National Electric Lamp Association. This bulletin discusses in much detail giving curves and data on the selection of incandescent lamps for use on circuits having a fluctuating voltage.

INDUSTRIAL ITEMS.

MR. C. B. MAHAFFEY, for some ten years past employed by the General Electric Company as engineer, has been appointed manager of the electrical department of the Woodward, Wight & Co., Limited, of New Orleans, La. The many friends of Mr. Mahaffey, who are familiar with his successful engineering career with the General Electric Company, wish him all success in his new undertaking.

CHAS. E. CHAPIN, CO., Inc., 201 Fulton St., New York City, are importers of French carbon brushes. These brushes have received a number of gold and silver medals of award on merits

MATHIAS KLEIN AND SONS has arranged to manufacture and market the Eichhoff line builders reel. This reel combines a take-up and pay-out reel in one. A descriptive circular is in preparation and will be mailed on request.

THE ROME WIRE COMPANY, of Rome, N. Y., has compiled a table showing copper history through prices for every month of every year between 1883 and 1913. This table shows the average price of copper for 1911 as 12.75 cents and for 1912, 16.7 cents. The table will be sent to those interested upon a request to the company.

THE WOODWARD, WIGHT & CO., LIMITED, of New Orleans, La., on account of the rapid growth of their electrical department, have found it necessary to obtain the services of a man who has had wide experience in the electrical field. Mr. C. B. Mahaffey has therefore been appointed manager of the electrical department. Mr. Mahaffey, for the past ten years, has been connected with the General Electric Company in the capacity of electrical engineer, and he is thoroughly qualified to see that the best possible service is obtained from this department. Recommendation and estimates will be furnished on complete electric light or power plants, and troubles with your present plants will be remediel The company acts as agents for the General Electric Company, and, at the present time, is carrying a large stock of electrical apparatus and supplies and can furnish, from stock, any needs along the electrical line.

THE LOWELL INSULATED WIRE COMPANY, of Lowell, Mass., advise that in the last quarterly report of the National Board of Fire Underwriters, their name appeared without a demerit. In both the stock and field tests, electrically, mechanically and chemically, the wire now manufactured stood far above requirements.

THE CUTLER-HAMMER MFG. CO. moved their Boston office from 176 Federal St to larger quarters in the new Columbian Life Building, the first of the new year.

THE DELTA-STAR ELECTRIC CO., of Chicago, recently filled an order for transformers in a remarkable fashion. The order was received from the Wanson Street Railway Co., of Wanson, Wis., and specified the delivery of 12 300-kva., 60 cycle, 22,000 to 2,200 volt transformers in 30 days under a forfeit of $50 per day or a bonus of $50 per day for each day over or under 30 days. The order was filled through the Pittsburg Transformer Co., of Pitsburg, Pa., the 12 transformers being built entire and delivered in 21 days. A bonus of $450 was thus received. This service was the result of a factory devoted solely to the manufacture of transformers.

THE ENGINEERING DEPARTMENT OF THE NATIONAL ELECTRIC LAMP ASSOCIATION, of Cleveland, has recently issued Bulletins 8D and 10C. The former contains data on Mazda miniature and low voltage lamps and considers in detail automobile, general battery, novelty battery and large low-voltage lamps. The latter is devoted to a discussion of Mazda train lighting lamps and their adoption to the various service requirements. The Engineering Department of the National Electric Lamp Association will gladly furnish copies of these bulletins on request.

THE WESTERN ELECTRIC COMPANY announces that a new railway system, the Gulf, Florida and Alabama, which is an outgrowth of a railroad originally used by a large timber company and now converted into a standard gauge road, is to be equipped with telephones for dispatching trains. In furtherance of this plan, an order for the necessary apparatus has been placed. Fifteen way stations are to be equipped with No. 102-B selector sets which contain the standard Western Electric No. 50 Type selector, while the talking apparatus will consist of head receivers and chest transmitters. There are also to be fifteen siding telephones of the No. 1317 magneto type installed along the right-of-way. A portable train set and line pole will be used by train crews. The train dispatching circuit will be about ninety miles in length extending from West Pensacola, Florida, to Local, Alabama. The dispatcher will be located in Pensacola.

THE WIRE INSPECTION BUREAU of New York, through its secretary, Mr. H. T. Wreaks, reports a continually increasing demand for special inspection, tests and general engineering work on railway signal, fire alarm and electric light installations from railroads such as the Lackawanna, Missouri Pacific, Chicago, Milwaukee & St. Paul, Northern Pacific, Chicago & Western Indiana, from municipalities, especially those operating under the commission form of government, and from fire marshals' officers of various states; also a similarly increasing demand for general inspection work by independent organizations on all kinds of electrical and transmission machinery and apparatus and rubber goods.

THE INDEPENDENT ELECTRIC MANUFACURING Company, Milwaukee, Wisconsin, have completed a new factory and moved all the equipment and stock into the new quarters. The building is located on the south side of Milwaukee and is complete and up-to-date for the manufacture of starting and concontrolling devices. Before building the company spent considerable time in thoroughly investigating different modern manufacturing plants and have endeavored to build a shop combining many new features. The building is constructed of concrete and brick, both sides being fitted with a large number of steel frame windows giving ample light throughout the entire floor space

Special attention has been paid to the experimental and test rooms, the test room being equipped with motor generator sets so as many variations of D. C. voltage may be obtained for testing D. C. apparatus and transformers have been installed for the different alternating curent voltages.

J. G. WHITE & COMPANY, INC. has received telegraphic advice of the award to their London associates (J. G. White & Company, Limited) of railroad construction work in the Argentine, amounting to about $4,000,000 from clients for whom they have carried out several previous contracts; this new contract, like the others, being on their usual basis of cost plus a fee. The railroad to be constructed constitutes the connecting link in the through system between Brazil and the Argentine Republic, with termini at Buenos Aires and Rio de Janeiro.

DOSSERT & COMPANY of 242 West 41st street, New York City, has issued a folder which takes up the use of Dossert connectors in signal work. An illustration is shown giving the plan for wiring of a 3,300-volt transformer and sectionalizing case by use of the Dossert two-way and three-way connectors. The three-way connectors are used in connecting the primary leads across the 3,300-volt mains and the two-way connectors in the mains themselves. The illustration shows the wiring methods used by the Pennsylvania signal department.

MESSRS. WOODMANSEE, DAVIDSON & SESSIONS announce that they have associated with them in the capacity of combustion engineer, Mr. C. M. Garland, of R. D. Wood Company, and formerly of the faculty of the University of Illinois. Mr. Garland has had extensive experience in theoretical and practical combustion work during the past ten years, and has specialized in the gasification of fuels and the application of producer and water gas to industrial and power requirements. After January 1, 1913, Messrs. Woodmansee, Davidson & Sessions, in addition to their present line of work, will be open for consultation on the design and operation of producer and water gas apparatus, gas power installations, gasification of low-grade fuels, and the application of gas to the various heating problems.

SIGN FLASHERS. The Reynolds Electric Flasher Mfg. Co. has issued bulletin No. 24 taking up the Reco Cobalt type of motor-driven flasher. This flasher is incased in an iron cabinet and may be installed inside or outdoors. It is designed for small signs flashing on and off as a whole, either side alternately, one, two, three or four color effects in transparencies, lens, sign or show-window displays.

THE H. W. JOHNS-MANVILLE CO. announce the appointment of Mr. C. S. Berry as manager of their Atlanta, Ga., office, located at 31 1/2 South Broad street. To facilitate delivery in the South a stock of roofings, packings, pipe coverings and other J-M asbestos, magnesia and electrical products is carried at this above address. This office also employs a force of workmen experienced in the application of J-M products.

THE SIMPLEX ELECTRICAL CO., announce a change of name to the Simplex Wire and Cable Co. This change took effect February 1, 1913. There will be no change of management or interest.

THE GREENWOOD ADVERTISING COMPANY, of Knoxville Tenn., a manufacturer of electric signs claiming "individuality" as its motto, has issued one of the most distinctive catalogues on signs that has yet come to our attention and bears out in all its features the motto above mentioned. As one, if not the pioneer in electrical sign advertising in the South, this concern has now come to know the peculiar needs, the likes and dislikes of the different cities and now seldom submits a design which on account of the design or construction is rejected. Like all goods of quality, the Greenwood signs cannot be purchased for a song; the management has and is yet exerting every effort to prove that the cheap is first cheap and then useless, while the quality product is well constructed, long in service and productive of results, for it portrays satisfactorily the effects that the designer made with his brush when producing the design. The catalogue contains 36 pages, is printed on heavy coated stock and shows some 75 designs, all different, that the company has recently installed. A number of these signs are in colors, showing the effect produced. In every respect and on every page this work shows the handiwork of artists in a productive art, namely, electrical sign advertising. The work on the catalogue is largely that of Mr. Earl B. Greenwood, chief designer, and Mr. N. B. Hickox, treasurer and manager, a very attractive cover being designed by the former in colors especially appropriate for the subject treated.

H. W. JOHNS-MANVILLE Co. announce the appointment of Mr. C. L. Wheeler as traveling representative in their Atlanta territory. Mr. Wheeler is an electrical engineer of practical experience, and formerly covered the Southern states for various large electrical and jobbing concerns. He will devote his attention to the well-known electrical products of the company, particularly "Noark" fuses, service boxes and protective devices, electric railway supplies, J-M fiber conduit, vulcabeston and other molded insulations. J-M electrotherm heating pad, Frink and linolite lighting systems.

The demand in Salt Lake City, Utah, and vicinity, for J-M products has increased to such an appreciable extent that this company has found it expedient to open a branch office in the Dooly block in that city. Their many customers in that section of the country will undoubtedly appreciate this, as it should materially facilitate the handling of correspondence, orders, etc., and affords another illustration of this company's inflexible policy to utilize every possible means to further the interests of their customers.

THE NATIONAL X-RAY REFLECTOR CO., of Chicago, Ill., has issued a bulletin taking up the illumination of churches. Types of fixtures for indirect lighting are treated and illustrations of installations shown.

Electrical Devices Recently Approved.

The devices and materials appearing in this section each month, having recently been examined under the specifications given in the National Electrical Code and working in practice, are approved by the Underwriters Laboratories, Incorporated. The information in this section supplements the list published in April and October by the National Board of Fire Underwriters, and is for the convenience of engineers and electrical contractors who desire to ascertain the names of manufacturers up to date whose devices have been examined and approved.

THESE DEVICES SATISFY THE REQUIREMENTS OF THE SOUTHEASTERN UNDERWRITERS ASSOCIATION, AND HAVE BEEN APPROVED BY THE ELECTRICAL DEPARTMENT, A. M. SCHOEN, CHIEF ENGINEER.

Cabinets.

UNITED SHEET METAL WORKS, 575 Howard St., San Francisco, Cal. Standard requirements. Approved Dec. 31, 1912.

WHEELER-GREEN ELECTRIC CO., 71-75 Paul St., Rochester, N. Y. Standard requirements. Approved Dec. 31, 1912.

Flexible Cord.

ELECTRIC CABLE COMPANY, Bridgeport, Conn. Marking. One white thread cabled with copper strands. Approved Dec. 13, 1912.

IMPERIAL WIRE AND CABLE CO., Montreal, Canada. Marking. Yellow thread woven in braid. Approved Dec. 18, 1912.

MARION INSULATED WIRE CO., Marion, Ind. Marking. One green thread cabled with copper strands. Approved Dec. 11, 1912.

Ground Clamps.

GILLETTE-VIBBER COMPANY, New London, Conn. "G-V" ground clamps for light and power circuits in sizes from 1-2 to 3-in. pipe. Approved Dec. 17, 1912.

SPRAGUE ELECTRIC CO., 527-531 W. 34th St., New York City. "S-E" galvanized sheet steel ground clamps for connecting to gas pipes and with lugs for securing it to outer box. Also provided with hinged joint and screw wedge for same purpose. Approved Dec. 16, 1912.

Panel Boards.

WHEELER-GREEN ELECTRIC CO., Rochester, N. Y. Standard requirements. Approved Dec. 31, 1912.

Receptacles, Standard.

ARROW ELECTRIC COMPANY, Hartford, Conn. Rosette receptacles mounted on link fuse rosette bases. Brass shell, cleat and concealed with and without shadeholders attached. Approved Dec. 21, 1912.

Receptacles, for Attachment Plugs.

CUTLER-HAMMER MFG. CO., Milwaukee, Wis. "C-H" 6-ampere, 250-volt, concealed, molding, and flash types. Approved Dec. 20, 1912.

ELECTRIC MFG. CO., 926 LaFayette St., New Orleans, La. Stage receptacle and plug and hardwood plug for stage cable. Approved Dec. 20, 1912.

METROPOLITAN ELECTRIC MFG. CO., East avenue and 14th St., Long Island City, New York. Detachable body, flush receptacle, 10 ampere, 250 volts and 15 ampere, 250 volts. Combined switch and receptacle. Approved Dec. 20, 1912.

Signs, Electric.

Greenwood Advertising Co., 511-515 State St., Knoxville, Tenn. Sizes of standard requirements. Approved Dec. 16, 1912.

Switches, Knife.

NEW HAVEN ELECTRIC MFG. CO., New Haven, Conn. Single, double and 3-pole mounted on state bases, with or without cartridge enclosed fuse extensions. Approved Dec. 16, 1912.

TRUMBULL ELECTRIC MFG. CO., Plainfield, Conn. 250 volts D. C., or 500 volts A. C. unfused, all capacities. Also "Vappa," 125 and 250 volts D. C., and A. C. 30 amperes. Approved Dec. 16, 1912.

ELECTRICAL ENGINEERING

PUBLISHED MONTHLY

Vol. 45. APRIL, 1913 No. 4

PUBLICATION OFFICE
DALTON, GA.

EDITORIAL and ADVERTISING DEPARTMENTS
GRANT BUILDING ATLANTA, GA.

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SUBSCRIPTION RATES

Domestic .... $1.00 For Two Years

Canada .... $1.00 Per Year

Foreign .... $1.50 Per Year

Complaints of failure to receive ELECTRICAL ENGINEERING regularly or of any errors of any nature, should be promptly made to the Atlanta office.

Advertising copy or change orders for standing advertisements must reach the Atlanta office by the 5th of the month preceding the month of publication.

Entered at Dalton, Ga., Postoffice as Second-class Matter.

CONTENTS.

Our New Name.

Beginning with this issue, this publication is to bear a new name. The announcement of this change in the February and March issues has brought numbers of letters regarding it, for the most part favoring the step and welcoming it on the basis of a name which defines the sphere of activity of this publication better than the old one. We welcome the criticism whatever its nature, appreciating most, however, the favorable comment on the basis mentioned since it formed the important consideration in determining upon the new name. Due to changed and still changing conditions in electrical affairs, especially in the South, only a term as broad as ELECTRICAL ENGINEERING can cover the nature and extent of developments taking place and those inevitable for the early future.

As an index to and a measure of Southern commercial development thus far, we have only to refer to the increase of population in the South to something more than thirty millions, or one half the population of the United States in 1890. The manufacturing enterprises of the South today alone represent an investment of nearly three and a half billion dollars producing products valued at something more than this figure, while the total value of the manufactured and agricultural products is twice this amount and four times a similar figure ten years ago. The capital invested in factories in cities having more than 25,000 population has in the last ten years increased over 140 per cent while the value of the products of these factories has increased over 100 per cent. A general spirit of progress and activity has and does now in an ever increasing degree prevail throughout the South together with a far reaching interest in her industrial and commercial affairs.

It is now generally recognized in commercial circles of this country that the South, once a land destitute of commercial assets is now teeming with industry and progress in every line. Back of this progress, there are found to be certain peculiar facilities for manufacturing, agriculture and every other business connected therewith and these facilities are attracting capital from all directions. Not the smallest factor in making these facilities peculiar are the natural advantages that our Southern streams offer for the development of electrical energy from water power. The cheapness of hydro-electric power now available in the South and especially in the Piedmont region, has in a large measure been responsible for the industrial development thus far, and this development has reached the point where it is now reacting to stimulate the control of Southern water powers and the transmission of this power through electrical energy to the remotest towns and cities where the potentialities are yet lying dormant as far as possible progress is concerned. This reaction has been assisted by a peculiar chain of political circumstances, important among which is the checking of water power development activity in the western section of this country through the so-called conservation movement. The capital therefore naturally interested in water power projects has been diverted to the Southern states where conservation is best interpreted by making developments instead of preventing them. This advantage will remain with the South until Federal authorities decide upon terms for re-opening of Western lands on a basis that will attract capital.

Judging from the industrial expansion that has already taken place and can be directly or indirectly traced to the existence of power facilities, it is reasonable to believe that the immediate future will year by year establish records unbelievable when viewed now even from the most optimistic standpoint. During the last year, hydro-electric enterprises alone have been organized in the South representing a capitalization of considerably over $200,000,000, and having in view the development of upwards of 1,500,000 horsepower. This activity is not confined to any particular section of the South, but is generally distributed throughout those districts where power possibilities are found through the development of water power.

The capacity of Southern hydro-electric stations and systems has increased with leaps and bounds. Electrical plants of 15,000-horsepower in the South are not more than five years old, yet such has been the extent of recent large work in these states that the creation of a development to produce 50 to 75 thousand horsepower causes little surprise and only casual mention. The beginning of electrical transmission in the South over any distance was seventeen years ago at what now seems a low voltage, that of 5,500. Today one of the largest transmission systems is found operated wholly within our Southern territory and toward the top notch of present transmission voltages with the possibilities of the field for equally extensive systems just opening. In every city of the South, down to the town of often less than 2,000 population, electric lights are now found, while in the largest municipalities, the street and residential illumination through electric light, the transportation by electric railways and the operation of mills and factories by electrical energy, rival conditions in any other section of this country.

The trend of this expansion is shown through a report of one of the most extensive Southern waterpower systems, to be an increase in industrial load during the past year of fully 10 per cent and a similar increase of 10 per cent in the load represented by municipalities, this increase being due to better lighting systems and a general and more extensive use of electrical energy in other ways. This corporation operates six hydro-electric plants, generates and distributes over 120,000-horsepower in a territory 150 by 200 miles in extent, furnishes the power that operates 160 cotton mills, lights the streets and buildings of 45 towns and villages and operates the trolley cars of six more. We refer to this large system of the South because it is among the first of the country to operate on a large scale and its progress can now be taken as representative of what similar systems may be expected to become in a much shorter time.

This publication sprang into existence at the time when this electrical activity began to show itself as a factor in the advancement of the South, its purpose as laid down by its founders being to identify itself with all worthy phases of electrical activity and interests and furnish a monthly record of Southern electrical progress. As an electrical journal, it has expanded as the industry has expanded, yet its purpose has remained and is at this time identically the same, including as its field of endeavor the many interests of Southern central stations, problems of electrical construction, design of electrical plants, the electrification of industrial plants, and the distribution and application of electrical energy. It will thus be seen that the change of name to Electrical Engineering is but a logical step in the progress of this publication—a means for an outward indication of and an identification with, the true character of the industry it represents.

The following letters present in a general way, the change of name from the viewpoint of our readers whose opinion after all is the stamp of final approval or disapproval. These opinions we believe bear out the statement made in the opening paragraph of these remarks.

E. C. DEAL, general manager, Augusta-Aiken Railway & Electric Corporation, Augusta, Ga., writes as follows: "I notice with much interest the contemplated change in the name of your magazine from Southern Electrician to ELECTRICAL ENGINEERING and with which the 'Electrical Age was some time ago consolidated. While I regret very much the elimination of the name 'Southern,' which has designated the field in which your magazine has been doing its most effective work, and in which its usefulness has been most greatly appreciated by all branches of the electrical industry, I believe that its field has expanded, and its usefulness become so general to the electrical profession that its new name ELECTRICAL ENGINEERING is more significant of its real sphere of activity, than is true of its former name. But irrespective of the name you may give it, your magazine will continue to meet with its great popularity in the electrical field, so long as you continue it upon the high plane, and broad policy that you have run it on since its inception. It is therefore gratifying to know that you do not contemplate any radical change in its policy, as I have been very much impressed with its close and sincere relations to the electrical industry, and most especially central station work."

D. R. SHEARER, E. E., general manager, Acme Electric Company, Knoxville, Tenn., offers the following: "Regarding the change of name of Southern Electrician to ELECTRICAL ENGINEERING, the writer concurs heartily in this step. Several years ago, there was little difference between the word 'Electrician' and 'Electrical Engineer,' for electrical development at that time had not reached a plane of such stability as to be ranked with the recognized branches of engineering. Such progress as was made depended more really on experiment and on a branching out into untried fields than on technical knowledge or engineering calculations. That stage of development in the science of electricity has passed and now, as never before, we can build upon established mathematical and engineering fundamentals and can determine characteristics or operating features theoretically.

"Two distinct phases of human activity are represented by the two titles just mentioned; that of the wireman, worker or mechanic in electrical work, represented as following a trade and that of the designer, engineer or supervisor of electrical installation represented as following a profession. Thus the present day acceptance of the difference in these two terms make it particularly appropriate for the Southern Electrician to make the proposed change, for as a magazine possessed of a marked individuality it has grown out of the field of 'electrician' into that of 'engineer,' broadening out in a corresponding manner to cover every phase of electrical design from the most intricate calculation to the actual details of successful installation. It is the writer's opinion that practically all your readers, especially those in the engineering profession. will concur in these remarks."

T. C. MARTIN, executive secretary, National Electric Light Association, New York City, says: "I have been quite interested to note your plan of changing the name of your paper, and would say that while the new name corresponds more closely with the mission of the paper, I should myself have maintained the old name for various reasons, which perhaps do not weigh so much with you. I believe that there are other papers, as in England, which have the name "Electrical Engineering," while your old name was certainly very distinctive so that no one else could even get anywhere near it."

W. M. SKIFF, manager, Engineering Department, National Electric Lamp Association, Cleveland, Ohio, writes: "Regarding the 'rechristening' of your magazine I certainly agree that the change is a good one. To most of us in the electrical fraternity the term 'electrical engineering' carries a broader and deeper significance than 'electrician,' and is, I think, more in accord with the general tone and dignity of your publication. I am also of the opinion that the dropping of 'Southern' will be of benefit by establishing your paper as a national organ, even though your main interests will be centered upon the development of electrical interests in the South. I have been watching the Southern Electrician with considerable interest during the past year, and have been very much impressed with the improvements that are continually being made evident. By past progress you have schooled us to expect big things in the future and, personally, I do."

E. P. PECK, assistant electrical engineer, Georgia Railway & Power Company, Atlanta, Ga., writes as follows: In my opinion the change in name from Southern Electrician to ELECTRICAL ENGINEERING is a good change. The name of an engineering publication should give an idea of the material it publishes. You are carrying now, and have for some time, a number of high-grade engineering articles and consequently the paper should appeal to the engineer. The term 'electrician' is now understood to apply to an electrical mechanic, rather than to an engineer, and thus the name applied to a publication implies that the paper publishes a class of popular reading which is not necessarily of an instructive nature. I am sure that engineers, operating men, etc., would rather have ELECTRICA ENGINEERING on their desks than Southern Electrician, as the former name would indicate a higher grade publication. The magazine is worthy of its new name."

PROF. H. P. WOOD, Georgia School of Technology, Atlanta, Ga., says: "In a very few years the Southern Electrician has made a place for itself among the technical publications of the United States as one of the foremost agencies for building up the electrical business and also the electrical profession, and in one sense a change of name seems like a backward step. With the new name, however, new subscribers will realize that its scope is intended to be national in character, as it has been in reality in the past, and I wish you abundant success."

WILLIAM R. BOWKER, Corando, Cal., writes: "I think the change of name is excellent and of the opinion that it will result in increasing your field of usefulness. The new name is obviously broader than the old one which implied a journal devoted to a restricted locality, although in reality its field had extended beyond its old name. By adopting the new name you have brought the journal more in harmony with its recognized broader field of usefulness."

ARTHUR F. GILES, district manager General Electric Company, Atlanta, Ga., says: "The principal feature that suggests itself to me in connection with your change of name is that it implies a broader scope and character, and a wider field of circulation for your paper. If this be true, you have set for yourselves the double task of maintaining the prestige and retaining the loyalty of your subscribers and advertisers, which your paper has commanded as a journal devoted to the Southern section of our country; and of extending its influence and popularity beyond this section as a magazine, as its new name implies, of national scope, with publication headquarters in the South. The first will, no doubt, be accomplished by continuing to show your Southern subscribers that your attention to the interests of this section is in no way diminished by this change; and it would seem that your effort to enlarge the usefulness of a paper published in the South should be encouraged by not only continued but increased support. The latter phase of this proposition would appear to me to be more difficult. The one thing which appears to me as most likely to contribute to success in both directions will be the quality of your paper, and I know that you have recognized what the new conditions will require and are prepared to exert redoubled efforts to maintain and improve the high standard which has heretofore characterized your journal in this respect."

T. JULIAN M'GILL, district manager, Westinghouse Electric & Manufacturing Co., Atlanta, Ga., says: "I think that the name ELECTRICAL ENGINEERING indicates more definitely the field covered by your publication. I wish you every success under the new name and shall always expect your efforts to be of increasing importance in the development of our Southern resources."

JOHN S. BLEECKER, manager, Columbus Railroad Company, Columbus, Ga., says: "Personally, I feel that you will be making a mistake to leave off the word 'Southern' from the name of your paper. Otherwise, I believe substituting the words 'electrical engineering' for the word 'electrician' is a commendable step."

WILLIAM RAWSON COLLIER, contract agent, Georgia Railway & Power Company, Atlanta, Ga., says: "When I look back and think of the paper a few years ago, it seems almost incredible that such advance could be made in such a short time. Keep it up. We need just such a publication in this part of the country, and I believe you are doing the electrical industry a great service."

OSCAR C. TURNER, president, Southern-Wesco Supply Company, Birmingham, Ala., writes: "I note that beginning with your April issue you are changing the name of your paper to that of ELECTRICAL ENGINEERING. While I do not see any reason for such a change, still I must admit that I am somewhat prejudice toward the old name. The old name is well known, thoroughly advertised, and I am afraid that ELECTRICAL ENGINEERING is going to be confused with some of the other engineering papers, or rather be more confusing than would the old name, but of course, there can be little or much in the name. You have my very best wishes under the new name or under the old. I trust you will continue to grow and serve the Southern electrical men as you have in the past."

PROF. B. C. DENNISON, Carnegie Technical Schools, Pittsburgh, Pa., writes: "A few years ago electrical apparatus was 'schemed out'—I will not say designed—was constructed, installed and operated by men whose knowledge of the subject was bounded by the narrow limits of their experience with the apparatus, unsupplemented by theoretical study or professional training. These men were electricians. They accomplished wonders and the world owes them a great debt of gratitude and respect. But now, while the electrician is as indispensible as those of early days, his place on the frontiers of development and invention has been largely taken by one better trained and more fully equipped to deal with the growing complexity of the electrical science. The 'electrical engineer' has succeeded the 'electrician.' His interests and his activities are not limited to one type of apparatus nor to one locality—he is no longer a 'Southern electrician' or a 'Northern electrician'—he is an 'electrical engineer' with the whole world as his sphere of action. It seems very appropriate, therefore, that the publication which, during the years of its growth, has been called the Southern Electrician should assume its proper and well-earned title of ELECTRICAL ENGINEER, or since the work and not the individual is of paramount importance, of ELECTRICAL ENGINEERING."

E. J. MORA, consulting engineer, Philadelphia, Pa., makes this comment: "I note the change of name of your journal, but why not call it the Electrical Engineer instead of ELECTRICAL ENGINEERING, or Journal of Electrical Science; although I think its present name is best of all?"

PROF. J. A. SWITZER, University of Tennessee, Knoxville, Tenn., has the following to say: "I note with interest that the Southern Electrician consolidated with the Electrical Age, is to appear heerafter under the name ELECTRICAL ENGINEERING. There are two reasons why I am glad to see this change: first, the enlarged scope of the journal will make it of wider interest; second, it is my feeling that the best interests of the South are not served by emphasizing its sectionalism. While I believe I have a sympathetic understanding of the Southern pride which leads people to emphasize their residence in this part of the United States, I feel sure that the larger view, namely, that we are all Americans, when it shall be adopted throughout the South, will conduce to a broader development, a higher patriotism, and a truer cosmopolitanism. And so I am glad to see you taking the broader and more impersonal title for your excellent publication."

L. S. MONTGOMERY, district manager, National Metal Molding Company, Atlanta, Ga., comments as follows: "As one of your subscribers, I have followed the growth and improvement of Southern Electrician from the first issue, published by the present management, which I believe was the issue of October, 1909, to date, and appreciating your ability to produce a paper second to none, I propose to continue as a subscriber and reader of ELECTRICAL ENGINEERING.

"While the name of Southern Electrician has indicated your object as being restricted to electrical development in the South, I have been pleased to note from time to time exclusive contributions from men of national and even international prominence. I also have noted matters of national importance which you have undertaken and successfully accomplished. I want to commend your neutral position in all matters and your liberal attitude in throwing the columns of your paper open to any worthy question. In the past I have acquired some valuable information and many original ideas from the columns of Southern Electrician, and under your new name, ELECTRICAL ENGINEERING, I wish you continued success."

HUGH T. WREAKS, secretary Wire Inspection Bureau, New York City, says: "I note the change of name of Southern Electrician to ELECTRICAL ENGINEERING. There is no question in my mind but that this is a more descriptive title and one indicating a larger plan and scope. I think it is a wise move."

R. B. MATEER, manager agricultural sales, Great Western Power Co., San Francisco, Cal., remarks as follows: "Like all publications that have attained success under one non-de-plume, the Southern Electrician appears in a new garb, ELECTRICAL ENGINEERING, it being generally believed that the new title is more appropriate for the enlarged field of electrical activity to be covered by it. Reference is made to the consulting, contracting, constructing, illuminating, operating and architectural engineers and their field of activity which is covered in a general way by various journals now devoted to their interests. Few journals have attempted to specialize on the activity of the commercial engineer, though some devote a few columns to that part of central station development. It seems, therefore, that eliminating technical discussion, a wider circulation would be possible and the journal eagerly sought by the official and operating engineer of the quasi public utility, if more attention were given to the discussion of commercial problems which directly govern the receipts of the corporation and its allied interests.

"Discussions on business policies, the marketing of current-consuming appliances and their value, co-operation between contractor and utility and how best accomplished, examples of good industrial and illuminating installations described in an attractive manner, are more to be desired and will fill the demands of the consulting and commercial engineer. Interesting papers on hydro-electric developments, stating facts, yet eliminating the minute details, are of equal value to all engineers, so in broadening the scope of the journal, let special attention be given to problems effecting most those men who are ever on the skirmish line and whose efforts mean not alone dollars and cents to the corporation, but its life. Without a market, what value has the apparatus and theorying in design?"

CECIL TOONE, consulting engineer, England, writes as follows: "There is no doubt in my mind but that the proposed change of title will be beneficial to Southern Electrician. The term "electrician" is usually associated rather with the class of smaller electrical contractors than with central station engineers to whom, in their various branches of activity, Southern Electrician has hitherto been chiefly devoted. The term "electrician" has, however, wrongly been given a rather narrow and it is to be feared in many cases, a rather contemptuous significance. In this country (England) at least, the name "electrician" has become a common trade term for the bell-hanger and small wireman type. Wrong this may be, but the fact remains. Let me hasten to say, however, that no such stigma or slight attaches to the title of our English ELECTRICIAN which, by its long and unique history, attaches the full dignity of the word to its title.

"ELECTRICAL ENGINEERING is the broadest and most comprehensive term possible for the field to be covered by the associated interests of your new periodical and if, indeed, as wide a field as the construction, application and operation of electrical apparatus and the interests of the central station, the consultant, manufacturing, contracting, illuminating and operating engineer and architect can be efficiently cultivated—a possibility which my years' experience with Southern Electrician does not lead me to doubt—then as the only and complete journal of the South, the future of the publication offers immense and assured possibilities. I believe that the new title will constitute the best declaration of the widened scope of the paper and the best possible recognition of the vast expansion, which has taken place during recent years in the range and importance of electrical engineering and of the distinct and high status now attached to this profession.

"The activities of Southern Electrician have increased steadily, consistently and thoroughly and adherence to and expansion from its present policy must constitute the surest guarantee for its continued success. As regards production, I believe the present method of presenting matter can hardly be improved upon from the standpoint of ease of reference and comprehension by the busy engineer. A "one-man" undertaking can never satisfy the needs of any industry, much less so great a one as electrical engineering, and in its technical-expert editorial department and in its policy of securing the co-operation of the leaders in every branch of electrical engineering—Southern Electrician has secured in the past, as ELECTRICAL ENGINEERING will secure in the future—the fundamental basis of its success."

The above letters are not presented solely to justify the changing of the name of this publication. We believe they express something more—an unmistakable indication of the need for a thoroughly technical publication devoted to every Southern electrical interest and reflecting in true perspective the trend of Southern developments. We pledge our readers an earnest effort in just this direction and as the South's technical electrical journal, will serve her interests in a bigger and a better way.

Southern Delegates to Chicago N. E. L. A. Convention, Attention!

Through affiliation with the Southeastern Section and the Mississippi State Section, the central stations of six Southern states are intimately interested in the annual convention of the National Electric Light Association. There will be this year a larger number of representatives of these states than ever before who will attend the June convention at Chicago. The suggestion has been made and a committee had been appointed by President E. C. Deal of the Southeastern Section to canvass Southern central station men and make arrangements to get them together to go to the convention in a special train honoring both our Southern section and the National Association by as large an attendance as any other section of the association or of the country. The recently organized Southeastern Section has been promised special recognition at the Chicago Convention and as a consequence it should be of decided interest in every way to Southern delegates.

A special train as such carrying Southern representatives to a National Convention has has never before been arranged, not because of the fact that a very few members attend from the South, but because of the separation of those who do attend and the failure of these to get together for the trip. It is now the duty of every member of the Southern Sections and every central station man who is not a member but who will attend the convention, to co-operate with the committee at work on the plan and make it such a success that a Southern special train will hereafter be a predetermined and arranged feature among Southern delegates to the National Convention.

Any suggestions in regard to the arrangements and any information including names of those now planning to go to Chicago, should be sent at once to the nearest member of the following committee: E. C. Deal, chairman (Augusta, Ga.); W. Rawson Collier, vice-chairman (Atlanta, Ga.); A. H. Sikes, (Athens, Ga.); T. W. Peters, (Columbus, Ga.); G. K. Dustin, (Columbia, S. C.); E. V. Taylor, (Charlotte, N. C.); J. E. Bigham, (Tampa, Fla.); C. E. White, (Montgomery, Ala.); T. K. Jackson, (Mobile, Ala.); R. B. Claggett, (Greenville, Miss.).

Loyalty.

If you work for a man, in Heaven's name work for him. If he pays you wages that supply your bread and butter, work for him; speak well of him; stand by him and stand by the institution he represents. If put to a pinch, an ounce of loyalty is worth a pound of cleverness. If you must vilify, condemn and eternally disparage, why, resign your position and, if you are a weakling, when you are outside damn to your heart's content. But as long as you are a part of the institution, do not condemn it. If you do you are loosening the tendrils that hold you to the institution, and the first high wind that comes along, you will be uprooted and blown away, and probably you will never know why, as many have experienced.

Electrical Features Power House No. 1, Tennessee Power Co., Parksville, Tenn.

(Contributed Exclusively to Electrical Engineering.)

IN THE December issue of this publication, the main features of the layout of power house No. 1 of the Tennessee Power Company were described. This power house is built below the dam on the north side of the river and its substructure forms an integral part of the dam itself. The power house is L shaped with the main building, which contains the generating apparatus and is parallel to the dam. As shown in Fig. 3 the north end of the main building contains the transformer bays, this floor being on a level with the switchboard gallery, which overlooks the generator floor. Above the transformer bays is the high tension room with high tension buses and switching apparatus. The general layout of the generator room and transformer bays is shown in the plan, Fig. 3.

The main floor contains the generators and exciters, overlooked by the switchboard gallery. On this same floor level but under two of the transformer bays is the oil treating apparatus for drying and filtering the oil. The low tension oil switches are on this floor also, arranged under the side of the gallery, but so as to be in sight from the switchboard. From these switches the cables go in separate compartments to the bus structures above on the gallery as shown in the plan. These compartments are shown on each side of the gallery, the main or transfer bus compartment being at the back of the gallery away from the switchboard, while the group buses are at the face of the gallery towards the generators. These bus compartments are of concrete with doors at points so as to be readily accessible.

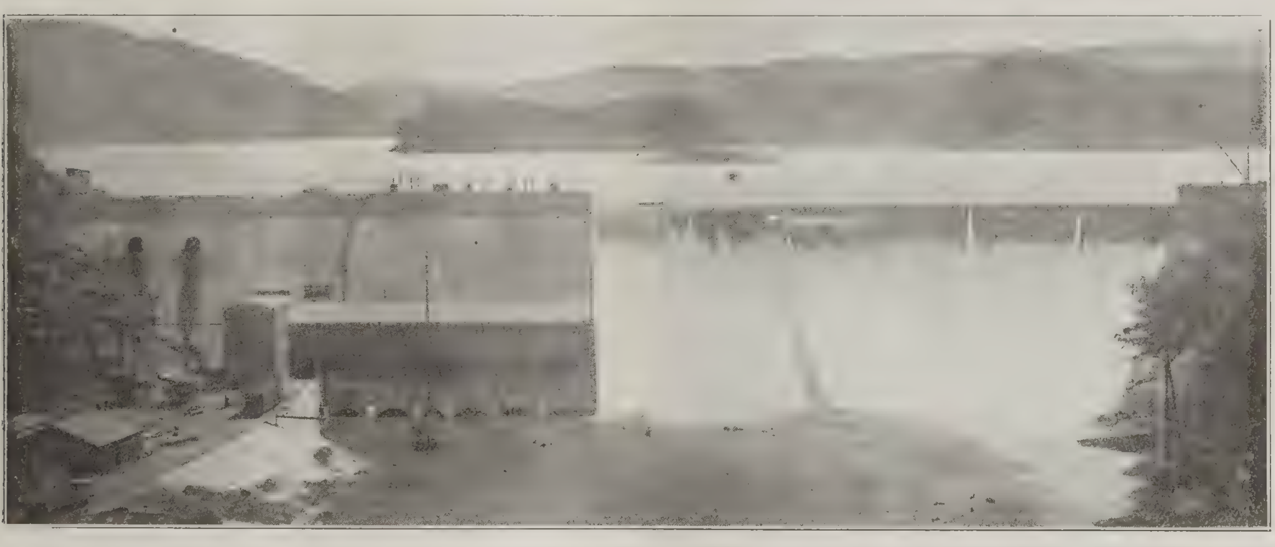


Fig. 1. View of Dam and Power House, Looking Upstream.

The transformer bays are at right angles to the entering tracks, as shown, and by means of a transfer truck the transformers can be easily removed. These transformers are mounted on wheels which facilitate the removal so as to be in reach of the crane. The leads to the low tension side of the transformers come through fiber conduit from the switches on the main generator floor, the ducts being laid in the floor concrete. A 25-ton traveling crane in the main building handles all parts of apparatus for repairs or for loading on cars. This crane is operated by 125-volt D.C. motors from the station auxiliary D.C. bus.

The leads from the high tension side of the transformer go through the opening in the floor up to the high tension room above. A section is shown in Fig. 4, there being five, three-phase circuit breakers for the transformer side of the high tension bus and at present two outgoing line breakers of the Westinghouse G. A. type. There are provisions for the five outgoing lines, as shown. These lines leave the building through roof bushings.

LAYOUT OF EQUIPMENT STATION NO. 1.

The electrical layout of this station consists of five units, each a water turbine consisting of two 39-inch Morgan Smith horizontal water wheels direct connected to a 3750 Kva. generator. Each generator has a corresponding 3750 Kva. 3-phase transformer for stepping up the voltage to 66,000, which is the transmission voltage.

The exciting current is supplied by two 120 Kw, 125-volt direct current generators driven by 20-inch special Morgan Smith horizontal water wheels in special spiral casings. Each exciter generator has an induction motor coupled to the shaft at the opposite end from the water wheel. The normal speed on the exciter is 600 revolutions per minute, so that the induction motor is designed for 12 poles, 60 cycles giving a synchronous speed of 600 revolutions per minute. The exciter is normally driven by the water wheel while the motor, which is connected through an oil breaker to the 2,300-volt auxiliary bus, thus runs at synchronous speed and neither gives out power to the bus nor receives power from the bus. However, if the generator on the exciter water-wheel allows a variation in speed the motor acts as a governor and gives power to the bus when there is a tendency for the exciter to speed up and receives power from the bus as a motor when there is a tendency for the exciter speed to decrease. The motor also can drive the exciter in an emergency so that excitation is further insured.

Each exciter has a capacity sufficient to excite the five main units when operating fully loaded at 80 per cent p. f.

The turbine wheels have a rated output of 5400 horsepower when operating at 360 revolutions per minute. Tests on the combined unit of turbine wheel and generator have been taken at 109-foot head. The results of this test of water flow and efficiency at the switchboard are shown in Fig. 7, for values of kilowatts as taken at the switchboard. The gate openings are given below output at the switchboard on the curve sheet. The most efficient point of operation is seen to be at 5/8 of full gate opening. These wheels are all governed by Lombard governors, which operate the segment controlling the butterfly gates. Each governor has a complete emergency auxiliary for closing the gates in case of over speed. This auxiliary is driven by a belt connected to the shaft of the generator.

The generators are rated 3750 Kva, 3-phase, 60-cycle, 360 revolutions per minute, with excitation at 125 volts. While this is the normal machine rating at a temperature rise of 35° C under continuous load, the machines are guaranteed for 4000 Kw at 80 per cent p. f. or 5070 Kva continuously with a 50° C rise on the armature coils and a 55° C rise on the fields. The efficiency of these machines are high, being guaranteed at 94½ per cent at 3750 Kva at 80 per cent p. f. The plotted curve in Fig. 7 shows the combined efficiency of water-wheel and generator at the switchboard. The generators are designed and were tested by the manufacturer for 100 per cent over speed for insurance against damage should the water-wheel governors fail to act and the water wheels run away. The guaranteed regulation at 3750 Kva, 100 per cent p. f. load on these generators is 9 per cent and at 80 per cent p. f. the regulation guaranteed is 24 per cent. At 125 per cent or normal load and at 80 per cent p. f. the excitation is 29 Kw.

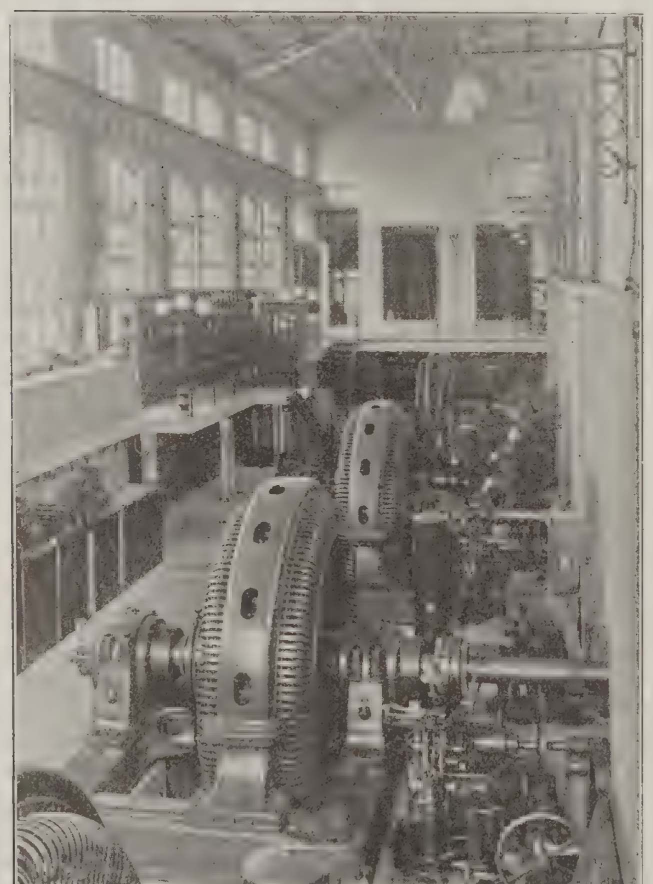


FIG. 2. GENERATOR ROOM OF STATION NO. 1.

The revolving part of each of these generators is 9 feet in diameter and weighs 28 tons. The field spider or hub is made of iron discs on laminations pressed on the shaft and bolted together. The field spool laminations are dovetailed to this spider. This construction gives a high factor of safety for the high peripheral speeds as used. The stationary armature of these machines slide on the base parallel to the shaft so that repairs can be made to any part without tearing down the machines.

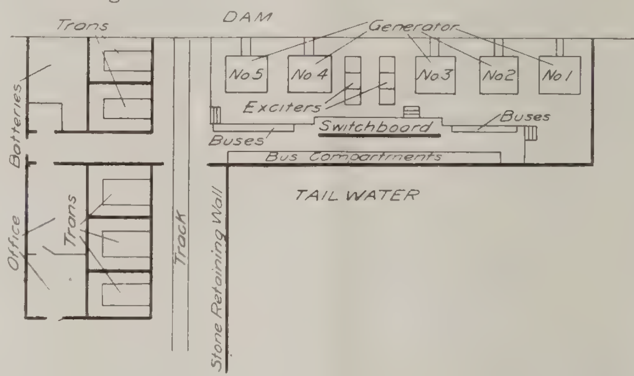


FIG. 3. FLOOR PLAN OF GENERATOR ROOM SHOWING TRANSFORMER, SWITCHBOARD AND BUS LOCATIONS.

The five transformers, one for each generator, used to step u pthe voltage to 66,000 volts, are 3-phase delta connected on the low tension side and star connected on the high tension side. These transformers are of the water cooled type, and each one is installed in its own compartment. Each transformer has a special thermometer connected to a bell alarm to ring when the temperature of the transformer reaches 75° C. As already stated, these transformers are installed in separate bays. The height from the wheel track to top of high tension terminals is 13 feet 10 inches. The transformer tanks are elliptical in section with diameters 9 feet 5 inches and 5 feet 5 inches. Each transformer weighs 27 tons complete and contains 1650 gallons of oil. Each is equipped with a 5-inch outlet which is piped to the storage tank and to the overflow to be used for emergency. The cooling water for each machine passes through three separate cooling coils in multiple, each coil having been tested to a hydraulic pressure of 250 pounds per square inch.

The oil for the transformers can be drained into the storage tank and then treated. By the piping system used the oil from any one transformer can be pumped through a filter and returned to the transformer without interrupting service on this transformer, and can be pumped from the storage tank through the filter press and back into the tank. Treated oil can be held in the tank with a capacity of 2500 gallons or 1½ times that required for one transformer. The transformers have the same normal load rating as the generators—3750 Kva, with a temperature rise of 35° C when using 22 gallons of water per minute. They can also carry 4700 Kva continuously with a temperature rise of 50° C with the flow of cooling water remaining the same. The full load efficiency on these transformers is 98.35 per cent.

On the high tension side of these transformers taps are brought out to give 60,000, 62,000 and 64,000 volts in addition to 66,000 volts while on the low tension side taps are provided for 2090, 2150, 2230 and 2300 volts. The neutral of the high tension winding is brought out and grounded.

The exciters are shunt wound machines designed for operation with a Tirrill regulator. This regulator operates by rapidly cutting out the resistance in the exciter field by means of contacts operated by magnets controlled by a floating main contact which is in turn operated by a potential coil of bus voltage. For operation with this type of regulator the exciter field voltage at normal must be such that inserting about three times the field resistance in the field circuit will lower the voltage to about 20 per cent of normal in a few seconds. In other words, the exciter is working on a steep portion of the saturation curve and responds quickly to changes of field current. With the Tirrill regulator acting on the exciter fields to hold constant bus voltage and with the induction motors connected to the exciter shafts regulating the speed of the exciter, the voltage of the system is held absolutely constant.

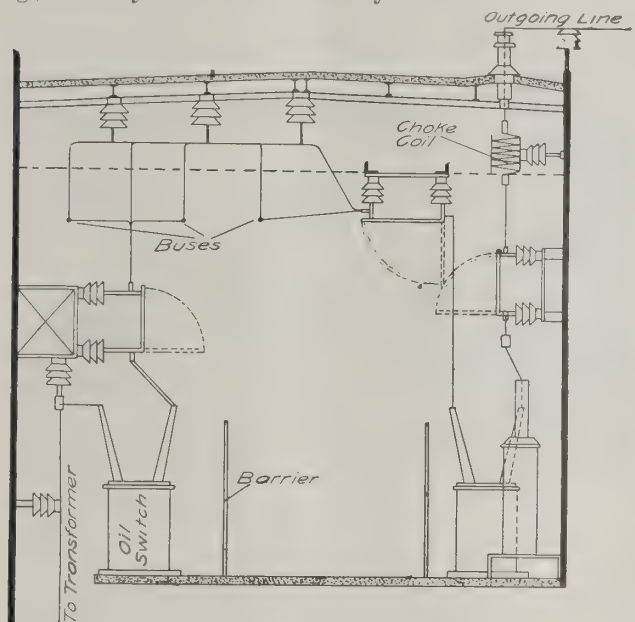


Fig. 4. Section Through High Tension Room.

The exciters are connected at the switchboard so as to operate on one of two sets of buses. There is a common negative bus and two positives so that one exciter can work on one bus and one on the other. The generator fields are connected so that they can be thrown on either bus and in this way two sets of generators could be used operating different lines independently of each other. In fact, the station itself can be operated in two independent sections. The two exciters can be operated in parallel controlled by the Tirrill regulator. The circuit breakers on the exciters are not operated by an overload trip, but are tripped by a reverse current relay.

BUS ARRANGEMENT AND SWITCHING EQUIPMENT.

The layout of the station is shown in Fig. 6 and is of the ring bus arrangement. It can be seen that each generator is connected to its own group bus from which connections are made to the main back bus or transfer bus and also to the transformer corresponding to the generator. By means of the transfer bus all generators can be operated with any transformer. Thus, if No. 1 generator should break down, No. 1 transformer could still be operated from the transfer bus. In the same way, if No. 1 transformer should break down, No. 1 generator could still be operated through the transfer bus.

On the high tension side of the transformers, the leads go through oil circuit breakers to the high tension bus. This high tension bus can be divided so that the station can be operated in two sections with generators paralleled on the high tension side only by having the generators working through the individual transformers or else the generators can all be in parallel on the transfer bus and each half of the high tension bus will have full station capacity behind it. At present one transmission line is taken from each half of the high tension bus to the Cleveland switching station.

The station auxiliary bus is connected to the transformer bus through a Westinghouse type "C" automatic oil switch with inverse time limit relays. From this auxiliary bus are fed the station lighting and A. C. motor equipment for air compressor and filter press as well as the exciter motors. The main transfer bus supplies the potential for the A. C. coil of the Tirrill regulator.

THE SWITCHBOARD ARRANGEMENT.

The switchboard is of natural black slate and consists of eighteen panels arranged as follows: One d.c. auxiliary panel; 2 exciter panels; 2 exciter motor panels; 1 station auxiliary bus panel; five generator and five transformer

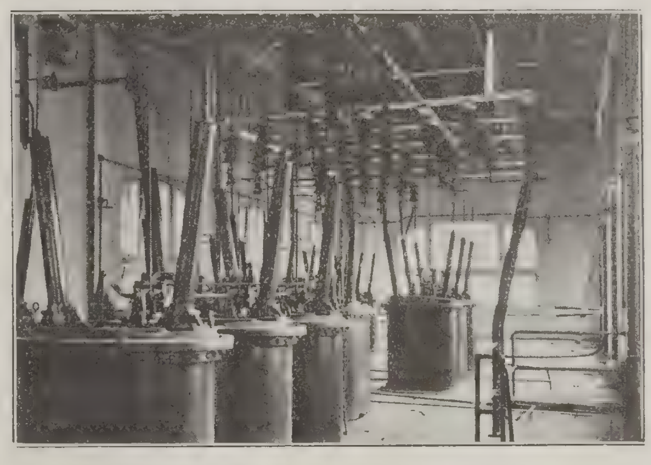


Fig. 5. View of High Tension Room.

panels, and 1 battery panel. The d.c. auxiliary panel contains 800 ampere circuit breakers with switches, by which 125 volts d.c. can be thrown on the operating bus for the gate hoist motors or for the crane. The gate hoist buses can also be thrown on the battery circuit. The regulator panel contains the Tirrill regulator with the operating hand wheel for the equalizer resistance between the two exciters.

The exciter panels are each equipped with shunt trip circuit breakers operated by a reverse current relay. The knife switches are connected so that the negative lead from the exciter is thrown on a common negative bus while the positive lead can be thrown on either of two buses so that there can be two independent exciting sources. Each panel contains a 150 voltmeter and 1500 ammeter.

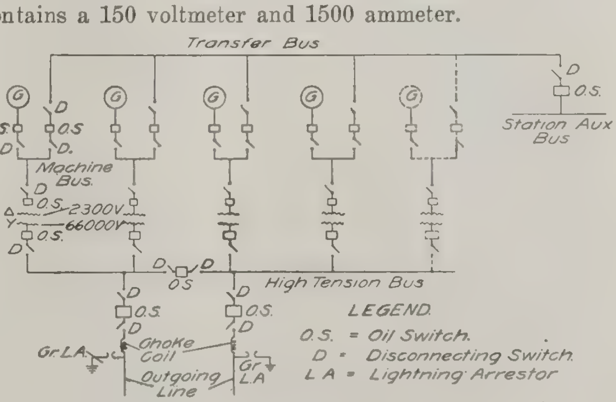


Fig. 6 Switching and Bus Arrangement at Station No. 1.

The exciter motor panels contain each a 60 ampere meter and a zero center indicating wattmeter. This wattmeter indicates whether the exciter motor is delivering power as a generator or receiving power as a motor. These motors each have a 400 watthour integrating meter mounted separately behind the switchboard over the concrete bus compartment. On the exciter motor panels are the control switches for the water-wheel governor and for the type "B" Westinghouse oil switches by which the exciter motors are connected to the auxiliary bus. These switches are non-automatic, but an indicating lamp on the panel is lighted by an overload relay when an overload results on the motor. Each motor panel also contains the control switch for operating its exciter turbine headgate.

The A.C. station auxiliary panel contains the control handles for the type "C" automatic oil switch which connects the auxiliary bus to the back bus and the control handle for the automatic type "B" oil switch controlling the transformers for power to station auxiliaries. Both switches have inverse time limit relays set to trip the switches. Switches for the auxiliary station feeders are also on this panel. These double pole switches are also made so that these feeders can be thrown on the d.c. circuits in case of emergency.

The generator panels are each equipped with a single pole double throw field switch for throwing the generator field to the positive bus, the other end of the field being tied to the negative through the generator rheostat. There is also the master switch for the individual governor control with control switches for operating the solenoid operated oil switches—between generator group and transformers, between group bus and generator and between group bus and transfer bus. Each generator panel has a field ammeter to read 400 amperes at full scale—a power factor meter—a polyphase indicating wattmeter with 6,000 kw. scale and one ammeter with a full scale of 1,600 amperes. This ammeter reads the resultant current in the common connections of the two current transformers that are used to read current in the 3-phase circuit and to supply the wattmeters. At the control switch for the generator breaker is the synchronizing receptacles. In synchronizing two plugs are used as will be described. For each generator there is a 6,000 watthour integrating meter mounted behind the switchboard on the bus compartment and also an indicating recording wattmeter.

Each transformer panel contains three ammeters to read the current for the three phases. This panel also contains the high and low tension transformer oil switch controllers. There is also on each transformer panel a voltmeter plug going to the voltmeter on a swinging bracket so that voltage can be read when synchronizing. There is also a synchronizing plug. In synchronizing a generator, the synchronizing can be done with the transfer bus or with the low tension side of the transformer. There are two plugs which turn in opposite directions in the receptacle. The plug for the running machine makes contact to one side of the synchroscope. The closing coil of the solenoid operated oil switch acts through a set of contacts in the synchronizing receptacle. The plug for the incoming machine thus has to be in before the generator switch can be closed. This insures care in bringing the machines into synchronism. The low tension transformer switches are automatic and synchronizing is naturally done through this switch, back to the generator after which the oil switch between the group bus and main transfer bus is closed. This means of course that the generator and transformer are worked together as units when possible. If a generator is used alone without its transformer it is synchronized directly with the transfer bus. The outgoing line switch control is on the panel of the transformer which corresponds to the location of the outgoing line oil switch in the high tension room.

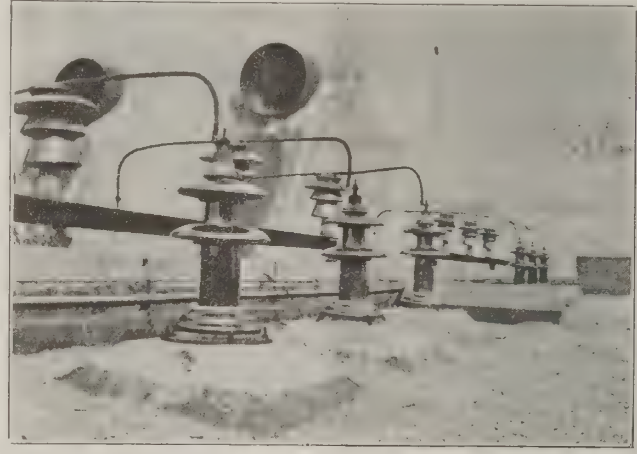


Fig. 8. Roof Bushings for Outgoing Lines.

The battery panel contains the switches for controlling the battery charging generator and its driving motor and also the switches which control the voltage supply to the control mechanism and indicating devices. There is a 75 ampere meter for reading battery discharge and there is also a 75 ampere zero center meter for use when charging. The voltmeter used with the battery is mounted on the swinging bracket at the end of the board next to the battery panel. From this panel the supply buses for the operating solenoids are taken and also the bell alarm relay is located at the back of this panel and connected to the relay bus.

There are two swinging brackets—one at each end of the board. At the end of the board next to the Tirrill regulator are two voltmeters, one bus and one incoming machine or transfer voltage. The frequency meter is connected to the machine voltmeter leads so that voltage and frequency are both read when the plug is inserted for any machine. At the battery end of the switchboard on the swinging bracket are the synchroscope, battery voltmeter and another

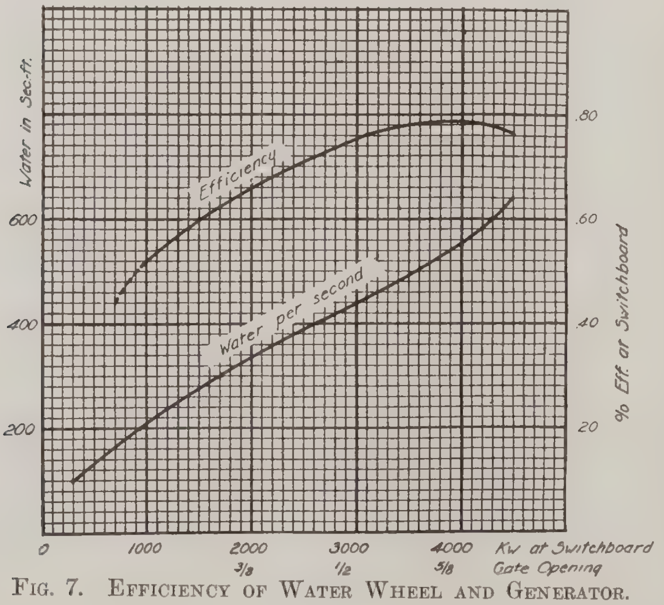


Fig. 7. Efficiency of Water Wheel and Generator.

voltmeter calibrated in tenths and also in feet to show the position of the head gates.

The switchboard is complete with mimic bus which shows complete layout from generator to outgoing lines. Each oil switch has indicating lamps to show red when switch is closed and green when switch is open. The disconnecting switches are shown also so that the operator has the complete station layout and condition of apparatus placed before him. The little single pole double throw switch controlling the head gates has red and green indicating lamps, red showing the gate to be open and penstocks filled.

STATION LIGHTING.

The station lighting throughout is at 110 volts with a double throw switch on the auxiliary panel so that the lights can also be thrown on the exciter circuit. From the switch at the board the circuits go to a panel box at the end of the switchboard from which the generator floor circuits feed. Another panel box located in the hall at the opposite end of the room contains the distributing switches for the high tension room and the transformer bays. In the main building the lighting is by an ornamental bracket at each pillar. Each bracket contains two 100-watt tungsten lamps. Over the switchboard the tubular lamps are operated direct from the battery. At each end of the switchboard is an ornamental pedestal with three lamps. These lamps are wired to a no-voltage relay on the back of the auxiliary panel. This relay throws the pedestal lights on the battery in case of failure of voltage on the station auxiliary bus so that the switchboard is lighted in case of an emergency.

The battery for operating the control circuits consists of 52 cells with a normal eight-hour rating of 20 amperes. The charging generator set is located on the generator floor at the end under the switchboard gallery.

ARRANGEMENT OF CABLES AND WIRING.

From the main generator, the 2,300-volt lines go through 2½-inch fiber conduit direct to the generator switch which is the Westinghouse type "E." Each line consists of 2-750,000 cm varnish cambric lead covered cable laid in single ducts. From this oil switch the lines go through disconnecting switches to the group bus. From the group bus the lines go to the disconnecting switches and then to the transformer low tension oil switch. From this type "C" Westinghouse oil switch the leads go to the low tension side of the transformer direct through the fiber conduit. The transformer leads are the same size as the generator leads and each cable is laid in its own duct. Where the cables pass through the manholes they are wrapped with asbestos to prevent injury to the cable sheath from mechanical forces or from induced currents in the sheathing. This type "C" switch is the only automatic switch in the main power circuits.

From the group bus the cables for the tie to the back bus pass through disconnecting switches to another type "E" oil switch and again through disconnecting switches to the back of transfer bus. All fiber conduit for generator cables are laid in the floor concrete.

From the high tension side of the transformers, the neutral lead goes direct to ground. The three line leads are of copper tubing and go from the transformers direct to the high tension transformer switch. From this switch (type G. A. Westinghouse) the leads pass through disconnecting switches to the high tension bus. The incoming leads are mounted on the 66,000-volt 3-petticoat Mershon type insulators. The disconnecting switches are mounted on channel iron supports by iron clamps cemented to the insulator heads. The high tension bus is supported by pin type insulators from the steel truss work. The three buses are horizontal so that the incoming leads and outgoing leads are supported above the bus by insulators hung from the roof purlins. The outgoing line circuit breakers have disconnecting switches between the outgoing line and breaker and between buses and breaker. Outside of the line disconnecting switches are the choke coils from which the line passes to the roof bushings and out to the towers which are located at the side of the high tension room.

FIG. 9. NORTH END OF STATION SHOWING OUTGOING LINES LEAVING HIGH TENSION ROOM, LIGHTNING ARRESTERS SHOWN AT SIDE BELOW.

Just outside the roof bushing, the taps for the lightning arresters are taken. These taps go down the side of the building to the horn gaps of the electrolytic arrestors. These arrestors are of the three-tank type used with grounded neutrals—one complete arrestor being used for each outgoing line. These lightning arresters have seen hard service during their year of operation. The section of country covered by the Tennessee Power Company's lines is subject to very severe lightning storms, and during the summer months the arresters have had very severe service. Each tank contains 150 aluminum trays separated by porcelain spacers and filled with an aluminum electrolyte. The electrolyte in one tray makes contact with the next tray above it. This electrolyte has a slight surface film of aluminum which will break down at about 320 volts. When a current then passes, this film reforms due to the current and the potential per tray has to increase again beyond the breakdown voltage before the arrester will again discharge. These arrestors are thus pop-valves for the system.

HEAD GATE CONTROL.

The motors operating the gear trains for the penstock head gates can be operated from the switchboard or from the top o fthe dam. The main penstock gates have 11 Hp. compound wound d.c. motors, while the exciter gates are operated by 5-horsepower omtors of the same type. For each motor there is a panel mounted on top of the dam. The supply for these motors is taken from the switchboard by a pair of buses which run the length of the dam between penstocks. The supply to the motors is made by four contactors which operate in pairs, one pair used in raising and one pair in lowering the gate. The operating coils for the contactors are controlled by a single pole double throw switch. The middle point of this switch is connected to the positive bus and from this switch the circuit passes through the energizing contactor or coils through the limit switch to

Fig. 10. Types of Steel Towers and Wood Pole Construction.

the negative. This limit switch consists of a pair of sliding contacts which are operated by a worm gear and are set to open the closing contactors when the gate is almost closed and also opens the opening contactors when the gate is almost open. In this way there is no jamming of the gates. The brake coils for the motor are directly in series and the brake releases when current is thrown on the motor and closes when the contactors open. By this method there are no auxiliary relays or jam magnets to become inoperative and the worst condition could be only the blowing of the fuses, which are in each individual motor circuit. The same gear that operates the limit switch also has a set of sliding contacts which make contact with a series of buttons going to a resistance connected directly across the positive and negative buses. This sliding contact has a lead going back to the voltmeter at the board which is calibrated to show gate position. This connection of motors requires only three small leads to go to the switchboard from each gate motor, one to the indicating device and two to the single pole double throw control switch.

TRANSMISSION LINE.

As shown on the plan of the building, the high tension room has its long axis at right angles to dam. The lines going out from the roof bushings, go out parallel to the dam to dead end towers located on the side of the hill. The lines are arranged flat from the roof bushings to these towers and form an outside bus. The transmission lines come from the main towers parallel to the high tension room and are anchored to the dam by suspension insulators formed of 5 discs anchored to the dam. The connections are made by vertical jumpers to the overhead wires coming from the roof bushings.

From the station the two lines go on separate double circuit Milliken towers until the Ocoee river is crossed, after which wooden poles are used with wish-bone crossarms. The poles are 40-foot standard height with spacing of wires at end of wish-bone 6, 8 and 10 feet. The two circuits are of No. 1/0 copper. The standard wish-bone construction lends itself readily to transposition and angles by the use of a third arm, as shown. The insulators as used are four 10-inch discs in series. These discs are the Ohio Brass suspension type, each disc having a flashover voltage of 75-80 kilovolts and a high efficiency. Each pole line carries a ground wire of No. 8 copper clad steel wire supported on the pole top by low voltage insulators. This wire is grounded about every fourth pole. The pole spacing is approximately 35 to the mile.

CLEVELAND SWITCHING STATION.

The Cleveland switching station forms the real load center of the system and from this point the lines radiate to the different cities. The station is situated about one mile from Cleveland, and thus gives it the following distances: 14 miles from Parksville; 26 miles from Chattanooga; 69 miles from Rome, Ga., and 85 miles from Knoxville. From the switching station two lines go to Chattanooga, one to Rome, Ga.; one to Knoxville and one to Cleveland. As the Cleveland line is tied in with one of the Chattanooga lines just outside of the switching station, there are really two incoming lines and four outgoing lines to this station. The Knoxville line feeds Athens, Tenn., Lenoir City and Sweetwater.

As the name indicates, this station is simply a switching station. The incoming lines enter through roof bushings and go to a disconnecting switch and then to a 66,000-volt G. A. oil breaker through another disconnecting switch to the roof bushings to the bus. This process is reversed for the outgoing line, the circuit being from bus to roof bushing to disconnecting switch to oil breaker to disconnecting switch to roof bushing to line. The high tension buses are located on the roof and consist of .84-inch copper tubing mounted on pin type 66,000-volt insulators on a steel framework. This bus can be divided by a tie bus switch. One line from Parksville feeds each half of the bus so that at any time it is considered advisable the two ties of the station can be operated separately.

The operation of the oil circuit breakers is handled by remote control from the Cleveland power house, which is

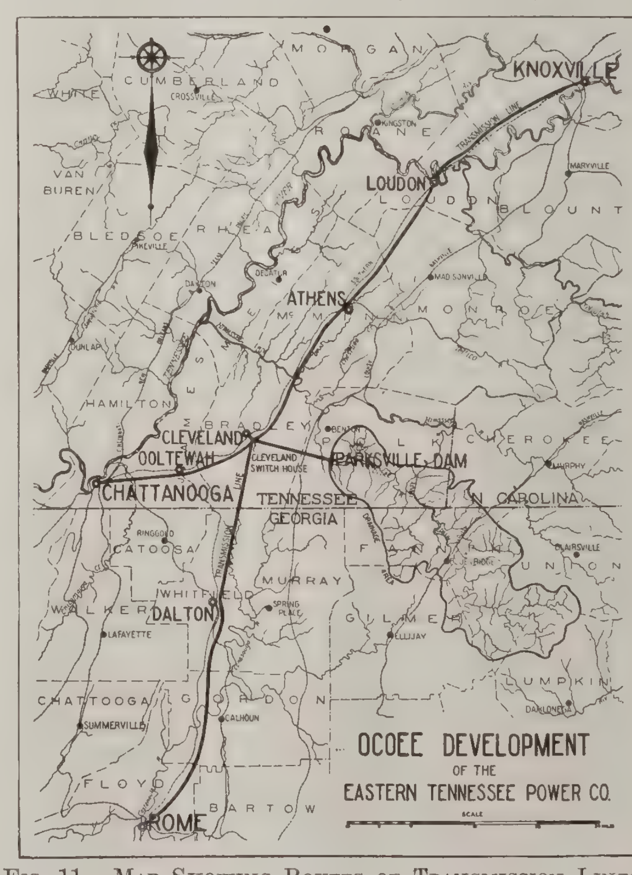


Fig. 11. Map Showing Routes of Transmission Lines.

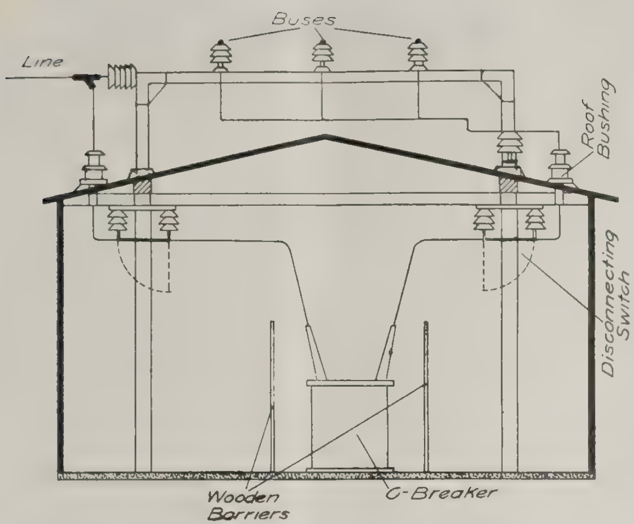


Fig. 12. Section of Cleveland, Tenn., Switching Station.

also a steam auxiliary of the Tennessee Power Company. There is a panel installed in the Cleveland power house with operating handles for each switch at the switching station. Each switch has its indicating lights to indicate whether the switches are open or closed. The operating wires are brought from the Cleveland switch house through a 26 conductor cable suspended on poles, between the Cleveland switching station and Cleveland. The solenoid operated high tension circuit breakers are thus operated at a distance of one mile from their location.

The building itself is 30 feet wide by 90 feet long and about 18 feet high. It is brick with a concrete roof and tar paper and gravel covering. The roof bushings (42 in number) are sent in forms made in the roof concrete with the anchor bolts set in the concrete. These points are then covered with tar and are waterproof in every way. The oil switches are set parallel to the long axis of the building so that the electrical circuit is through the building at its narrowest diameter. The tie bus breakers are at right angles to the other breakers so that the buses can continue direct through these oil breakers. The disconnecting switches are manually operated and give a 30-inch break. The roof bushings are all Ohio Brass Company's No. 10657.

At the present time, the Tennessee Power Company is giving highly satisfactory service and cheap power to the Chattanooga Railway & Light Company, as well as to

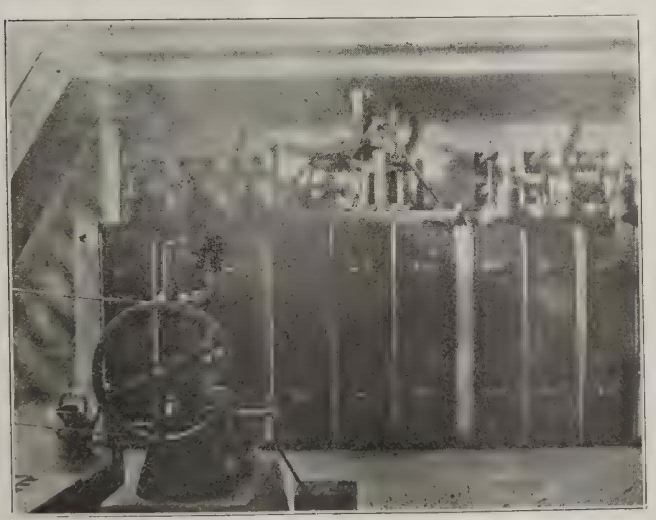


Fig. 13. Types of 2300 Volt Oil Switches.

Rome, Knoxville, Athens, Tenn., Sweetwater, Lenoir City and Cleveland. With the present development there is to be linked the new 30,000 kw. development eight miles above Parksville on the Ocoee. This will be ready about June 1, 1913. After that, there are two other stations of equal capacity or greater capacity, to be developed, which will make the Tennessee Power Company one of the largest systems in the South, and will furnish Eastern Tennessee with an unlimited supply of power. A transmission line is in process of construction to Nashville, and will be ready when the No. 2 station goes into operation.

The entire development at Parksville was done by J. G. White & Company, and the work at Caney Creek, now nearing completion, is being done by the same company.

Convention of Tri-State Water & Light Association.

The Tri-State Water & Light Association will hold its second annual convention at Charlotte April 15 and 16. This association was organized June 28, 1911, and now has an active membership of superintendents and managers of waterworks systems and electric light plants, of about 50 in the states of North and South Carolina and Georgia. The association has the support of manufacturers and dealers in supplies for these departments through associate memberships.

The object of this association is to bring together those in charge of municipal plants for the discussion of common problems and the promotion of economy, efficiency and uniformity of operation of electric plants and pumping stations, as well as for furthering the interests of consumer and supplier. At the convention held in 1912 an interesting program was carried out and enough interest created in the work of the body to assure a much more successful meeting this year. An elaborate program is planned for the coming convention, including papers on important topics to be presented by influential men connected with the departments of the different cities and by representatives from the manufacturing companies.

The program will include addresses as follows: "Conservation of Purity of Public Water Supply," by J. L. Ludlow, of Winston-Salem; "Preventable Economic Losses in the Operation of a Boiler Plant," by M. F. Corbin, Philadelphia, Pa.; "The Effect of Purification of Water Supply on Health of Community," by G. H. White, of Columbia, S. C.; "Fire Prevention and Fire Protection," by A. M. Schoen, Atlanta, Ga. An address on a lighting subject will be given, the subject and speaker as yet not being announced.

The following officers have served during the past year and will retire in favor of others to be elected at the coming convention. President W. F. Stieglitz, commissioner of public works, Columbia, S. C.; first vice-president, W. E. Vest, superintendent water and light plant, Charlotte, N. C.; second vice-president, George Hubbard, superintendent water and light plant, Monroe, Ga.; third vice-president, B. F. Erwin, president Hersey Manufacturing Company, Atlanta, Ga.; secretary-treasurer, J. W. Neave, superintendent water and light plant, Salisbury, N. C. According to the constitution of the association the first vice-president is advanced to president. It is therefore expected that W. E. Vest will serve during the coming year. He is a man of much experience and capability and will ably continue the work of Mr. Stieglitz, who is said to be the father of the movement, and who by special request has served as its president since its organization.

The Design of Steam Power Plants

(*Contributed Exclusively to* Electrical Engineering).

BY EARL F. SCOTT, M. E., MEMBER A. S. M. E., MECHANICAL ENGINEER, ATLANTA, GA.

Section 1. Selection of Sizes of Units and Specifications of Apparatus.

IN THIS series of articles the writer will discuss the details of the design of small steam plants, those with a capacity ranging from one to five thousand kilowatts. The subjects and conditions under which they will be treated are explained in the foot note below. The articles will discuss the mechanical and steam end of the different plants and not attempt to develop the electrical end.

In connection with such plants as the writer has in mind, the mechanical end begins at a certain fixed point and extends in one direction, while the electrical portion extends in the opposite direction. However, use may be made of motor drives in connection with the power house machinery where desirable, merely as prime movers, but no attention will be paid to the design of equipment beyond the efficiencies such machines may have over steam driven machines.

As already stated, definite examples as far as possible representing actual cases will be used for illustrations. The first design will be a 2,000 kilowatt power plant furnishing light and power in a small municipality as well as furnishing current for manufacturing purposes. The first and principal item to consider is a plant where continuous service may be obtained as this is the first question a customer will ask when an attempt is made to sell power or current to him. Since continuity of service is the prime factor in our plant, we must divide the capacity of 2,000 kilowatts into such sizes of machines that the station will not be crippled when any one machine may be out for repairs. Also, we must consider such sizes of machines that we may operate the plant on light day loads without being compelled to run the large units at much less than full capacity. We will therefore assume that the plant has a normal load of 1,500 kilowatts for 10 hours each day, during the hours of 7 a. m. to 6 p. m. From 6 p. m. to 12 p. m. 1,000 kilowatts. From 12 p. m. until 7 a. m. 600 kilowatts. These loads are selected as nearly as might be expected under such actual conditions.

By studying the conditions, it will be observed that the following machines will operate in combination and give good results: one 1,000 kilowatt turbo-generator and two 500-kilowatt turbo-generators. With these machines we may make the following combinations: The 1,000 and 500 together will give 1,500 kilowatts with one 500-kilowatts for repairs. Two 500-kilowatt machines in operation will leave a period from 6 p. m. to 7 a. m. for repairs on the 1,000-kilowatt machine. It will also be noted with these combinations that the machines will be running at full rated capacity, which is the most economical condition. The overload capacity of the machines will further care for any peak loads.

We have now decided on the size of units to purchase. The next consideration is the specifications covering these machines. In preparing a specification for any machine, it is best not to limit the manufacturer by too rigid guarantees, as such guarantees will force machinery builders into making

Note: In a series of articles, of which this is the first, the writer proposes to present the fundamental principles upon which the good design of a steam power plant should be based. He does not claim to present any undiscovered rules or engineering principles, but will emphasize the important considerations and their relative bearing on each other in the design of the plant in order that the combined economy may be the highest at the least possible expense. Further, little if any of the basic theory will be presented or formulas or factors explained in such detail as to require a mathematical discussion. The writer will stand in the position of a consulting engineer throughout this series, presenting to the best of his ability the design of a particular power plant equipment from the standpoints that he has found, through his experience, economical in first cost of apparatus, installation, and operation. On account of the position he will thus assume, the reader may consider, therefore, that all data has been carefully weighed and is in accordance with the best engineering theory and practice. Such data can be checked by referring to any of the standard text books available and to the note books of consulting engineers who have collected other similar information.

The method of treatment in these articles may be open to criticism by the severely analytical reader in that certain details are excluded from the statement of conditions under which the plant is designed. For instance, no load curve is presented from which to determine economy of operation and to select sizes of units which would undoubtedly be the writer's method of approach, were he to undertake the design of a particular station where he could secure all of the details necessary. As a reason for the method of treatment in these articles, the writer desires to emphasize the fact that in what he shall present, strict adherence will be made, first to methods in power plant design, and second to an interpretation of these methods, enabling the engineer to select apparatus for a steam plant, prepare the specifications that are necessary and only such, and to analyze bids when purchasing the apparatus, and finally, to install the apparatus for best efficiency and economy. The many details referred to will of necessity bring in assumptions of one kind and another and would prevent giving the true importance to the essential parts of the design, were it carried out in any other way than outlined. As already mentioned, the writer's experience will form the basis for adjustment of the minor details to the important ones, so that the latter will be presented in their true proportion and significance, from the standpoint of actual design and construction. In what follows, therefore, there will be no pose at designing a plant with erection details or designing a plant to prove that the well established theory on which design is based is correct, but to design a plant in such a way as to furnish the mechanical and electrical engineer who knows his conditions, whether in mill, factory or central station, a basis upon which to work out his own problems, or at least to know how they can best be attacked by competent engineers and the design made, the apparatus purchased, and the plant installed with a reasonable assurance that it will operate as originally supposed.

The order in which the subjects will be treated and the conditions under which they will be worked out in separate articles as far as possible, are as follows: (1) The selection of the proper sizes of apparatus with sufficient specifications on each machine to force the manufacturer to bid on the type of machinery desired, but sufficiently open to allow each machinery builder to bid on his particular type of machine. (2) In the second article it will be assumed that bids have been received from the several bidders. An analysis will then be made of the merits of each bid, and the machinery to be installed in the particular plant decided upon. In selecting this machinery, the names of manufacturers will not be given, although specific designs will be referred to, so that there will be no reason for partiality to be shown. (3) In the third article, the machinery will have been selected and the discussion on the layout of the plant will be taken up, showing plans and elevation, and giving a discussion of the best arrangement of machinery for the best results. This layout will also show the detail pipe arrangement. (4) In this article the writer will take up the specification of the pipe work and the other small apparatus that may be required in connection with the plant, but not included in the specification. (5) The fifth and final article will be devoted to a discussion of the finished plant as a whole.

special machinery, which necessarily the purchaser must pay for. Therefore, it is advisable to prepare specifications in such a manner as to force the builder to come up to standard guarantees but permit them to specify in their detailed proposition just what they will furnish. It will be necessary, however, for the owner or purchaser to give some conditions, natural or otherwise, that may govern the machinery selection. With this in view, we will give what may be considered location of plant and natural advantages.

The size of the plant under consideration has been given and a site has been selected where plenty of good water may be obtained for condensing purposes, and boiler feed water. Also the location of the plant is such that it may be reached by a railroad side track for hauling coal.

The necessary considerations in the specification from which we may purchase machinery are as follows:

TURBINES. So far as the generator is concerned, we will only mention the type we will require: For this service, alternating current, 3-phase, 60-cycle, 2,300 volts will be considered advisable for the lighting and power demands. The sizes of the units have been selected above, and what may be said here will apply to all machines. Either a low or a high-speed machine must be selected. Practice will show that moderate and high speeds are being installed in the newest plants. A speed of 3,600 revolutions per minute will then be specified.

In order to furnish lighting service of the highest character, it will be necessary to secure machines that will be constant in speed. Therefore it is important that the builder furnish a machine with a turbine that will control within 2 or 3 per cent. Next, it is important that the guarantees on the different makes of machines be brought out in the manufacturers' proposal. For instance, they should state what amount of commercially dry steam at the operating conditions given, will be required per kilowatt or brake horsepower. This should show the guarantees at 1-4, 1-2, 3-4, full load and 25 per cent overload. Also the temperature rise of the generator should be specified for the machine operating at a 25 per cent continuous overload, also 50 per cent overload for short periods. As to the details of the machine, such as bearings, oiling devices and other parts, nothing should be said in the specifications further than to require the manufacturer to bring out these points in full in his detail specification, so that a thorough comparison can be made of the several machines.

With this explanation of the selection of the turbines, we will now tabulate these requirements into a short specification:

SPECIFICATIONS FOR TURBINES.

SIZES. One 1,000-kilowatt turbo-generator, and two 500-kilowatt turbo-generators. Each machine to produce these ratings at normal load, the maximum load to be 25 per cent above normal rating for continuous service.

OPERATING CONDITIONS. Turbine to give normal rating when furnished with commercially dry steam @ 150 pounds pressure at boiler (gauge) and 150 degrees superheat at throttle of turbine. A 27 3-4 inch vacuum to be maintained at point beneath turbine when barometer is 29.92 inches (mercury col).

CONTROL. The machines shall govern the speed within 2 per cent when running at all loads.

DETAILS. A detail specification shall accompany each bid giving in full a description of the machines with drawings showing outlines of the machines. Also working drawings shall be furnished as soon as practical, after contract is awarded.

EXCITER SETS. It will be necessary to secure exciter sets for the alternators to suit the conditions and types of machines; therefore, it will be in order to prepare a specification covering same. It is not good economy to run a steam driven exciter set continuously as the steam consumption is high. On the other hand, we can not start up on a motor driven set. Therefore, we will select one of each, the steam-driven set to be used for starting up and also for lighting the plant, when the other machinery might be shut down, the motor-driven unit being for continuous service. Each set should be large enough to excite the full capacity of the plant, say at 1,500 kilowatts, when running at normal load, and the overload capacity of the exciters would care for the overload of the machines.

SPECIFICATION FOR EXCITERS.

There shall be two exciter sets—one steam-driven and the other motor-driven.

CAPACITY ELECTRIC-DRIVEN UNIT. The exciter shall be of sufficient capacity to excite the full capacity of the plant at 1,500 kilowatts plus a lighting capacity sufficient to light the plant with 50 40-watt lamps The generator to be driven by a direct connected synchronous motor mounted on an extended base with flexible coupling connecting same. The motor to be designed to run on current furnished by plant. A detail specification to be furnished covering the unit.

STEAM-DRIVEN UNIT. There shall also be furnished one steam-driven exciter set with a capacity the same as mentioned for the electric-driven set. This unit shall be driven by a non-condensing steam turbine direct connected to the exciter and mounted on an extended base. A full specification covering the details of the turbine shall be furnished, giving full characteristics of the machine.

BOILER EQUIPMENT. The first consideration in connection with boilers is the sizes that will be required. In order to determine these sizes we must go back a step. It has been found that the normal load developed will be 1,500 kilowatts. We can assume under the operating conditions, that it will require 22 pounds of steam per hour per kilowatt developed. Therefore, we will require a total of $1500 \times 22 = 33{,}000$ pounds of steam per hour to operate the turbines on average load.

An additional amount of steam for the auxiliary machinery, such as boiler feed pumps and condensers, must be provided for if it is decided to install this apparatus steam driven. It is good practice to figure about 10 per cent of the turbine consumption to run the auxiliaries. On this basis it is found that the steam required is 33,000 pounds plus 3,300 pounds, equals 36,300 pounds of steam per hour. After we have proceeded further with the discussion of auxiliaries we will check back on the assumption of 10 per cent for auxiliaries and if too great a discrepancy is found the figures will be revised. This cannot be done at this point, as we are not ready to figure the actual steam required for the auxiliary machinery.

The next determination is the boiler horsepower required for the plant. A boiler horsepower is the work represented in evaporating 30 pounds of water into steam from 100 degrees feedwater temperature to steam at 70 pounds pressure, or 34½ pounds of water evaporated from and at 212 degrees temperature of feed water. Thus, 36,300 divided by 30 equals 1210 boiler horsepower. Therefore, we will require 1210 boiler horsepower in boilers for the plant when developing 1,500 kilowatts. It will be necessary to divide the boiler capacity up into units of practical sizes. In selecting the boilers it is good practice to arrange the units in such a manner that we may always have one unit in reserve for repairs, etc. With this in view, we will select four 400-horsepower units which will give 1,200 boiler horsepower and one unit for reserve.

Having determined the size of units required, we next determine the type of boiler to install. From the service required of the boilers and the size selected, it is almost imperative to decide on the water tube type for the plant. In addition to this, for the nature of the plant discussed, the water tube boiler is the proper type to select. In regard to type of specifications the same remarks apply to the selection of boilers as to the selection of turbines. That is, let the manufacturers bring out the good points of each boiler in their proposition. With this in mind it will only be necessary to give the governing conditions which may apply to any first class water tube boiler.

SPECIFICATIONS FOR BOILERS.

SERVICE. Each boiler must be designed to deliver steam at 150 pounds (gauge) pressure, and 150 degrees superheat (see superheaters).

CAPACITY. Each unit shall be capable of developing 400 boiler horsepower, based on 30 pounds of water evaporated from 100 degrees temperature into steam at 70 pounds gage pressure.

HEATING SURFACE. Each unit shall also be based on 10 square feet of heating surface per horsepower. The ratio of grate surface to heating surface shall be such as to permit the use of run of mine Bituminous coal.

UNITS. There shall be four units each 400 horsepower capacity.

SUPERHEATER. Each boiler shall be fitted with an internally fired superheater capable of superheating the full steam capacity of the boiler 150 degrees.

ACCESSORIES. Each boiler shall be fitted with proper safety valves, blowoff valves, gages,, water columns and firing tools. Each proposal to name in detail just what will be furnished with each boiler.

DRAWINGS. The manufacturer will be required to furnish full working plans of the boiler setting and foundations.

BOILER ERECTING. The manufacturer shall submit the price based on boilers erected on foundations furnished by owners.

BRICKWORK. The purchaser shall furnish all fire and common brick for the boiler setting, furnish all labor and other materials for the brick work, but the manufacturer must furnish a competent erecting man to supervise the brick setting.

By preparing the specifications as noted above, we give the salient points required to enable and require responsible boiler manufacturers to bid on the boilers required, while on the other hand, we have left the specifications open so as to get full benefit of competition and still be in a position where we can make a final selection from the units of the different boilers offered by studying the propositions.

The next step will be to select the size of boiler feed pumps and prepare specifications for same. The first determination is the amount of water that will be handled by the pump. From the boiler calculations we have found that 36,300 pounds of water (steam) per hour will be required to run the plant. Reducing this to gallons per minute we find $36{,}300 \times .002 = 72.6$ gallons per minute required. Having determined the amount of water per minute we can prepare a pump specification.

SPECIFICATIONS FOR PUMPS.

PUMP CAPACITY. Two pumps, each large enough to deliver 75 gallons of hot (210 degrees) water per minute when running at a piston speed not to exceed 60 feet per minute, are required. The velocity of water through the ports of the pumps shall not exceed 250 feet per minute.

TYPE OF PUMP. Each pump shall be of the duplex pattern, inside packed plunger type. It shall be fitted with rubber valves suitable for hot water service.

SERVICE OF PUMP. Each pump must be capable of pumping against a pressure of 200 pounds of water pressure when furnished with steam at 150 pounds pressure.

DETAILS. Detail specifications with illustrations must be furnished.

In selecting the pumps we could have specified a particular size of pump, as we have been definite in our piston speed. Had this been done, it would have been necessary for each manufacturer to submit prices on the one size and thus not provide for the chance that some other condition might influence a more favorable price. Therefore, with the above specification, all that will be necessary is to check up the detailed proposals to see if they come up to the specification and select the one best suited to conditions, considering price.

Our next step will be to select feed water heaters, with two general types to select from. One is known as the open type heater, where the steam comes in direct contact with the feed water, and the other the closed type, where the steam (heating medium) is kept separated from the feed water. The writer is convinced that the closed type of heater has no place in the plant under discussion, still we will in all probability find advocates for the closed type in such an installation. Therefore, we will give some advantages and disadvantages of each type before selecting the heater. The closed type heater is made up of a cast-iron shell with usually copper or brass tubes. The feed water passes through the tubes and the steam (exhaust) or heating medium passes on the outside. The water being heated by means of transmission of heat through the metal surface. The only advantage of this type of heater would be to prevent the oil in the exhaust steam from coming in contact with the feed water and eventually getting into the boilers. The disadvantages are several, the tubes or heating surface become dirty from deposits from the water, such as carbonates, which are precipitated at or below 210 degrees temperature, and have to be cleaned. The tubes have to be packed to prevent leaking, which is a decided disadvantage. Another disadvantage is the fact that it is impossible to heat the water as hot as the exhaust steam, or in other words, the difference of temperature between the water and heating medium will be from 5 degrees to 15 degrees, which is a total loss, as the difference can be reduced to zero in the open type of heater. The open type of heater has the disadvantage of a possibility of passing oil from the exhaust steam into the boilers. The difficulty can be and is overcome by an oil separator, which is sold with and attached to the heater as a part of it, and requires only occasional attention for cleaning. In the particular installation considered this difficulty of oil will not be great, as most of our exhaust steam for boiler feed water will probably come from the condenser turbine, which will be non-condensing in all probability. The oil trouble is about the only serious argument that can be brought against the open type of heaters, and in favor of this type the following can be said: The feed water temperature can be brought to within one or two degrees of the exhaust steam without putting a back pressure on the auxiliary machinery. We can also dispose of the sediment or precipitation that will fall upon heating the water to the required temperature and often it may be blown off without stopping the heater. The heater is not under pressure, as in the case of the closed type, consequently it does not require the attention to keep it tight that is required by the closed heater. Having determined the type of heater required, we can prepare a specification covering same.

SPECIFICATION FOR HEATERS.

CAPACITY. The heater shall be large enough to heat 36,300 pounds of water from 60 degrees F. temperature to 210 degrees temperature when furnished with sufficient exhaust steam at atmospheric pressure (212 degrees temperature).

TYPE. The heater shall be of the open type unit, cast-iron shell, removable trays, and to be fitted with an oil separator and filter. The heater may be of the thoroughfare or vacuum type.

ACCESSORIES. The heater must be fitted with maximum and minimum water floats, water glass, water regulating valve and overflow valve.

DETAILS. A detail description, including photographs and drawings, must be furnished with the heater proposal.

SMOKESTACK. In order to complete the boiler room equipment before leaving the subject, the smokestack will next be taken up. While this item does not come under this heading in the fullest sense, we will discuss it briefly in passing. Three types of chimneys may be selected from, the brick chimney, concrete chimney and the steel stack. As to size, there is very little to be said, as it is an easy matter to turn to a good chimney table and select the proper size and height for any given horsepower. In selecting the chimney, it is well to bear in mind the amount of draft required under the boilers. For instance, if a 0.5 inch draft at the grate level is desired, it will be necessary to consider the chimney height for this service. If we were designing a plant where stokers and economizers were to be used, it would be necessary to take these into consideration in selecting the height of stack, as each effects the draft on the boiler. In this particular plant, we will not use either of these, and in selecting the stack will not take either into consideration. While the cost of a brick chimney is three or four times greater than a steel stack, in a permanent plant of this character it is usually good economy to pay the difference and install the brick chimney. If we take into consideration the lining of a steel stack with fire brick up to a distance of about 60 feet from the ground, also the maintenance o fthe steel stack in the way of painting, the difference in cost of the brick chimney over the steel stack will not be as great.

CONDENSING APPARATUS. We now turn our attention to the condensing apparatus. Before we actually select the condenser, it will be well to review the conditions for the most economical layout. In the selection of sizes of turbines, namely one 1,000-kilowatt turbine and two 500-kilowattts, it was the intention to run the 1,000 in connection with one 500, for the normal load. In selecting the condensing machinery, therefore, it will not be good practice to buy a condenser for each machine, but to use one condenser for the two 500-kilowatt machines. This combination is made on account of the fact that most of the time one of the 500-kilowatt machines will not be running. When the two 500-kilowatt machines should be running, it means that we will not get quite as high a vacuum as we would with one, provided the initial water temperature should be at the point the condenser is designed for. If this temperature is below this point, it is probable that even when the two machines are running together there would be very little loss in vacuum. We also have the choice of selecting a condenser a little larger than is required for one machine, which will balance the conditions very well.

In discussing the details of the condenser selection, the first matter to decide is the type required. There are three distinct types, the surface type, elevated jet, or barometric, and the low level jet type. For the services of the plant in question, the last named type has proven most satisfactory, therefore we will decide on the low level jet type of condenser. The other two types have their advantages and for certain classes of service would be preferred. Such conditions, however, will not be taken up here, but a condition will be discussed later involving each type.

SPECIFICATIONS FOR CONDENSERS.

CONDENSER CAPACITY. We will require two condensers, one to be capable of condensing 22,000 pounds of steam per hour, and one 11,000 pounds per hour. Each condenser to maintain a vacuum of 27 3-4 inches at a point beneath the turbines when furnished with condensing water at an initial temperature of 80 degrees F.

TYPE. Each condenser shall be of the jet type and so designed that they may be placed below the outlet on the turbine. (This means to one side, if more convenient).

CIRCULATING PUMP. Each condenser shall be equipped with a centrifugal circulating pump, either direct connected to condenser, or separate, driven by a steam turbine, direct connected. The pump shall be sufficiently large, so that the velocity of water in the pump shall not exceed 10 feet per second when pump is delivering sufficient amount of water to condense steam under above conditions. Details of pump must be furnished by manufacturer.

AIR PUMP. A rotary air pump shall be furnished with each condenser, connected direct to condenser or separate. If direct connected to condenser, the air pump shall be driven by circulating pump turbine; if separate, it may be driven by motor or steam turbine. The air pump shall be of sufficient capacity to handle all non-condensible matter contained in the steam under conditions named above.

AUXILIARY TURBINE. The condenser circulating pump and air pump shall be driven by a non-condensing steam turbine if on the same shaft, the design of which, and steam consumption, shall be given in full in the detailed specification.

SERVICE CONDITIONS. The plant site is such that ample cooling water may be brought to an elevation not more than 12 feet below the injection pipe on condenser. We have selected this condition for convenience; however, this height can vary from zero feet to 18 feet, including friction in injection pipe. A greater lift than this would require special apparatus for raising the water, a condition which we will discuss later.

The Illumination of Store Show Cases

(*Contributed Exclusively to* Electrical Engineering).

BY G. C. CONNER, ILLUMINATING ENGINEER, NATIONAL ELECTRIC LAMP ASSOCIATION.

A Consideration of Illumination Required and Suitable Light Units and Fixtures.

UNTIL within the last year, little attention had been given to the matter of show case lighting. It has been considered in most cases as a minor detail, the chief problem being to obtain adequate, efficient and pleasing general illumination within the shop or store. The commercial value of show cases as a factor in increasing sales was not fully realized. Today the store which takes advantage of every legitimate means of putting its goods before the buying public, pays a great deal of attention to the show window and show case. The show window attracts the prospective customer on the outside, while the show case should further attract this prospective customer after he has been induced to enter, and at least hold his attention until a salesman has an opportunity to exert his influence.

A little investigation will show further that show case lighting is an attractive commercial field for the dealer in electrical fixtures, reflectors, etc., as well as for the central station. If the reader will investigate large stores, he will, in general, find antiquated lamps and fixtures which are poorly arranged, and in some cases no provision whatever for lighting show cases yet in which the best goods are displayed and in the arrangement of which much time and thought has been spent. In some cases it has been found necessary only to call the attention of the management to this condition to secure their appreciation of the situation and in order to install approved lighting methods.

One investigator has found that only 30 per cent of the total number of stores visited had made any provision for show case lighting. He found, however, that in some of the larger stores, where the subject had been given attention, good illumination and a large number of lamps were in use. For instance, in three large stores in New York 2,000 25-watt lamps are used for lighting the show cases. In fact, the proportion of lamps and fixtures used in the show cases compares favorably with those required for show windows. In general, it will be found that the window frontage is only one-tenth that of the length of show cases.

The same factors should be considered in the design of show case lighting as in stage and show window lighting. These considerations are: uniform intensity, absence of glare, shadows, heat produced, neatness of the fixtures and color quality of the light. The intensity of the light should

Fig. 1. Poor Show Case Lighting—Note Glare of Bare Lamp.

be high enough to render the goods in the show cases so conspicuous that attention will be drawn to them. Accordingly, the intensity of the light must be at least double that of the surrounding floor and shelves. The ordinary case is about forty inches high and twenty-four inches deep, and an illumination of sufficiently uniform intensity can be obtained by using 25-watt lamps with proper reflectors spaced one and a half feet apart. Cases in which jewelry, cut-glass or dark goods are displayed should, of course, have higher intensity.

Particular care should be taken to avoid glare. This is an extremely important factor, often entirely disregarded. No direct light from the unit should enter the eye. A bright light is trying to the eyes and is generally irritating. For this reason we instinctively shun a bright light in the field of vision and, for the same reason, unless care is taken to avoid glare, the effect produced by lamps within a show case is just the opposite of that desired.

The effect of glare is shown in illustrations, Figs. 1 and 2. The arrangement shown in Fig. 1 is similar to that most frequently seen and consists of a bare carbon lamp hung near the middle of the case. Fig. 2 shows the result obtained by using a lamp and reflector which have been designed for this particular service. In taking the photographs from which the illustrations were made the exposure and development of the negative was the same in each case, and the prints have not been retouched in any way. The results of good and bad methods of lighting are very plainly shown.

Some trouble from heat has at times been experienced when carbon lamps were used in show cases in which there is little or no ventilation. However, recent tests on installations of tungsten lamps have shown that this difficulty has been overcome by using this type of lamp.

The old style tubular carbon lamp operates at about 3.57 watts per candle, the 30-watt lamp producing 8.4 horizontal candlepower. The modern tungsten tubular lamp consumes 25 watts and produces 21.4 horizontal candlepower. Consequently, the heat radiated per candlepower has been reduced more than 67 per cent. A recent test shows that the rise in temperature of a thermometer, the bulb of which was coated with chocolate and placed three inches from a 60-watt carbon lamp, was from 70 degrees to 90 degrees F. in thirty minutes. The chocolate was appreciably softened, showing that in confectionery stores, at least, goods could not be placed near this type of lamp.

Fig. 2. Good Show Case Lighting With Suitable Lamp and Reflector.

At the same distance from a tubular tungsten lamp of the same candlepower, the temperature rise in thirty minutes was only eight degrees, and at the end of half an hour the chocolate on the bulb was not appreciably affected. It should be noted that in each test there was a free circulation of air.

Tests were made of the average rise in temperature of the air confined in the small show case shown in illustration, Fig. 1, using two 25-watt Mazda tubular lamps. The fixture was similar to that shown in Fig. 3. The case was 48 inches long, 24 inches deep and 40 inches high; the arrangement of goods was as shown. It was found after two hours' burning, during which time the temperature of the store remained practically constant, that the temperature of

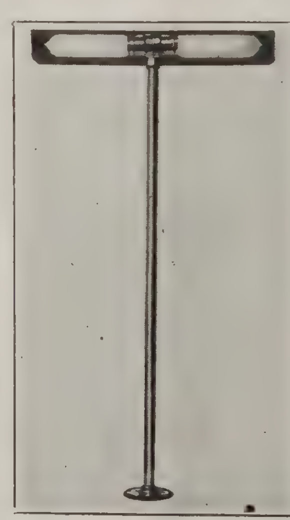


Fig. 3. Light Units and Reflector Used in Fig. 2.

the air 4 inches from the fixture had risen only from 77.5 degrees to 85 degrees F. This test seems to indicate that under ordinary conditions tungsten lamps can be used satisfactorily in show cases and that the amount of heat generated cannot injure even the most perishable goods.

A jeweler in Pittsburg recently reported that he had had trouble in lighting his show cases on account of heat destroying the paste used in certain kinds of jewelry. Experience shows that under ordinary conditions this may be entirely avoided by the use of tungsten lamps, which supply adequate illumination without the undesirable heat radiation.

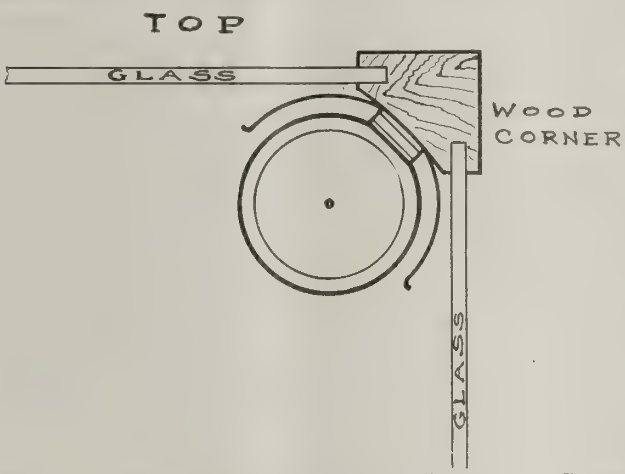


FIG. 4. LIGHT UNITS AND REFLECTOR SECURED TO CORNER OF SHOW CASE.

It is essential that the fixture used in lighting a show case be neat and inconspicuous, and as far as possible it should harmonize with the fittings of the case. The lamp shown half size in illustration, Fig. 5, is 1 1-4 inches in diameter and 5 3-4 inches long, and often supplied with a so-called candelabra case, 7-16 inches in diameter. This permits of a much smaller socket in the fixture and consequently a neater unit can thus be obtained.

There are now on the market a large number of different kinds of fixtures and reflectors for show case lighting. The most desirable method of mounting the reflector is to attach it to the framework of the upper front corner of the case, as shown in Fig. 4. Many types now on the market are designed to be mounted in this way. However, the modern show case frequently has so little woodwork about it that a fixture cannot be attached in this manner and must be supported from the floor, as shown in Figs. 2 and 3.

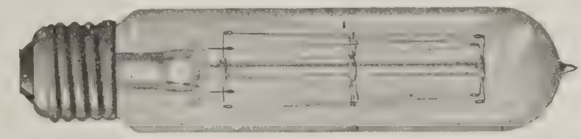


FIG. 5. A TUBULAR 25-WATT TUNGSTEN LAMP FOR SHOW CASE LIGHTING.

Experience has shown that a type of tungsten lamp adapted for show case lighting is the 25-watt tubular, shown in Fig. 5. This lamp has a drawn-tungsten-wire filament mounted on copper hooks, the filament loops being supported at the center. These center supports tend to make the lamp more rugged and prevent crossing of the loops. Recent tests on this type of lamp show that the average rated life of 500 hours to 80 per cent initial candlepower is conservative, and that the performance is in all respects thoroughly satisfactory for show case lighting.

Conditions, Practice and Developments in English Central Stations

(*Written Exclusively for* ELECTRICAL ENGINEERING).

BY CECIL TOONE, AN ENGLISH CONSULTING ENGINEER.

IN ORDER to present in an early issue, a discussion of economic features of electrical supply, including the treatment of consumers, the costs and results of operation, which are of greatest interest to the central station engineer, in that they alone are entirely under his care, the present section will deal only briefly with the generator equipment of English stations. A cursory treatment of generating plant in a review of the whole central station equipment and policy, is justified by the high degree of standardisation now attained. In a number of old stations, situated in areas where development has been slow, queer machinery is still to be seen, but a round of the stations in average English towns is now quite monnotonous, unless one is prepared to go into local circumstances and difficulties and details of plant design and the handling necessitated thereby.

PRESENT INSTALLATIONS.

Table 1 shows the extreme and average characteristics of generation in various groups of English stations, still adhering to the kilowatt grouping hitherto employed in these articles. The predominance of d. c. supply needs no comment. The average station voltage, (at the bus bars), rises from 330 to 615 volts in the d. c. undertakings according to the kilowatt capacity of the plant, and in the a. c. stations, as the total generator capacity increases, the mean station voltage increases from 2000 to 6000 volts. The most frequent supply in a. c. systems is at 50 cycles per sec. and the extreme and average values in various groups of stations are shown in the final columns of Table 1. Among 140 stations, supplying alternating current, 90 work at 50 cycles; 29 at 60-80 cycles; and 22 at 90-100 cycles per second.

By far the most common consumers' pressures lie in

TABLE 1. CHARACTERISTICS OF GENERATION AND SUPPLY.

KW Group	No. of Stations DC	AC	DC & AC	Station Voltage D. C Max.	Min.	Mean on	A. C. Max.	Min.	Mean on	Frequency of A. C Supply Max.	Min.	Mean on
0 /100	34	1	..	505	110	333 /40	2250	....	2250 /1	50	...	50 /1
100 /250	44	8	2	505	115	363 /63	3000	1100	2010 /10	100	40	76 /10
250 /500	46	6	6	520	212	373 /74	3000	1025	2294 /12	100	40	55 /12
500 /1000	71	5	6	525	220	410 /110	6500	2100	2720 /13	100	50	52 /11
1, /2500	67	15	23	1000	207	468 /123	11000	2000	3046 /49	100	25	68 /37
2,5 /5000	14	7	22	550	300	464 /50	11000	2000	3660 /17	100	25	52 /28
5, /7500	4	8	9	825	210	546 /16	8000	1000	3670 /15	90	25	55 /17
7,5 /10000	1	3	5	525	230	446 /6	6300	2000	4427 /13	100	40	58 /9
10 /15000	2	2	3	540	337	462 /8	6000	2000	4615 /10	93	46	57 /6
15 /20000	1	1	3	1000	200	615 /4	10000	2000	6090 /5	83	25	24 /54
20 /40000	1	..	3	....	...	... ...	6500	5750	1125 /2	100	40	47 /3
Totals & Averages	288	56	82	1000	110	420 /494	11000	1000	3390 /147	100	255	93 /139

the range 200-250 and 400-500 volts (three wire), 329 undertakings, among some 425, providing house and motor services at these pressures. In 37 cases, 200-250 volts is alone available at the consumers' terminals and in 38 cases, the three wire voltages are 100-150 and 200-300 volts. The total kilowatt capacity of generating plant now in use in pubic supply stations in this country exceeds 1,000,000 kws., divided between the various groups of undertakings in the following proportion:

Table 2. Total Kilowatt Capacity of Generators in Various Station Groups.

Station Kw. Range	No. of Stations	No Trac. Load Gen. Capac. Total	No Trac. Load Gen. Capac. Pr. ct. of T'l	No. of Sta.	With Trac. Load Gen. Capac. Total	With Trac. Load Gen. Capac. Pr. Ct. of T'l	Traction and Non-Traction Generator Kw. per cent of Total
0 /100	35	.1150	0.2	...	......	.....	0.1
100 /250	55	9110	1.8	...	......	.....	0.9
250/500	53	19800	3.9	3	1270	0.2	2.0
500/1000	57	39000	7.7	27	21200	4.1	5.9
1/2,500	40	67300	13.3	68	111700	21.9	17.6
2,5/5000	17	69400	13.6	23	81100	15.9	14.8
5/7,500	10	60900	12.0	13	80400	15.7	13.9
7,5 /10000	7	60100	11.9	4	34700	6.8	9.3
10 /20000	9	132500	26.2	4	49800	9.8	[illegible]
20 /40000	2	47500	9.4	3	131100	25.6	17.6
TOTALS	285	506760	100.0	145	511270	100.0	100.0

From special information supplied by Messrs. Dick, Kerr & Co., and the G. E. Co., respectively, it appears that the most important modern electrical machinery supplied to English central stations by these firms amounts to:

	Dick, Kerr No. Machines*	Kw.	General Electric. No. Machines	Kw.
D. C. Generators	141	63,750	75	16,500
A. C. Generators	29	22,200	29	19,650
Turbo Alternators	31	89,300	29	19,650
Motor Generators Balancers; Boosters. Rotaries etc.	10	56,750	60	21,350
	211	232,000	164	37,500

*Ranging from an 8,500 kw. turbo alternator for Sheffield to a 40 kw. booster.

From the G. E. C. data, which may be regarded as representative of good modern design, it appears that the average speed and terminal voltage of various types of rotary electrical machinery are as follows: D. C. generators, 440 v., 400 r. p. m.; single-phase generators, 2750 v., 170-430 r. p. m., (mean 330); two-phase generators 2750 v., 100-250 r. p. m.; three-phase generators, 5500-6600 v.; speed (engine driven) 85-400 r. p. m, turbo-driven 1500 r. p. m.

Among 19 shipments of motor generator and convertor plant, (from one to 14 machines per order), the machinery was arranged for the conversion of three phase to direct current in 15 cases, from two phase to direct current in 2 cases and from 3 to 1 phase and from 1 phase to d. c. in one case each. The A. C. voltage served averaged 5500 v., the frequency varying from 33 to 50 cycles but usually having the latter value. The average pressure on the d. c. side was 540 volts and the speed of the sets, ranging from 300 to 1500 r. p. m., averaged 540 r. p. m.

EXTENSIONS.

Fully half the central stations in the country are now engaged in installing modern and additional generating plant, totalling a considerable percentage, (often 50%), of the existing capacity, and, in several installations which the writer has recently visited, 500-1000 kw. extension units have been fully loaded when they were ready for service. With such rapid extensions in demand and corresponding increases in the annual turnover, our central stations are in a better position than ever before, to take full advantage of improved designs and thereby accelerate the progress of the latter.

A limited amount of reconstruction of existing machinery to meet altered conditions, is taking place but the change. as regards the generating equipment, is usually radical; rebuilt machinery, if retained by the station, is generally used for a different and subsidiary service. "Scrap" prices, varying from 5 to 25% of the capital cost are being obtained for old plant by extending stations according to the type and conditions of the equipment rejected.

TENDENCIES.

The most noticeable recent tendency in generator design has, of course been towards larger units and higher terminal voltages. Direct driving is almost universal and practically every new generator of over 500 kw. capacity is turbine driven. During the last three years many turbo-generators of from 1000-3000 kw. capacity have been installed and there are a number of important stations where 5000-8000 kw. units are in use. The turbo-dynamo still suffers from the enormous difficulties of high speed, high power and high voltage commutation and the standard arrangement in all large stations may be taken to be the use of high tension 3-phase turbo-generators with an output of from 1000-8000 kws. at 2000-11000 volts, supplying sub-stations and remote or near transformers, converters, motor-generators and so on, as required by the nature of the supply area and demand.

The high speed impulse type of turbine is now very popular. Not only is the space occupied per kw. output a minimum but also, the initial velocity wheel enables efficient utilization of high pressure steam, while reducing the pressure to which the turbine casing is exposed to 40-50 lbs. per sq. inch, and the subsequent Rateau stages occupy little space and utilize the remaining low-pressure steam with very high efficiency.

The ventilation of such large alternators as are now common calls for great care. About 125 c. ft. of cooling air per kw. of internal losses is required, (say 5 to 7.5 c. ft. per kva. output), hence, a 5000 kw. machine with, say 5% internal losses, requires roughly 30,000 cu. ft. of air per minute to be forced through its windings and cores. In a 20,000 kw. generator, this amount will rise to 100,000-120.000 cu. ft. per min. and even a minute percentage of dust content in such vast volumes of air will lead to rapid fouling of the air ducts in the cores and windings, hence filtration of the air prior to use becomes essential. Natural ventilation fails to meet the needs of such cases and air must be pumped into the base of the closed-in housing through ducts fed by special compressors or blowers, or must be sucked in by special fans on the alternator shaft; the former method is generally preferable.

AUXILIARY ELECTRICAL APPARATUS.

Under modern conditions of generation and distribution. the auxiliary equipment is steadily becoming of greater importance. In place of the simple balancers and boosters which formed the main auxiliary equipment of a central station in the 90's, we now have, in a high tension, a. c. station supplying lighting and power loads, the latter often over a wide area, tramways and possibly surburban railways—transformers respectively reducing and raising the generated pressure for local and distant a. c. supply, convertors or motor generators in the power house or substations for providing various pressures and phases of a. c. and various pressures of d. c. supply and, possibly, rectifiers and frequency transformers—all in addition to the balancers and boosters still required by the d. c. section of the plant.

Various arrangements of static two-phase to three-phase transformers have been proposed and discussed during the past year or two and a much wider use of this class of apparatus may be anticipated henceforward.

The utility of convertors and motor generator sets—for converting high tension alternating to low tension direct current or vice versa or for converting one form of a. c. to another—can hardly be exaggerated. Their use enables full advantage to be taken of large central generating units while providing maximum flexibility and diversity of supply and enabling (by the interconnection of various generating units, even though the latter provide very different forms of electrical enerby), maximum security of supply with minimum stand-by plant.

The effect of changes in generating and distributing practice has been to call for larger and larger convertor or motor generator sets and sets of 500-1500 kw. capacity—often fully 50% of the generator capacity—have become quite common. The efficiency of an 800 kw. convertor may easily be 94% on full load and 92% on half load so that losses in the electrical conversion are more than compensated by the reduced generator capacity to be provided and the improved generating efficiency enabled.

Without venturing far into a very controversial field, it may be stated that recent experience has shown the traditional economies of rotary convertors over motor generators to be much exaggerated. The latter are generally the most flexible in use but the individual needs of the case to be met usually determine the selection. The split pole convertor is much more flexible than the ordinary synchronous convertor but, at high frequencies, the synchronous motor generator shows considerable advantages over induction motor generators and all types of synchronous convertors. The greater reliability of motor generators is a considerable point in their favor in central station application. A few old fashioned rotary rectifiers are still in use in various parts of the country but modern convertors or motor-generators are generally employed.

Co-operation Between Electrical Manufacturers and Central Stations

(*Contributed Exclusively to* Electrical Engineering.)

BY M. C. TURPIN.

Extensive Campaigns Promoting Use of Small Motors Has Proven of Advantage to Both Users and Manufacturers.

THE success of a central station as every manager knows, is dependent on the ability to generate, distribute and market a reliable and continuous supply of electric energy. In order that this may be accomplished, it is necessary that the manufacturer supply the central station with equipment suited to the conditions to be met. There is, therefore, a strong bond between the two and the manufacturer, by supplying efficient (in its broadest sense) apparatus, is rendering a service to the industry. If he supplies equipment meeting the specific requirements at low operating costs with every emergency feature possible scientifically provided for, a long step has been taken in the advancement of the electric industry.

When in addition to this, he helps by practical means to load that central station to its maximum earning capacity, then indeed may we say that cooperation is assured. This cooperation is in the nature of a service and this service is exemplified by the designing and building of high grade current generating, distributing and consuming devices. The day when the manufacturer sold a piece of apparatus and then forget about it is past; instead a broad gauge policy has been adopted by the manufacturer; that of enlarging his own business by broadening the field of central station activity. That this policy has redounded to the mutual benefit of both, one has but to look around him and observe.

Realizing then that it is distinctly to his interest to increase the power load of the central station, this phase of the subject has been thoroughly studied by the manufacturer, plans formulated for its development and in some cases a corps of engineers devoted their time to nothing else but securing data on motor driven devices. This data is then available to the central stations for aid in building up their load. The progress of the use of electric energy attests the success to a high degree of this policy and has resulted in a generous increase in the power sold by central stations throughout the country. Since the inauguration of this policy a great deal of data has been accumulated and classified and by its aid the central stations have often been able to prove to the prospective purchaser the serviceability and inexpensiveness of electric energy furnished from a central station. This data also furnishes proof oftentimes of the influence of electric drive in increasing the output and bettering the quality of the manufactured product. This may be termed efficiency engineering, and the manufacturer, by his association with the maker of motor driven devices is enabled to make the cooperation doubly valuable.

In addition to other services provided in the interest of Central Stations by the manufacturer, there is a publicity service which includes the assistance of advertising experts in the preparation of advertising copy and designs for newspapers, booklets, street car cards, posters and bill board sheets. This advertising assitance embraces the laying out of complete campaigns for central stations that have no advertising departments of their own, all of which are placed at the disposal of the central stations without any cost whatever. It must not be imagined that this is done by the manufacturer without any thought of return. On the contrary it is distinctly realized that by increasing the demand for central station power he is, in turn, increasing the demand for his own apparatus. In many cases such advertising service may benefit a competitor as well, but it benefits the industry in general and the chances are that he will derive similar benefit from the advertising done by his competitors.

One successful form of advertising has been the sending out of booklets or envelope stuffers designed to stimulate interest in use of electric power, and this is supplemented by advertisements in popular periodicals. Booklets are sent to the central stations in quantities for distribution in their respective fields. This results in many inquiries which are in most cases referred to the company or dealer covering the territory from which the inquiries emanate, so that they can be followed up with the result that many new customers are thus secured.

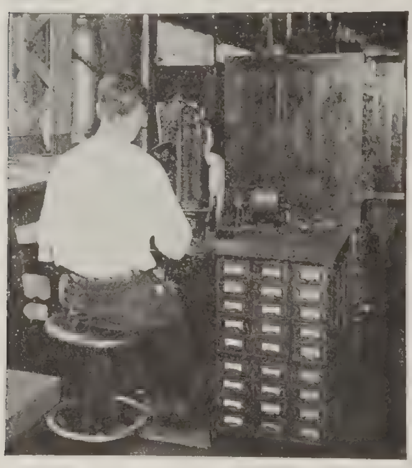


Fig. 1. Addressograph Machine Driven by Small Motor.

Fig. 2. Showing Application of Standart Small Motor to Hand Operated Washing Machine.

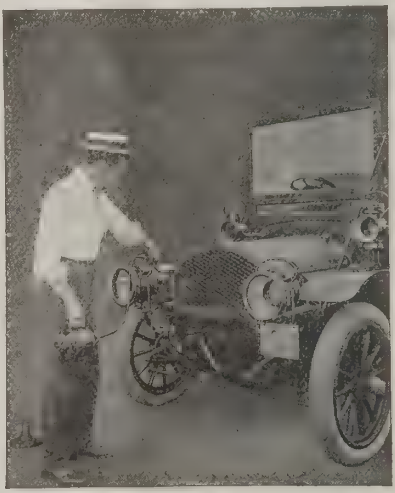


Fig. 3. Showing Use of Small Motor in Garage.

The advertising has been so successful that many others have followed the lead of the pioneers, and with increased advertising resulting therefrom there has been built up a tremendous interest in the popular use of electric devices. It has been the aim of these manufacturers to create a community of interest between the prospective user of electric power, the manufacturer of devices to be operated by electric power required in various industries, the central station power campanies, and themselves, for the purpose of educating the public to the great advantage of the use of electric power, not only for mechanical operation, but for lighting and heating as well. There could be no greater proof of the whole-heartedness of this policy of helping to extend the use of central station power than the willingness to spend real money in it. It goes without saying that the only way a return can be secured is through the increase and enlargement of the local central station service and plant, and, in consequence, the business they will receive through such sources.

Every central station manager appreciates the advantages of educational advertising and the advertisements in popular magazines have been as a rule educational in the broadest sense on the uses of electricity—not on single specialties of the manufacturer, a point of particular interest as exemplifying the co-operative spirit now extant in the industry. Many central station men who were skeptical as to the outcome of such a policy are now ardent supporters of this co-operative plan and are setting aside yearly liberal appropriations for local campaigns in order to reap the full benefits from this national advertising.

With a rapidity of which it is very hard to conceive, electricity has been displacing hand power for the operation of all manner of small machines, for every known industrial and domestic purpose. The agency which has made possible this development is the simple, safe and reliable small motor, which may be generally applied to all classes of machines and called on to operate at any time with the least possible attention. The manufacturer of small motors has made a careful study of this business, with a view to meeting the demand of all classes of purchasers successfully, and this work has involved among other points: (a) A careful analysis of the application of small motors along strictly engineering lines. (b) The embodying of principles of design and construction in the small motors which have proved so successful in the larger motors. (c) A broad policy in co-operative selling intended to promote the use of all classes of small motor-driven machines.

In building and applying small motors, many problems are encountered which are not met in connection with larger motors for general industrial service. The design of small motors must be based not only on extensive experimental work, but also on practical experience gained from applying a large number of small motors to machines of every description and observing their operation over a long period of time. Large quantities of motors must be produced rapidly with a high degree of precision and uniformity and must be thoroughly tested to insure reliability, all of which operations require special facilities. For these reasons the larger manufacturers have segregated the small motor and generator business into separate buildings, in reality independent factories. This segregation of work is not confined to manufacturing processes alone but is extended as well to the engineering, drafting and commercial service departments.

Small motors must not only be carefully designed, but the wide distribution of motor-driven devices and the fact that they are generally operated by unskilled persons makes a careful analysis of their applications necessary in order to insure good service to the user. This results in the necessity of an engineering staff not only to design the motor but to study its applications. By such proceedure the manufacturer is cooperating in the most practical way by placing on central station lines, devices which will not tend to discredit the use of electric power. One inefficient or poorly adapted piece of electrical apparatus does more harm to the reputation of electricity as an efficient form of energy than a dozen successful pieces can counteract.

THE USES OF THE SMALL MOTOR.

The uses of the small motor are many and it would be beyond the limits of this article to cover them, but a few o fthe more important ones are described and illustrated here with the hope that some ideas may be conveyed as to possibilities of this almost universal device. Among the more general applications are: sewing machines, vacuum cleaners, laundry machines, house pumps, tire pumps, air compressors, portable tools, ironing machines, coffee grinders and roasters, ice cream freezers, dough mixers, meat choppers, candy mixers, centrifuges, envelope sealers, duplicating machines, addressographs, sign flashers, etc.

A table is given below showing the capacity and characteristics of motors required for a number of these small motor-driven devices. As an indication of the extensive use of these labor saving devices, it may be of interest to note that the Westinghouse Electric & Manufacturing Co. alone has in successful service now, 125,000 small motors.

VACUUM CLEANERS—A few years ago there sprang up in all parts of the country vacuum-cleaner manufacturers. Many vacuum cleaners designed along strictly engineering lines and embodying the best workmanship were placed on the market, but unfortunately many more, flimsy in construction and capable of doing little effective cleaning were sold broadcast, and are now usually found stowed away either in the garret or woodshed. The result was twofold. In the first place the purchasing public, who knew nothing of vacuum cleaners when they were first placed on the market, became suspicious of vacuum cleaners as a whole. In the second place central stations, realizing the attitude of the purchasing public and also experiencing some "comebacks" on vacuum cleaners sold by them, fell to questioning whether handling vacuum cleaners was really worth while, and some finally decided to exploit or sell them no longer.

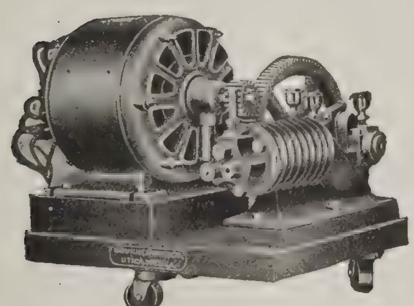


FIG. 4. WESTINGHOUSE MOTOR-DRIVEN AIR COMPRESSOR.

FIG. 5. CHILD OPERATING HOME MADE VACUUM CLEANER DRIVEN BY SMALL MOTOR.

FIG. 6. IRONING MACHINE DRIVEN BY WESTINGHOUSE SMALL MOTOR.

Greater progress has been made in the art of vacuum cleaning and the construction of vacuum cleaners during the last two years than has ever been made before. The principle of vacuum cleaning is as sound today as it ever was and is becoming more broadly recognized. The progress however, has not been made, so much in principles of construction as in details of construction, which have simplified the vacuum cleaner, reduced the number of moving parts and above all vastly increased its life by building it, not as a toy but as a machine for service. Good clean competition in the vacuum cleaner field will do as much as any one thing to boost the electrical business.

HOUSE PUMPS—The small water-lift is useful for obtaining soft water for bathroom, kitchen and laundry where the city or artesian well water supply does not exist or the water is hard and unfit for domestic use, or where the city pressure is low and requires boosting. The source of supply may be a deep well, spring, lake, river or reservoir. The demand for small motor-driven pumps exists among city and suburban residences, bungalows, cottages, apartments, factories, farms and public institutions, where electric current is available.

The usual city pressure of from 30 to 50 pounds per square inch may be obtained from these small motor-driven pumps by properly adjusting an automatic switch. This makes it possible to obtain as good a supply of water in a country residence or cottage as it is possible to obtain within the limits of the city. The cost of operation of these pumping outfits is largely dependent upon the capacity of the pump. A fair average operating cost which has been obtained as a result of exhaustive tests is 9 cents per thousand gallons of water pumped, on the basis of a 10 cent rate.

LAUNDRY MACHINES.—The electrically-operated washing machine offers one o fthe best means for introducing the use of motor-driven apparatus into the home. In the first place it can be sold to all classes of housekeepers. Secondly, the motor itself is an obvious feature of the machine. It is not concealed in the interior but is recognized at once for just what it is. Even the most unmechanically-minded woman can infer that the source of power of her washing machine can be applied with equal advantage to other machinery that she uses, such as the sewing machine. Her husband will also appreciate the value of the motor as the means of driving his lathe, saws, buffing and polishing wheels, and other devices of a similar nature. When, therefore, a successfully operating washing machine is once installed in a home, the way is at once opened for the sale of other motor-driven appliances.

When applying a small motor to a hand-operated washing machine, the following points should be carefully noted: The method of driving the washing machine should first be considered. The simplest and most effective way of driving the hand-power machine is by either a round or flat leather belt. The leading types of washers ("dolly," "revolving drum," or "cradle" types), usually come supplied with a driving wheel to which a handle for turning the wheel is attached. Washing machine manufacturers are largely supplying these wheels with flat-faced or grooved rims, so that the motor may be belted directly to the driving wheel without difficulty. Other manufacturers will usually supply, upon order, washers with driving wheels thus arranged for driving by a motor. Great care should be taken to see that the motor is so placed that it will not be subject to dripping water, such as at the side away from the washer or on the wall. Where the machine is protected from dripping water, an open type of motor is thoroughly satisfactory, otherwise a totally-enclosed motor should be used.

For washers of the "cradle" or "dolly" type, a 1/12 horsepower to 1/8 horsepower motor is required, the latter should always be chosen if the motor is to operate both wringer and washer. For the "revolving drum" or "revolving reversing drum" type a 1/8 to a 1/6 horsepower motor should be used, unless the machine is very large, in which case a 1/4 or 1/3 horsepower motor may be needed.

Motors selected for this service should not have a speed above 1700 r. p. m., since this high speed necessitates the use of too small a pulley upon the motor, resulting in the liability of the belt slipping over the motor pulley and failing to transmit the power. Where an alternating-current motor is to be used, an "overload start" motor should be specified since considerable starting effort is required to start the washer. Where a direct-current motor is to be used either a shunt-wound or compound-wound motor will be satisfactory.

Fig. 7. Testing Small Motors in Plant of Westinghouse Electric & Mfg. Company.

Air Compressors—The field for the sale of small portable electric-motor driven air compressors is large and it would seem advisable for central stations to cater to this class of business. This type of air pump is in great demand today and its use will continue to increase in garages, both public and private, tire agencies, and supply houses. This is not its only field, however, and other practical applications are continually being discovered.

The electric motor supplies the only economical and truly successful motive power for portable air compressors and this is especially true of the small compressors used for tire inflation. The facility with which these compressors can be moved from place to place owing to the diminutive size and light weight of the motor, their ease of starting and exceedingly small cost of operation, are points worth considering by those who desire to give perfect and up-to-date service to their patrons. The dentist requires air at comparatively low pressure for his work and all the more successful ones will consider the small electric motor-operated air pump supplying the tanks they already have installed. The artist is a user of compressed air for his air brush work and all firms employing this art can use the electric pump with excellent results.

Garages.—Every automobile owner or repair man will appreciate the advantages of being able to drill out broken bolts and to do such other jobs without having to dismantle the car. The portable electric drill is especially handy where it is necessary to work under the body of a car. For attaching speedometers, drilling small bolt holes and for other innumerable cases there is no tool so convenient. The cost of operating these small drills ranges from 1/2 cent per hour for the smaller sizes up to about 1 1/2 cents per hour for large sizes.

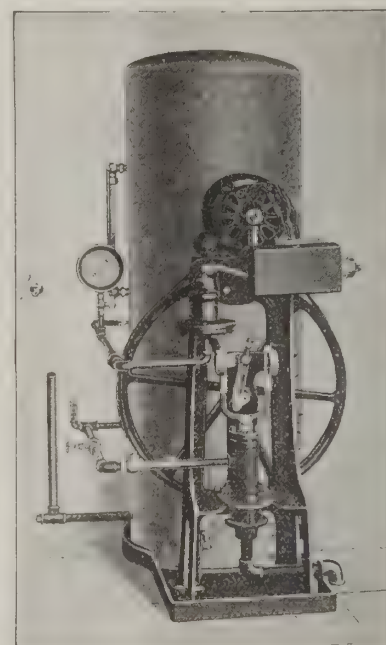


Fig. 8. House Pump Driven by Motor.

For grinding valves of automobile engines and for other similar jobs the portable electric grinder is indispensable. Portable grinders are also made for mounting on the compound rest of lathes for internal work and for grinding centers, reamers, dies, etc. They can also be used on a shaper or planer for surface grinding. For bench work they are especially convenient.

It is true that a large percentage of the automobile owners do not secure maximum service from their tires where they use the manually-operated pump as they do not inflate to the proper pressure recommended by the tire

Characteristics of Motors for Operating Different Devices.

Device		Motor			
Name	Capacity	H.P.	Starting	R.P.M.	Belt
For the Office, Store, Hotel, Etc.					
Revolving Table for Window Display	Depends on display	1/12 to 1/4	Full load	1700	1/4" dia.
Candy Mixer	Small sizes	1/2	Overload	1700	1 1/2" wide
Centrifuges	Small sizes	1/40	Light load	1700	1/4" dia.
Coffee Grinders	2 lbs. per min.	1/4	Overload	1700	1 1/2" wide
Coffee Roasters	25 lbs.	1/6	Light load	1700	3/16" dia.
Duplicating Machines	Av'ge size for office use	1/8	Full load	1700	3/8" dia.
Envelope Sealers	Av'ge size for office use	1/20	Light load	1700	1/4" dia.
Mailing Machines	Av'ge size for office use	1/20	Light load	1700	1/4" dia.
Sign Flashers	Small size	1/20	Light load	1700	1/4" dia.
Sign Flashers	Medium size	1/12	Light load	1700	1/4" dia.
Sign Flashers	Large size	1/6 to 1/4	Light load	1700	3/16" dia.
Stationary Vacuum Cleaners	Various domestic sizes	1/2 to 1	Overload	1700	1 1/2" to 2" wide
Water Pumps	360 gals. per hour	1/2	Overload	1700	1 1/2" wide
Water Pumps	720 gals. per hour	1	Overload	1700	2 1/4" wide
Air Pumps, 130 lbs. pressure	1 cu. ft. per min. of free air	1/4	Overload	1700	1 1/2" wide
Air Pumps, 130 lbs. pressure	2 1/2 cu. ft. per min. of free air	1/2	Overload	1700	1 1/2" wide
Air Pumps, 135 lbs. pressure	4 1/2 cu. ft. per min of free air	3/4	Overload	1700	2" wide
Air Pumps, 135 lbs. pressure	6 cu. ft. per min. of free air	1	Overload	1700	2 1/4" wide
For the Home					
Ironing Machines	Rolls 7"x26"	1/6	Overload	1700	3/16" dia.
Ironing Machines	Rolls 7"x42"	1/6	Overload	1700	3/8" dia.
Washing Machines Including Wringer	9 sheets	1/6	Overload	1700	3/8" dia.
Washing Machines Including Wringer	6 sheets	1/8	Overload	1700	3/16" dia.
Small Water Pumps	120 gals. per hour	1/6	Overload	1700	3/8" dia.
Vacuum Cleaners	Average portable	1/8	Full load	1700	3/16" dia.
Vacuum Cleaners	Small stationary 600 r.p.m.	1/4	Overload	1700	1" wide
Vacuum Cleaners	Medium stationary 600 r.p.m.	1/2	Overload	1700	1 1/2" wide
General Uses					
Egg Beaters, Coffee Grinders, Meat Grinders and many other household uses	Household sizes	1/8	Full load	1700	1/4" dia.
Clothes Wringers	11" long x 1 3/4" diameter	1/6	Overload	1700	3/8" dia.
Bread Mixers	Household size	1/8	Full load	1700	3/16" dia.
Ice Cream Freezers	2 quarts	1/8	Full load	1700	3/16" dia.

companies. As long as hand pumping is a laborious operation just so long will tires be run insufficiently inflated and irrepairable damage done to them. All tire companies claim that more damage is done tires through insufficient inflation than all other causes. When the small motor-operated air pump is used there is no danger of this occurring as the motor will not stop until it reaches the pressure for which it is previously set.

Large department stores in many cities are using the automobile for delivery services and where a large stationary compressor plant is installed in their private garages, a portable electric motor-operated tire pump as an auxiliary in cases of emergency is an absolute necessity, and is comparatively inexpensive. A portable pump is economical and always ready for service. The motor is kept in operation only while the tire is being pumped up, thus doing away with the necessity of keeping a large storage tank under pressure at all times. In this way a minimum operating cost is insured with maximum results. These pumps are very rapid in action and are designed for a steady flow of of air, either by the use of several cylinders, or by one cylinder in connection with a small tank which is rapidly brought up to pressure. They overcome the difficulty of blocking the garage by taking the pump to the automobile, insteadof the automobile to the pump. They also eliminate the necessity of using long air lines which are cumbersome, expensive to keep up, and inefficient. The motors may be attached to the nearest lamp socket and will start the pump against a high pressure. The entire outfit is mounted on a truck fitted with wheels or castors. Pressure is regulated by means of an automatic switch. The small motors shown in the above illustrations are of Westinghouse design.

The Engineering and Commercial Status of Current Consuming Devices

(*Written Exclusively for* Electrical Engineering).

Section 1. The Demand for Current Consuming Devices in the South.

With the extensive application of the electric iron through its perfection and readily appreciated usefulness, numerous other devices for household and industrial use have become popular, until now there are definite and highly successful methods exploited by manufacturers, electrical dealers and the commercial departments of central stations in small cities and towns as well as the larger ones. Various canvasses have been made year by year to arrive at the relative popularity of the now rivaling devices, each canvass showing that new devices are coming into prominence while those introduced are rapidly gaining new ground.

A most convincing indication of the popularity of current consuming devices of the household type, and a fair indication also of the relative standing of each at the present time, was shown in a table published in the February issue giving the number of devices sold by 32 of the Byllesby properties during the early part of last December. The report given in this table may be taken as representative of conditions and demands generally on account of the different properties being widely distributed and each property pushing practically all the devices that the table mentions. In all something over 5,200 devices were sold, the following table showing the percentage of the total sales credited to each device:

Irons	43.5%
Toastors	16.3%
Percolators	7.2%
Grills	5.4%
Curl Irons	3.9%
Disc Stoves	3.7%
Heating Pads	3.5%
Chafing Dishes	1.7%
Wash Machines	.5%
Vacuum Cleaners	.3%
Total	86.0%
Miscellaneous Devices	14.0%

The sales shown here do not represent the total sales for the districts covered by the properties since the devices sold by the electrical dealers are not included. For the purpose of showing relative popularity however, the data is sufficiently accurate to tell the story of present demands.

The merchandising of these current consumption devices, as well as many other electrical products, seems to be a problem only partially solved, in view of the fact that total sales include the activity of central stations, electrical dealers, department stores, hardware stores, and others. Electrical merchandising, while a business with a legitimate field, has not become anything like established, especially in so far as current consuming devices are concerned and yet the success of such devices and their further extensive application depends in a large measure upon keeping the cheap and inefficient product out of the field or at least retailing these devices through those agencies capable of comprehending their deficiencies and able to advise the purchaser at the time and later make repairs if required.

A vital discussion on this subject was recently held at the conference of the Society for Electrical Development at New York City, reported elsewhere in this issue. In this discussion central station men, manufacturers, jobbers and electrical dealers aired their differences and took up in a common sense way the solutions. The grievances of the jobbers and electrical dealers in regard to devices were that the central stations hold special sales and campaigns, selling at a cut rate and that they do not cooperate in the proper way. The manufacturer they complained, sells direct to the customer and maintains no schedule of prices on quantity orders. The central station representatives complained of the lack of push on the part of the dealers and emphasized the fact that it is necessary for the devices to be placed in service in order to secure a revenue. They further hold that the defective appliances pushed on the market by manufacturers and dealers have made the public skeptical and even now hinder the introduction of reliable apparatus. The manufacturer complained that the dealer does not follow up sales to learn the criticism of the devices and thus help the manufacturer to carry on the research work on nature of the demands and make the apparatus fulfill satisfactorily the expectation of the customer. This co-operation the manufacturer believes essential to produce satisfactory apparatus in a new field and enable the dealer to increase his sales of such apparatus. An interesting plan was suggested for carrying on the sales work through a combination of jobbers, dealers and central stations in any locality, the expense being divided among each according to sales. It is to be hoped that some such scheme can be worked out and speedily for the good of all concerned. We quote Mr. H. L. Doherty on this point as follows: "I have wished many times that someone would devise a scheme for cooperation which in its application would benefit all and injure none but I have yet to learn of such a plan. I am still hopeful that the problem can be solved."

CURRENT CONSUMING DEVICES IN THE SOUTH.

The demand for current consuming devices in the South and the status of those that seem to be most popular, is interestingly told in the following letters from Southern jobbers and dealers handling these devices.

W. R. Herstein, Secretary and Treasurer Electric Supply Company, Memphis, Tenn., comments on the demand for current-consuming devices as follows: The electric flat iron is, of course, so far ahead of all other heating devices as to be in a class entirely its own, and I presume this will always be the case, since the flat iron is a necessity in every household and its first cost is low; whereas, the first cost of the other lines is comparatively high, and the majority of them are more or less luxuries. The electric chafing dish for several years was the most promising among the remaining devices, but our experience shows it has given way to the coffee percolator, presumably because of the more nearly universal use of coffee-making devices, and the fact that the percolator makes a lower priced and equally attractive present for weddings, holidays, etc. After these devices, we would name the different kinds of combination sets, particularly those consisting of the electric flat iron, water heater and small stove or hot plate; and also those presenting the combination form of chafing dish, broiler, toaster and grill. We also find a demand for the heating pad, shaving mug, and the curling iron, or curling iron heater, though the demand is not great.

With regard to electric fans, we find that every year these are coming to be regarded more and more as a necessity instead of a luxury. Many of the humblest homes now use the small desk fan, and the more pretentious residences are using severel instead of one, as formerly. Our sales of fans have steadily increased year by year, despite the fact that they seldom wear out, and an entirely new set of consumers must be found for each year's supply.

As to small motors, our experience has been that the margin of profit on them is not sufficient to interest jobbers, and the business is usually worked closely by the manufacturers and contractors, the former taking their profit on selling price, and the latter on the wiring job. There is undoubtedly a considerable demand for small motors, but their prices have gone to such a low point that there is nc margin for more than one middleman's profit and frequently not that.

Oscar C. Turner, President Southern-Wesco Supply Company, Birmingham, Ala., says in regard to the current-consuming device situation: We have found a considerable increase in the sale of current-consuming devices lately. I believe the lighting companies are awakening slowly to the fact they ought not to furnish current-consuming devices of any character unless they get a living profit from the sale, and this has considerably increased our own sales and those of the local dealers throughout our territory. I believe this is going to grow and I look to the time that the central station will have the co-operation in the sale of current-consuming devices actively, of every electrical interest in the town, instead of conditions as they have been in many places.

We have been selling a large number of irons, electro-curls, electric combs, toasters, etc., of the heating devices. The small motor sales are improving each year and it is hard to realize where all the fan motors go. I believe that the future is most inviting in the current-consuming end of the lighting game.

C. Robert Churchill, President, Electric Appliance Company, New Orleans, La., has the following to say on current-consuming devices: With reference to current-consuming devices, I know of nothing more popular, more unique and at the same time more satisfactory to the trade, than the several new current-consuming devices put out by the Wagner Electric Manufacturing Company, the single-phase converter, the unity power-factor motor and the alternating current rectifier.

F. K. Levy, of Interstate Electric Company, Ltd., New Orleans, La., writes as follows: We had a very good season, and have sold more heating devices in the past six months than in any similar period before. We believe that magazine advertising is making heating devices familiar to the public and so a demand has been created and it is steadily increasing. Another influencing reason for increased sale of heating goods is the better appearance and the more lasting nature of the devices that are now manufactured.

The iron is the most in demand, and after that we believe would come the toaster, grill stove, percolator, warming pad, disc stove and chafing dish, in very much the order given. We believe that the two factors that are doing the most good are the more reliable construction and the magazine advertising.

A. D. Peabody, President, Peabody Electric Company, Muscogee, Okla., mentions the following devices as most popular in his territory, and in the following order: Irons in all sizes, fans, percolators, toasters, grills, vacuum cleaners, sewing machine motors, curling irons and power motors.

J. M. Domble, Sales Manager, Harry I. Wood Company, Louisville, Ky., writes: We find at the present time that electrical heating types of devices seem to have the greatest demand of the current-consuming devices. In fact, electric irons are sold more than any other heating appliance manufactured, but we presume in the future many homes will have their irons, and this business will drop off materially. As soon as the lighting companies give a better rate on heating devices, we believe electric stoves, toasters, etc., will be used more extensively.

Julien Binford, Jr., President, Binford Electric Company, Richmond, Va., remarks as follows on device situation in his territory: It has been our experience that during the spring season there is a demand for irons and small heating devices, and this year we expect in this vicinity a very large demand for electrical stoves. The housekeeper is learning very fast the great advantages of using electrical devices during the summer months, thereby reducing the heat which is caused from an ordinary coal stove, and it has been a great surprise to us to see how this particular line has recently developed. Of course, during the summer months the "fan" season comes on, and there is a very large demand for this product throughout our territory.

So far as the small motor line is concerned, we have not found that the seasons have had much to do with the sale of this product. The demand for small motors is constantly growing, and about the household it is surprising to find the large numbers which are now in use.

Section 2. The Electric Motor and Its Application as a Current Consuming Device.

Automatic advertising devices, calculating machines, electric fountains and other inventions too numerous to mention have sprung up almost in a night. The demands of the manufacturers of these various specialties could only be met by a motor of fractional horsepower so small indeed as to be heretofore regarded as a toy.

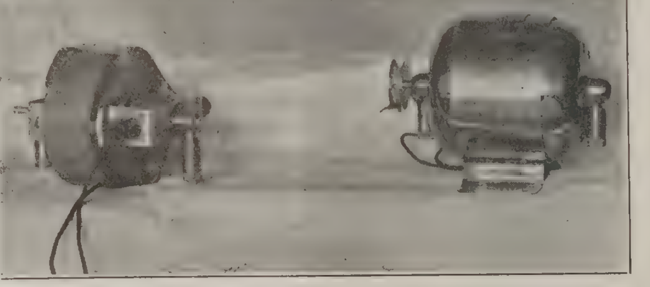


FIG. 1. SHOWING DESIGN OF 1/50 H. P. MOTOR.

One of the smallest practical motors made is shown in Fig. 1. This motor, developing from 1/50 horsepower at a speed of 1,125 revolutions per minute, to 1/20 horsepower at 2,500 revolutions per minute, may be constructed to run on either 110-volt direct or 60 cycles A.C. with but small speed change. Wholly laminated field frames, sheet metal casing and bonnets reduce the weight to the minimum of 2¾ pounds.

An interesting application of the small motor in question is shown in Fig. 2. Here the motor is applied to the weight-winding mechanism of a well-known make of chime clock. By a worm and wheel method of drive and an ingenious automatic switch which makes and breaks a circuit every twelve hours, the manual labor involving the winding o fthe family timepiece is rendered superfluous. This is a good example of intermitten drive, the motor running but 1 1-2 minutes every winding period.

The application of a small motor to a cloth cutting machine is shown in Fig. 3, the motor being an integral part of the apparatus. The speed required was 3,000 revolutions

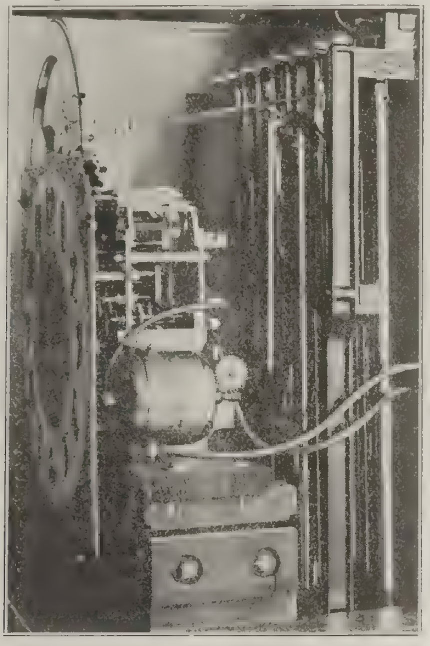


FIG. 2. SMALL MOTOR APPLIED TO CLOCK-WINDING MECHANISM.

per minute, the windings being arranged for direct current at 110-volts supplied from lighting circuits. Laminated field frames, together with covers of aluminum bronze render the apparatus light in weight, the whole thing being so balanced that the machine which is fitted with rollers is responsive to the slightest inclination of the operator's hand. Ball bearings, both front and rear, minimize frictional heating.

INDUSTRIAL APPLICATIONS OF SMALL MOTORS.

We will now take up the subject of motors as applied to

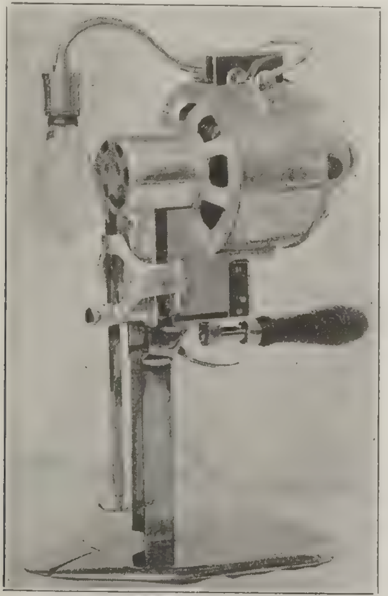


FIG. 3. SMALL MOTOR OPERATING CLOTH-CUTTING MACHINE.

ventilating fans, sewing machines, portable ventilating sets and forge blowers. These subjects cover a diversified use of the small motor of fractional horsepower.

VENTILATING FANS. The outfit illustrated in Fig. 4 is particularly adapted for ventilating duty in a room or apartment where space considerations will not permit or do not require the use of the larger sizes of exhaust wheels. The motor is very small but powerful, being capable of turning the blades at an approximate speed of 1,250 revolutions per minute, and moving 1,030 cubic feet of air per minute. The whole has an approximate net weight of less

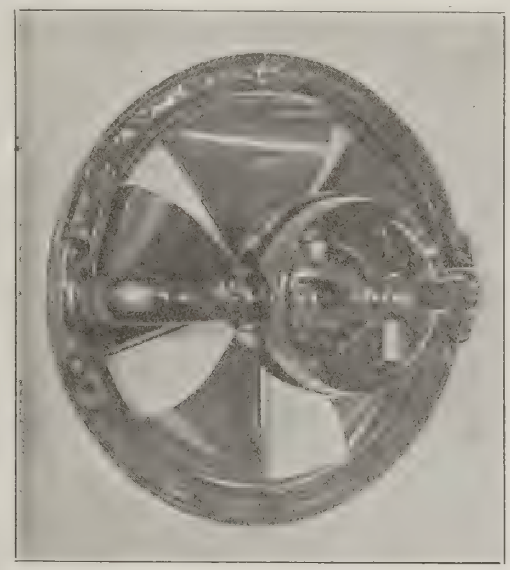


FIG. 4. A TYPE OF VENTILATING FAN.

than 40 pounds, and can be connected with an ordinary light socket. The cost of maintenance is very small, even though the motor be used continuously.

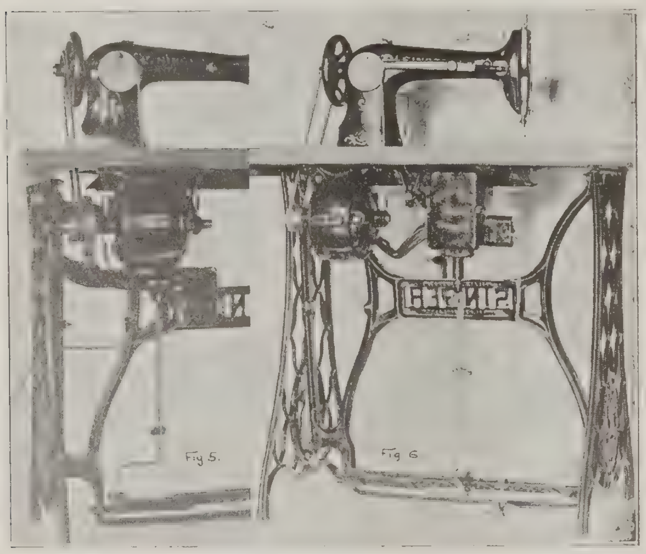
In choosing a ventilating set, obtain the cubic feet capacity of the room, and choose the maximum diameter of wheel, which can be installed in the window space at hand. The formula being:

Cubic feet capacity of fan per minute $\times$ 60 $\div$ cubic feet capacity of room $=$ change of air per hour.

In many instances fans are required to force air through a duct of considerable length and the prospective purchaser omits to mention this all-important fact to the manufacturer, and the latter supposes that the apparatus is intended for use against free discharge; consequently the motor is severely taxed and often overloaded. It is not generally understood that the operating conditions of disc propeller fans and cased blowers of the centrifugal type are totally different. A disc fan discharging air against no resistance consumes its minimum power for the reason that the volume of air is allowed to move freely at high velocity. The moment that the discharge side is closed, however, and the air restricted, a resistance is created to overcome which an increase in power is necessitated. This is not the case with the centrifugal fans, the horsepower required being at maximum when the inlet and discharge sides are wide open, that is, maximum volume of air handled. When both inlet and discharge are closed, the fan merely revolves, having no air to move, consequently requiring little power.

When specifying power required to operate such fans sight must not be lost of the fact that the horsepower increases as the cube of speed. This means that eight times the power is required to drive a fan at just double its original speed. This proportion applies also to disc fans.

Sewing machine applications. In shops where it is necessary to operate a few machines on special work after working hours, and in factories where machine work is very intermittent, although a large installation of machines may be necessary in certain periods, the individual form of motor drive commends itself. Certain features are necessary, however, for the successful operation of a sewing machine plant by individual motor drive as follows: The motor must be out of sight and way of operator; it must be under the perfect control of the operator at all times by treadle pressure, giving a variation of from a single stitch to 2,100 stitches per minute. It must have an instantaneous brake, capable of stopping the needle in the middle of a stitch. It must be fool proof and practically indestructible, with a minimum of working parts and a maximum of life.



Figs. 5 and 6. Application of D.C. and A.C. Motors to Sewing Machines.

In Fig. 5 an application is shown where the direct current variation of the sewing machine, motor power is applied through the medium of the transmitter which consists of a spring carbon switch controlled by an arm which is attached to the treadle rod. This arm acts as a lever, moving a loose pulley in a direction parallel to the shaft by the same pressure which closes the switch and applies the current. Speed regulation is obtained by variation of pressure on the treadle, the tight pulley running at the full speed of the motor which is 1,800 revolutions per minute, the loose pulley being brought into more or less contact with it by means of the treadle in connection with the lever and pitman rod. Light pressure effects a slight engagement of the wheels, and an increase of pressure lessens the slip between them until they are at full needle speed, brought into close contact. A brake is operated by the lever and is instantly applied when pressure on the treadle is released and the transmitter wheels disengaged.

When pressure on the treadle is released and brake is automatically applied, the current is cut off from the motor by the release of the switch described. The motor is rated at 1/7 horsepower, and is self-contained, being fastened under the table. The entire outfit consists of motor, transmitter, switch and brake, together with necessary brackets, levers, attachment plug and pitman rods.

In addition to the friction arrangement of motor and transmitter, it is sometimes found desirable to use the direct current motor in connection with the dynamic brake in place of the mechanical arrangement, which obtains with the friction transmitter. The desirability of this outfit shown in Fig. 6, to many users of sewing machines is due to the fact that the resistance of the rheostat is divided into a series of fixed steps giving fixed speeds which can at once be reached when the contact is made upon the proper point of the rheostat. The motor for this outfit is also rated at 1/7 horsepower, with a speed of 2,800 revolutions per minute, this speed being determined as the most desirable one for use with the average manufacturing machine and filling the requirements of the average manufacturer.

It must be considered in taking up the subject of alternating current motors that these require an appreciable period of time to attain full speed and must therefore run continuously and the arrangement of automatic switch used with direct current motors cannot be utilized. The motor is therefore placed in circuit by a snap switch, while the same method of speed variation is obtained as we described in connection with the direct current friction clutch outfit. All motors are lubricated by grease cups placed vertically on the bearing housings.

A new type of treadle-control motor is being placed on the market through the agencies of the Singer Sewing Machine Company. This motor is intended for use on all Singer or Wheeler & Wilson sewing machines, illustrated by Fig. 7. Simplicity combined with a minimum of parts formed the rule for the construction of the outfit.

The speed regulating device is entirely concealed within the end cover, the movable contact being connected by a strong light chain to the treadle. A clock spring closes the circuit and regulates the movements of the carbon as pressure on the treadle is varied or entirely removed.

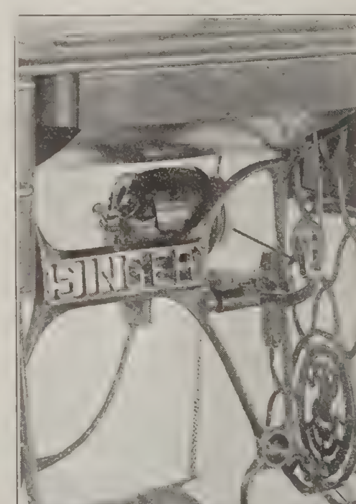


Fig. 7. A New Treadle-Control Motor.

The pulley is saucer-shaped and made of pressed steel with a steel hub. It is set on the armature shaft with set screws. An idler wheel is made part of the motor bracket and controlled by a spring. This idler acts as guide and belt-tightener, obviating the necessity of boring an extra hole for the belt through the machine table. The belt from the motor pulley, held in place by a belt guard, runs over the idler. When the machine head is dropped, the belt is always in position about the pulley, ready for instant use. A leather brake, released by the treadle-controlling mechanism when the circuit is broken, bears upon the saucer-rim of the pulley, causing an instantaneous stop. The motor is wound for direct and alternating current circuits, and may be readily attached to a lamp socket or other outlet.

PORTABLE VENTILATING SETS. Fig. 8 shows a portable ventilating set consisting of a blower of the centrifugal type driven by a direct current motor. The motor is totally enclosed, its frame being cast steel and is placed on the right side of the blower, the steel frame, in conjunction with ball bearings, have the effect of increasing the efficiency of the outfit and decreasing the weight. The motor is bipolar, series-wound, and is so placed that the commutator end is most remote from the blower casing. The brush holders are mounted directly on the front end cover and the end cover bolts are set in slots so that there may be adjustment for brush position.

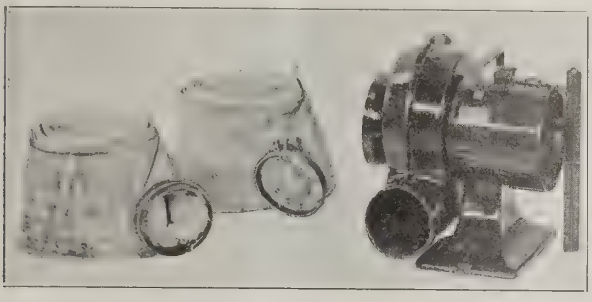


Fig. 8. Portable Ventilating Set.

The blower runner, which is of the multivane type, is mounted directly on the armature shaft, making it with its casing of pressed metal, an integral part of the motor, and the whole set self-contained. The blower has a horizontal discharge end and outlet 4.375 inches in diameter.

The set runs at approximately 2,200 revolutions per minute, with a watt imput of 155, gives a delivery of 425 cubic feet of air at a velocity of 4,100 feet per minute. The set is especially useful for portable ventilating work on shipboard, for ventilating rooms, for cooling resistances, etc.

ELECTRIC FORGE BLOWERS. In many cases it is convenient to carry a long line of blast pipe to supply a machine shop with blast for forges, brazing, hearths, ovens, etc., and for that reason the individual electrically driven blower has come into prominent use. If one or two individual forges only are required for some special job, the large machine would have to be run and would consume practically the same amount of power as if it were feeding all the forges.

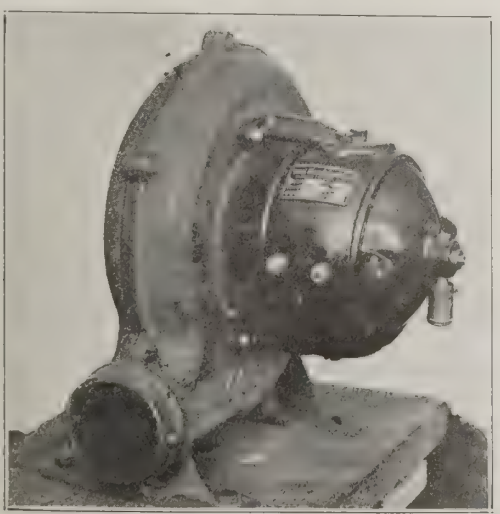


Fig. 9. Electric Forge Blower.

The individual system allows of brazing hearths and forges being placed in any position in the shop, and independent of each other regarding the location. A particular instance of saving and convenience would be shown by a large brazing shop working on automobile parts, which work is more or less intermittent and divided. For particular metals a different temperature is needed, consequently, hearths may be adjusted to suit. In some instances the blower and motor units are attached directly underneath the forge pan in a reversed position, so eliminating the piping entirely the outlet of the blower being directly underneath the tuyere. In this outlet is connected a clinker catcher so as not to allow the ashes dropping into the blower itself. A new use for these blowers has been devised by one of the largest bread-baking organizations in the United States. They have at present 16 blowers direct connected to 1/10 horsepower motors operating at a speed of 3,000 revolutions per minute. These blowers are fixed in close proximity to certain machines, through which dough in the process of kneading is passed. The air is blown directly on the passing dough when exposed to the atmosphere, so preventing foreign particles of dust or dirt settling. In the inlet of the blower is attached a double mesh and muslin screen which tends to keep particles from entering the blower. It has been found in many cases that this has a distinct advantage in purifying the material and it is a very decisive steps towards absolute cleanliness. The motors shown in this section are of the Diehl Manufacturing Company's design.

Section 3. Control of Current-Consuming Devices.

BY GEORGE T. KIRCHGASSER.

While the term "Current-Consuming Devices" may include all kinds of electrical appliances, such as motors, lamps and heating devices, it is of the last named apparatus that this article will treat. Brief mention, however, is made of ventilating fans and portable motor-driven devices, as they also belong to a class of current-consuming devices that is becoming more popular every day, and which can be made to represent an important part of a central station load.

When the first commercial applications of electric motors were made, not yet 30 years ago, no attempt at speed variation or control was attempted or even thought of. There was no automatic starting or stopping, no smooth acceleration nor dynamic braking. The main idea was to turn the current into the motor, start it running and be thankful for that. The resistance boxes that were later used to get better acceleration without damaging the motor had no release magnets, as the present-day starting rheostats have, all of which indicates that there was no such thing as motor control in the 80's and early 90's of the last century.

Also the first motors simply operated line shafting which in turn furnished power to various countershafts and machines. For this kind of motor application which does not make use of the best characteristics of electric motors, no control other than starting is desired. More experience, better design and recognition of the real advantages of electric motor drive led to the wonderfully increased number of installations and to means of control, which widened the field of applications. These same steps are taking place in the case of electric heating devices, the features of current and temperature control being of the same relative importance to electric heaters as the various forms of motor control have been to the motor industry.

The first electrically heated devices that were used to any great extent were irons, and these were connected up to the fixture socket or wall receptacle. If the fixture socket key were used to control the current to the iron (and therefore, its temperature) damage to the socket would result eventually, due to the breaking of a current of greater capacity than that for which it was designed. Many of the earlier devices were connected up and the current left on during the entire operation (and sometimes longer) although if ready means had been available for cutting off the current at intervals, the temperature of the device could have been regulated and current saved. Table stoves, toasters, etc., were also connected in this way and the only means of control was to jump up and turn off the current at the socket or pull out the plug.

Manually and automatically-controlled irons are now on the market, which allow either the obtaining of the temperature desired through the provision of an easy means of turning the current on or off, or which automatically cut off the current in the iron itself when the temperature reaches a certain point. Several irons are fitted with manually operated switches so that the current can be controlled and the temperature regulated. The switch parts, however, being in the iron are subjected to oxidation resulting from the high temperatures of the devices and are apt to give trouble. The elimination of all delicate parts from the electric heating device and providing control by other means, is the solution which parallels the case of the motor and its controller which is never built into the frame, base or other part of the motor, but is installed in the line.

For such devices as irons, toasters, table disc stoves, percolators, chafing dishes, etc., the small push-button "feed-through" or "cord" switch which can be placed at any place on the cord, provides a convenient means of control. When ironing light materials, the iron can be cooled down by operating the switch to turn off the current for short periods. In case of interruptions, the current can be snapped off, and on again in the same way when ironing is resumed, thus saving current.

Fig. 1. Application of 3-Heat Cord Switch.

This kind of control switch is particularly suited for use with heating devices used at the table also. To control the temperature by operating the socket key or by pulling out the plug at the device or at the receptacle is very liable to result in an embarrassing accident, such as the upsetting of a cup of coffee or cocoa, or something equally damaging to table linen. This type of switch is shown as used on the heating device cord in the accompanying illustrations. Being installed on the cord, it is not subjected to the varying temperatures of the device. This switch is also used to control such current-consuming devices as motor-driven drills, small portable vacuum cleaners, etc. No matter what distance these devices are taken from the receptacle to which they are connected, the control is not affected, as the switch is placed near the device.

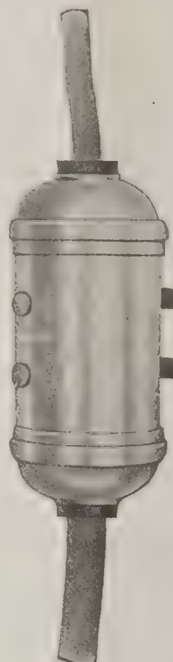


Fig. 2. A 3-Heat Cord Switch.

Surface type snap switches are usually used with such stationary devices as chocolate warmers and radiators, as the switch can be permanently mounted and thus easily operated. Where the ordinary surface switch is used with household table devices it is not satisfactory, for to operate it, it is necessary to hold it with one hand and turn the button with the other.

The control of the portable water heater, shown in Fig. 3, is obtained by means of a 10-ampere single pole pendent switch operated in a similar manner to the cord switch and by means of a single push bar. As the water heater shown is of 9-ampere capacity, the 10-ampere pendent is better suited as the rating of the cord switch is 6 amperes—suitable for practically all household devices. Where this type of water heater is installed in a permanent location on a bar or soda counter, a surface switch is also suitable for controlling the current. Where a cord switch is used the same cord and connection plug can be used with any of several devices (of the same make) used in the household—the toaster, the iron, the disc stove, etc.—and in each case provide easy control of the current. A switch on each device is not required.

Some classes of electrical heating appliances now on the market are designed to operate at a low, medium or high heat. Water and coffee urns, table stoves, heating pads, tailors' irons, are included in this class, and are so designed that the resistance is divided into sections so that for low heat only a small part is to be connected in circuit, while at a medium heat a larger section is in circuit and at high heat the entire heating element is connected across the line. In some cases the device has special contacts and a plug which can be placed in several ways to give the control desired. One manufacturer uses a push button three-heat cord switch similar to the single pole cord switch. The urn shown in Fig. 1 is controlled by a switch of this type.

Fig. 3. Control of Water Heater by Pendent Switch.

With heating devices used for industrial purposes, such as in hat making, it is sometimes desirable to vary the temperature over a wide range because of the nature of the work. This can be accomplished by installing a small 5-inch or 6-inch rheostat in series to vary the amount of current passing through the device. The 6-inch resistance plate is now made which provides heat regulation in six steps, from full heat to low heat, the latter being usually ½ to ¼ full heat. This meets the required needs of these devices.

Electric fans in use are easily and satisfactorily controlled and the speed varied by means of the small lever, usually mounted in the base, the other end passing over a series of contacts of a small resistance plate, and thus varying the speed of the motor. Where fan electroliers are used, however, and it is desirable to control the lamps and fan separately, the two-circuit pendent switch, already mentioned, can be used, and makes possible the turning on or off of either fan or lamps independently. For small ventilating fans requiring no speed variation, a magnetic switch is convenient to start the fan from a distance. For larger fans requiring speed control, a regulating rheostat is required.

Section 4. Industrial Application of Heating Devices and Other Equipment.

To the commercial department of the central station, perhaps no heating device field appeals more than that of the industrial application of electrical heat, and the exploitation of those devices that on account of their current consumption can command a rate making their use attractive to the customer and placing the load on a power demand basis. An interesting comment in this connection was made by C. D. Williams on industrial applications, in a recent issue of the *Age Bulletin,* a small publication issued by a New York central station. What follows is taken from this source:

Probably the most obvious industrial application of electric heat and at the same time one of the most interesting from the station manager's point of view, because of the current consumption involved, is that of the electric iron in laundries, tailoring establishments, dyers' and cleaners' shops, corset manufacturers and clothing houses, as well as in the laundry department of hotels and institutions. To be interesting to your customer, the proposition must not only be economical and durable in maintenance and repairs

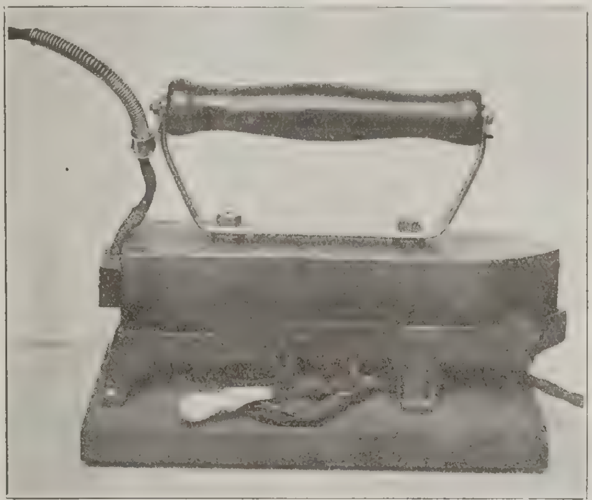


Fig. 1. Tailor's Goose, With Automatic and Hand Regulator Stand.

expense, but it must also captivate his imagination from the standpoint of efficiency, sanitation and up-to-dateness.

The properly equipped establishment includes suspension arms, designed to eliminate cord trouble, breakages, and to increase efficiency by keeping the cords out of the way of the operators; pilot lamps, automatically indicating when an iron is left in circuit; automatic stands cutting down current supplied to the iron when running idle (in themselves savers of perhaps 15 per cent of the current); the hand-controlled stand, permitting individual control of temperature suitable to the class of work in question, and the combination hand and automatic control.

The application of electric heat to cooking operations is primarily interesting in such places as manufacture their own current, but it is still possible with the assistance of a rate calculated to meet the requirements of the situation, to

Fig. 2. Electric Glue Pot.

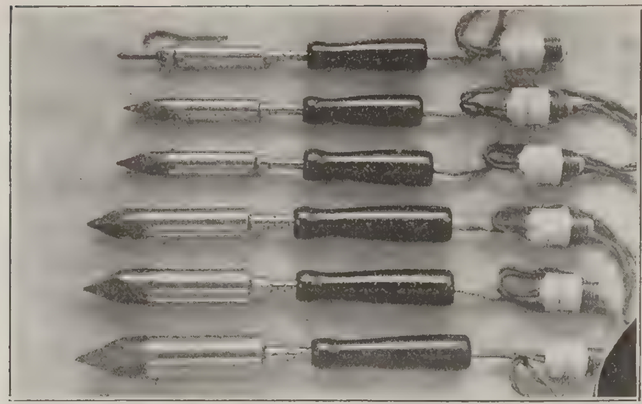


FIG. 3. ELECTRIC SOLDERING IRONS.

employ electric heat not only in the main operations of hotel and institutional cooking, but in any case to utilize the benefits of smaller devices such as waffle irons, griddles, hotel toasters, broilers, fry kettles and the like, in addition to the ornamental table devices, such as percolators, chafing dishes and toasters for individual service.

FIG. 4. ELECTRIC VULCANIZING OUTFIT.

While we are speaking of hotels, it is worth while to mention the curling iron heater as an extremely important device in modern institutions either in the form of surface type hotel curling iron heater, which automatically cuts on and off, on the introduction and removal of the tongs, or the flush type, built for fireproof walls, having the same

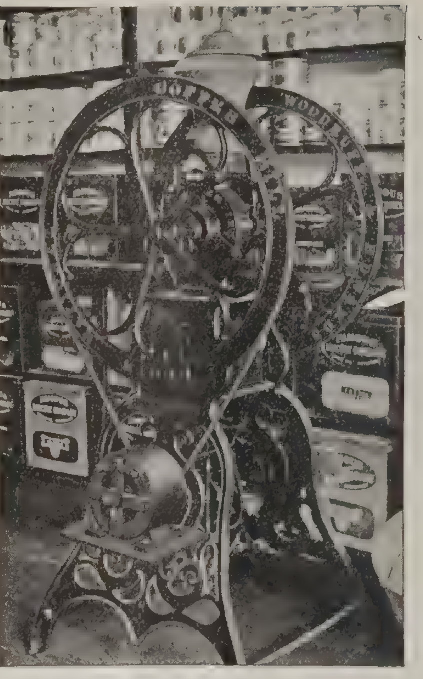


FIG. 5. ELECTRICALLY OPERATED COFFEE GRINDER.

principle of operation, offering a more attractive form of installation when it is possible to specify these curling iron heaters during construction.

The factory applications of electric heat are so numerous as to limit me at present to a mere mention. Besides soldering irons and glue pots, which are familiar to every one, there are electrically-heated kettles for pitch, varnish, insulating compounds and paraffine, where the advantages of electric heat are obvious through the absence of danger probable in the presence of inflammable gases when flame is used. Melting pots, which are used for solder, babbit and other metals, sealing wax pots, both for factory use—particularly in the manufacture of electric wiring devices—as well as in offices and express companies, are widely used. Manufacturing operations, requiring printing, embossing

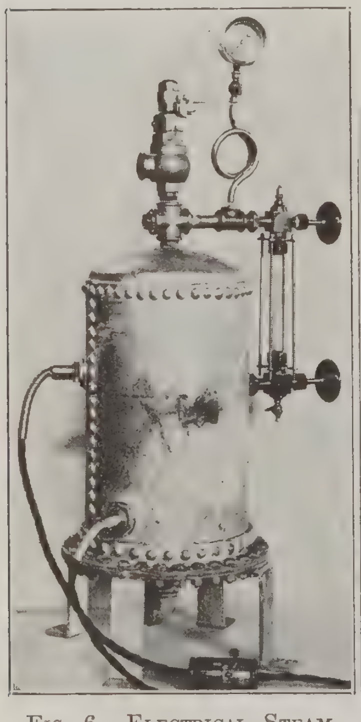


FIG. 6. ELECTRICAL STEAM BOILER.

FIG. 7. ELECTRICALLY HEATED COFFEE URN.

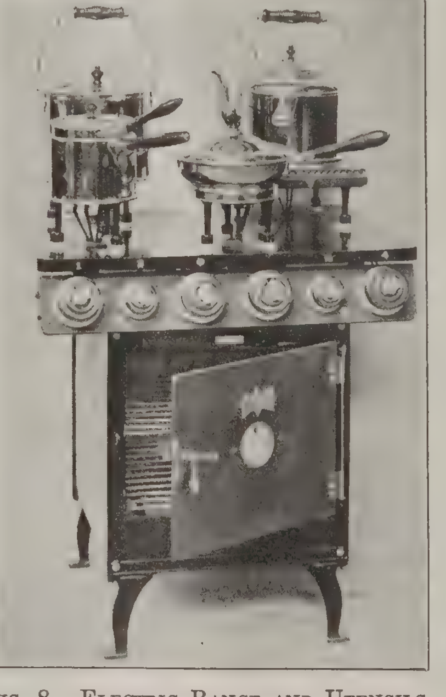


FIG. 8. ELECTRIC RANGE AND UTENSILS.

Fig. 9. An Electric Ozonizer.

and stamping where heat is required, can be conducted with excellent results, by the introduction of electric heat. The use of embossing heads electrically heated in printing and book-binding establishments, is frequent.

Fig. 10. Motor Driven Floor Polisher.

Lately an application of the principle of the electric baking oven has been made to factory operations for japanning, drying lacquered parts, etc. Notably in a factory in Connecticut where there are several of these ovens in successful operation with more in course of manufacture are they used; the capacity of each oven being under control from 3 to 8 kilowatts.

In hat factories electric heat is much used; it may be said that all establishments using smoothing irons will have recourse to electric heat as the natural progress of their growth. Laundry machinery, such as rolls, mangles and special laundry irons, operating from power are using electrically-heated surfaces with increasing frequency.

Electrically-heated shoe machinery has already come to a recognized industry and this market is thoroughly canvassed by a specialty company restricted to the shoe trade. Electric radiators for factories are efficient in construction and operation. The expense of operation while prohibitive on many rates yet permits many applications of this sort

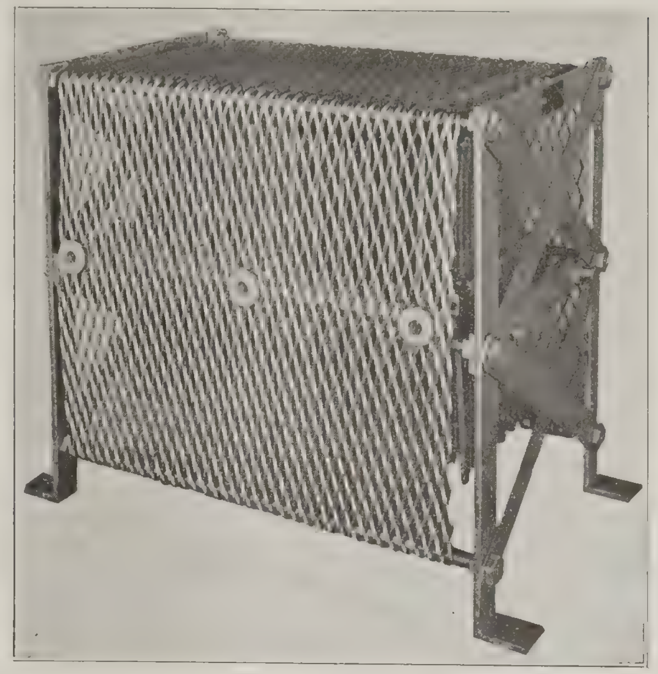


Fig. 11. Electric Radiator of Workshop Type.

where the convenience and cleanliness of the electric radiator is a factor.

With regard to electric boilers, one of the most interesting and practical forms of construction is the coil spring unit with mica insulation between each convolution, supported by a rod in tubular boilers. By reason of its solidity of construction and the fact that there is no insulation or envelope surrounding the heating element it is found to

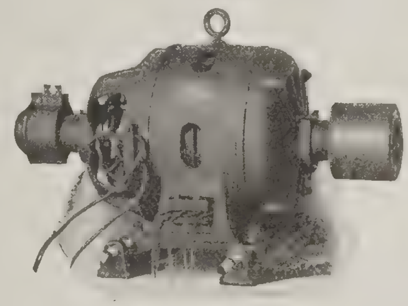


Fig. 12. Wagner Unity Power Factor Single Phase Motor.

be very efficient, it being practical with these boilers to supply hot water for apartment houses and institutions without limit, so far as is yet known, as to size. In a recent case a 200-gallon boiler was equipped with 5 kilowatts heat controlled and is operating with perfect satisfaction.

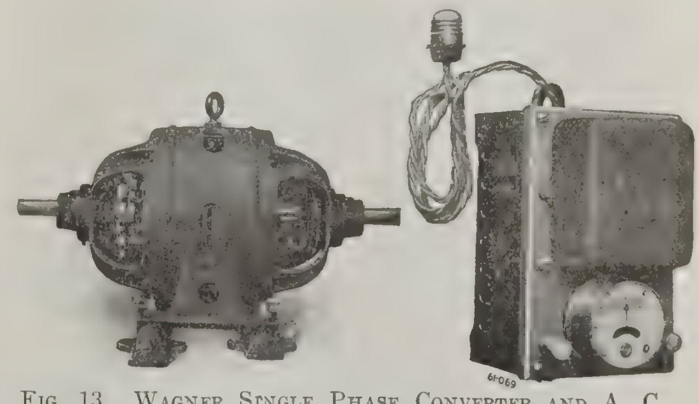


Fig. 13. Wagner Single Phase Converter and A. C. Rectifier.

Other successful installations have been made in 25, 50 and 75 kilowatt sizes, and there was recently under consideration a 1,000-kilowatt boiler for a paper mill.

In laboratory practice, there are many electrically-heated devices which, because of their nature, have pre-empted the use of other forms of heat. Among physicians, surgeons, hospitals and dentists, the use of heating pads and electric sterilizers is already very widespread. At the present time there is no suggested application of electric heat that is not important enough to refer to an electric heating engineer for his comment on practicability.

A Modern Telephone Exchange at West Point, Ga

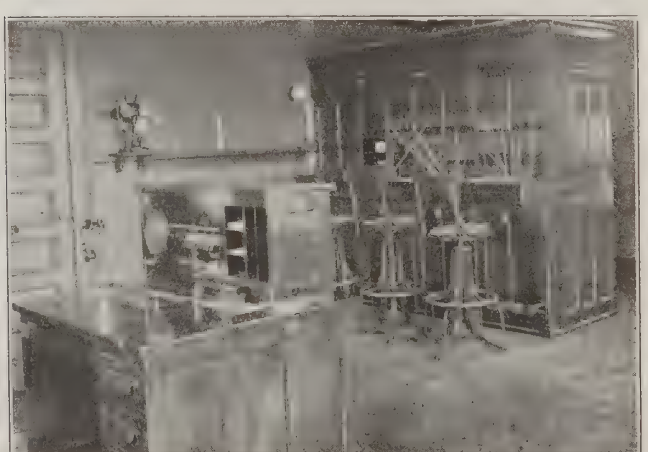
(*Contributed Exclusively to* Electrical Engineering).

BY E. H. BUSSEY.

The ever increasing demand for a quicker and more efficient means of communication is one of the brightest signs of the commercial awakening of the South. Recognizing the necessity of furnishing the best possible service to its subscribers, the West Point Telephone and Electric Company, of West Point, Ga., has just completed the erection of a new exchange building, installing a modern, lamp signal multiple switchboard, and changing their outside system to an all-cable plant and installing new telephones throughout.

The exchange building is located on a site overlooking the Chattahoochee river, and no expense has been spared to make this the very best constructed telephone building of its size in the country. In the basement, which is solid concrete throughout, is located the storeroom and repair shop. The first floor is occupied by the distributing frame room, power plant and manager's office. A provision is made in the lobby on the first floor for subscribers, in paying bills, to have access to the cashier.

The central office equipment, including the switchboard, power plant and protection devices, are of the Western Electric type. The switchboard consists of three single-position sections of two panels each. The first section is arranged to take care of the toll and rural lines, of which there are twenty now connected to the board. Service over the long distance lines of the Southern Bell Telephone & Telegraph Company is afforded to Opelika, LaGrange and Atlanta over special lines. These lines and the long rural lines connecting West Point to adjacent small towns are all equipped with magnetic local battery sets and are terminated in the board on special high-wound signals. These signals have the answering jacks associated with them, so that their operation is practically as fast as that of a regular common battery line. In general the board possesses the same transmitting and operating features as the larger boards in the country. It is provided with line lamp signals and supervisory lamp signals. The arrangement of the equipment is shown in Fig. 1. With the equipment installed as shown, it is possible for any operator to complete a connection with a minimum reach, thereby resulting in the quickest possible service.



Interior of Telephone Exchange, West Point, Ga.

A distinctive feature of the operating room equipment consists of a combination chief operator's and wire chief's desk. This desk is finished in mahogany to match the woodwork of the main board and is so designed that it is possible to make any of the tests necessary in quickly locating any troubles that may occur from time to time. The work of making these tests is done by the chief operator. Another distinctive feature of the equipment is an harmonic ringing system and an "instantaneous" call. The instantaneous call feature is so designed that immediately upon a subscribers' taking a receiver from the hook on a telephone, the subscriber is in position to talk to the operator. The subscriber's line lamp lights up in the usual way, but with this feature it is unnecessary for the operator to plug into the answering jack before being able to ascertain what number is desired. Upon the subscriber lifting his receiver and telling the operator what is wanted, the operator takes the front cord of a pair of connecting cords and inserts the plug of this cord into the jack of the desired party. The called party is then signalled and the back cord of that pair of cords used is then inserted into the calling party's answering jack. It is claimed that this method of operation results in rapid operation.

The harmonic system makes use of the fact that every vibrating reed has a natural period of vibration and can be made to take up this vibration by a series of impulses of force occurring in the same frequency as that in which the reed or pendulum vibrates. In the harmonic ringing system, a device at the central office known as a converter delivers an alternating current of four different frequencies, that is, 16 1-3, 33 1-3, 50, 66 2-3. The ringers in the telephones are constructed with respect to the length and weight of its armature so that it has a period of vibration which corresponds to the number of alternations made by one of the four alternating currents.

An interesting feature in connection with the outside plant is the crossing of the Chattahoochee river with a 150-pair cable. The span at the point of crossing is 540 feet in length. To accomplish this task in a successful way, one 60-foot steel tower was erected on each side of the river, the cable suspended on a 10,000-pound messenger from a 50-foot height on the tower and a similar messenger was strung from the top of the tower and used to pick up the main cable messenger at two points in the crossing.

Both the inside and outside plants were installed from plans furnished by the Western Electric Company. The resulting plant is something of which the city of West Point and the owners of the property may well be proud.

The New York Conference of Society for Electrical Development.

The organization of the Society for Electrical Development in the early part of September, 1912, together with accounts of its meetings since that date, its plans and its purposes have already been reported in these columns. The most important event in the history of this society, however, took place at New York March 4 and 5. This meeting, as announced in our March issue, was more than a regular "get-together" of the officials of the society, since the entire electrical fraternity was invited for the purpose of discussing from all angles arrangements of the society for co-operation and general educational work through the electrical and allied industries. The result of the meeting, attended by some 175 men influential in the different lines of electrical activity, proved that the work has a strong hold on all the agencies that are interested in or have to do with anything electrical. While the society represents the interests of and recruits its members from central stations, manufacturers, jobbers, contractors and dealers, all others who have interests lying in any of these directions have shown a willingness to enter into the spirit of the work and lend a helping hand. From the nature of the plans now formulated and adopted, the society has a definite work of tremendous proportions which cannot but reflect to the benefit of the entire electrical industry.

SESSIONS ON TUESDAY, MARCH 4.

The following program was carried out during the two days o fthe conference: An opening address was delivered Tuesday morning by the president, Mr. Henry L. Doherty. In this address, Mr. Doherty briefly outlined the reasons for calling the conference, stating that the society desired through a meeting open to the entire electrical fraternity to present its plans for future work and discuss thoroughly these plans from every angle. He referred to the sentiment against big business on the part of the government and expressed the opinion that the prosperity of the country in the future depends upon a correction of this attitude. He referred to conditions in other countries, especially Germany.

In commenting upon the work of the society, Mr. Doherty stated that it amounts to more than a National advertising campaign in that its desire to bring about a consolidation of interests that will be beneficial to everyone and objectionable to none. He referred to the collection of data on cost of operating industries, which can be furnished to all central station companies. He further referred to the promotion of electricity in the country and its use in connection with vehicles of all kinds.

Following Mr. Doherty, General Manager J. M. Wakeman, discussed the aims of the society. He expressed the opinion that there is a need for publicity that will induce the public to realize the advantages and economy of electrical energy and such publicity can be secured through advertising on a large scale, furnishing articles of electrical news written by men whose names will insure that the articles will be read, supplying the daily press with electrical news, exhibiting subjects of electrical interest through moving pictures, discussing in the technical press business and practices along manufacturing, contracting and electrical supply lines and the educating of farmers, architects and others in the merits of electrical service.

Mr. Wakeman was followed by F. H. Gale of the General Electric Company, with a paper on, "The News Value of Electricity." The author discussed in this paper the news value of progress in the branches of the electrical industry, taking up the features of interest to newspapers and to the technical press. He commented upon publicity from the standpoint of the public service corporation and mentioned the benefits that can be received from favorable newspaper comment. He distinguished between items of news interest and the work of press agents. Mr. Gale's paper was thoroughly discussed by a large number present.

The afternoon session opened with a paper on, "Electricity and the Architect," read by Frank E. Wallace, of Wallace & Goodwillie, architects, of New York City. This paper discussed relations between architects and electrical men, pointing out how and where the architect needs the aid of the electrical engineer. He suggested a committee to act with the American Institute of Architects in bringing about closer relations between electrical men and architects. He spoke favorably of the assistance he received from central station salesmen, supply dealers and electrical contractors who discuss matters referring to electrical work with him.

Following the discussion of Mr. Wallace's paper, a paper on the dissemination of news was read by Dr. Talcott Williams, of the School of Journalism, Columbia University, New York City. The author referred to the lack of knowledge of what is being done by the engineering professions and explained how the school of journalism is giving to its students, training in physics, chemical and electrical engineering so they will be able to express electrical and engineering matters in the proper manner. He outlined in considerable detail the nature of journalistic work, and the way it should be handled, referring specially to the engineering field.

The next paper, by T. Commerford Martin, executive secretary of the National Electric Light Association, outlined the part the N. E. L. A. is to play in the work of the Society for Electrical Development. In view of the fact that the central station industry is doubling every five years, anything the society can do to advance the industry at a more rapid rate is of mutual interest. Mr. Martin's remarks were supplemented by those of the president of the National Electric Light Association, Mr. F. M. Tait, who advanced the assurance that the society would have his co-operation for he believed that the central station companies should co-operate to the fullest in the work.

The subject of "Efficiency in Local Advertising," was next discussed by J. C. McQuiston, of the Westinghouse Electric & Manufacturing Company. He outlined in detail his idea of future development and expressed the opinion that publicity is to play an important part in bringing this about. He further referred to the "People's Electrical Page," now running in numerous daily papers, and objected to the method of carrying it on, in view of the fact that matters are presented of little local interest and appeal only slightly to the average layman reader. He further referred to profitable sources of advertising, mentioning window dressing and personal demonstrators for the sale of electrical appliances, talks by competent men before clubs and moving pictures on electrical subjects. He further mentioned co-operation with city officials in order to make plain the true relationship which each should bear to the other. Regular meetings were suggested between jobbers, contractors, dealers and central station sales agents and advertising men, discussing advertising methods by central station companies as well as the other interests aiming to bring about a co-operation and good to all concerned. A traveling electrical show organized so as to be able to go from one place to another was mentioned as a means of presenting the same results as the present show at less cost.

SESSION ON TUESDAY EVENING.

A session was held on Tuesday evening. At this session Mr. T. C. Martin reported the contributed material to the society by various individuals and electrical associations proposing lines along which activities of the Society for Electrical Development may be directed. The heads under which the material was divided included general publicity, publicity within the industry; educational work; traveling shows; traveling representatives; campaigns of educational work for the public and for the electrical industry, books on commercial development and commercial practice; the unification of water power laws; cooperation with civic bodies, relations with the general press; education of young men for the central station industry, and stimulation of electrical merchandising.

SESSIONS ON WEDNESDAY, MARCH 5.

The Wednesday morning session was opened by a paper on, "Co-Operation in the Electrical Industry," read by J. Robert Crouse, of the National Quality Lamp division of the General Electric Company, Cleveland, Ohio. He outlined the part commercial co-operation is to play in future development, believing that it is a recognized factor in increasing the efficiency of production and distribution. The author advanced means for promoting co-operation, including a national campaign of advertising; a national electrical press bureau, the use of advertising service through agencies, the creating of new business departments in the technical press, the establishment of schools of electrical salesmanship, and the sending out into the field of men experienced in lighting business, electrical contracting business and allied trades, the distribution of commercial literature, and the offering of special prizes for excellence in commercial work.

This paper was followed by one entitled, "The Sales End," and read by James H. Collins, of New York. He commented upon the need of instruction for modern central station salesmen, and discussed co-operation with electrical contractors and dealers.

"Merchandizing Co-Operation," was the subject discussed by W. E. Robertson, vice-president of the Robertson Cataract Company. In discussing retail merchandizing, the author mentioned that location, window display, courtesy, newspaper advertising and direct appeal from the counters of the store are important factors in the success of the business. It was the opinion of Mr. Robertson that a retail dealer can secure the confidence of the public easier than the central station, and that many retail stores can be successfully carried on if there is a substantial co-operation among the interests effected.

In the discussion of the merchandizing subject as presented, Mr. Doherty agreed that articles should be sold at a price which would net a profit by central stations, and called attention to the public antagonism toward corporations and toward middle-men. He believed that the middle-man is now recognized as a necessary factor and that antagonism toward him will probably diminish. Mr. Doherty favored marketing products under a fixed retail price, referring to the Ingersoll dollar watch as an example of successful price fixing for the retail trade. He stated that the cry for low prices is an economic policy, and that low prices do not compensate for poor service, which is an inevitable accompaniment. He further referred to the handling of tungsten lamps by central stations and the effect of introducing defective appliances. The latter he believed on account of failures have made the public so skeptical as to injure the introduction of reliable devices.

The afternoon session continued the discussion of the merchandizing situation, Mr. C. W. Stone, of the General Electric Company, discussing the situation from the standpoint of the manufacturer. He pointed out that dealers and jobbers have a distinct part in the development of central station business, the one endeavoring to improve its load curve, while the others are endeavoring to secure larger profits through increased sales. He mentioned the fact that often small devices are neglected when installed, and thus fail to give satisfaction, believing that there should be some follow-up method specially on the part of the dealer who gives such attention only occasionally. He stated that the society can help the manufacturer to develop along lines of greatest benefit to the central station companies and dealers, as well as all concerned in the industry.

J. R. Strong, of New York, further discussed the situation, referring to jobber, contractor and dealer, and suggested a harmony department of the society to bring about the sale of electrical merchandize at a profit to all. He stated that the contractor only asked of the central station satisfactory business conditions and cooperation in regard to sales. He referred to the manufacturer as being at fault with the central station in regard to electrical merchandizing, by selling direct to the customer and quoting to such a customer prices lower than to men legitimately engaged in the electrical business. He believed that the society can establish a harmony in these cases.

Various other speakers took up different lines of argument in this regard and related instances which show that the society has a decided field for work in straightening out the problem of electrical merchandizing.

The advertising campaign proposed by the society was explained by W. B. McJunkin, of Chicago. The author of the paper presented this campaign and showed through a large chart the nature and classification of the work to be done. He discussed the fields to be entered, the nature of copy, the nature of mediums and the amount of space to be used in various publications.

The conference closed with a banquet on Wednesday evening attended by a large number of those attending the conference. The banquet was a fitting close for the remarkably successful work of the two days' sessions and crystallized the well laid-out purposes of the society in the minds of not only its founders, but those who are giving it their hearty support.

Convention Mississippi Electric Association, April 21 to 23.

As announced in our January issue, the Mississippi Electric Association, a state section of the National Electric Light Association, will hold its fifth annual convention at Natchez, Miss., on Monday, Tuesday and Wednesday, April 21 to 23. At a meeting of the executive committee on March 10th, at Jackson, Miss., the details of the program were determined upon and definite plans formulated for accommodating a larger attendance than has ever come to a past convention as there is every indication from the growth of the association and the interest taken in it that such plans will be necessary.

The executive committtee has arranged for all members and delegates to the convention to meet at Vicksburg on the morning of April 21. At 12 o'clock a steamer will be taken for Natchez arriving on Tuesday morning. The opening session of the convention will be held on the boat at 2:00 P. M. Monday. The committee promises an enjoyable trip, having secured Bud Scott's band, a famous negro aggregation, and planned other splendid features of entertainment, all of which is in charge of F. J. Duffy of Natchez—"enuf sed."

The details for the convention sessions are as follows:

MONDAY, APRIL 21. Association members and delegates assemble at Vicksburg and take the boat at 12 o'clock for Natchez. At 2:00 P. M. the convention is opened on the boat by the address of the president, R. B. Claggett (Greenville). This address is followed by reports from committees on electric heating and cooking and on meter testing and practice. This will close the business session. At 4:00 P. M. the members will go into executive session.

TUESDAY, APRIL 22. The boat arrives at Natchez and a morning session will be called at 9:30 when W. G. Benbrook, mayor of Natchez will deliver a welcoming address. At this session two papers will be presented, one on "Large Power Contracts" by A. B. Patterson, (Meridian); the subject of the other has not as yet been announced. The afternoon session of Tuesday will be called at 2:00 P. M. and reports of the committees on line construction and the grounding of secondaries presented. The report of the secretary and treasurer will also be presented at this session as well as a paper, the subject of which has not been given out.

WEDNESDAY, APRIL 23. The morning session of Wednesday will be called at 9:30 and reports of committees on membership, on insurance, and on public policy presented. A paper will also be delivered on "Single Phase Motors" by J. F. Jones and one on "Lubricating Oils" by W. A. McWhorter. At the afternoon session a paper on "Ornamental Street Lighting in Small Cities" will be presented by an illuminating engineer from the National Electric Lamp Association. An executive session will then be called and the election of officers for the year 1913-14 held.

A rejuvenation of the Jovian Order is planned for Tuesday night and will be in charge of Statesman F. J. Duffy.

On Wednesday night a banquet will be held.

Second Convention of Oklahoma Gas, Electric and Street Railway Association to Be Held in May.

The second convention of the Gas, Electric and Street Railway Association is to be held May 6, 7 and 8 at Oklahoma City. On account of the success and interest shown in the first convention held at Oklahoma City last year, it has been planned to carry out the coming convention on a thorough plan, arrangements already having been made for a number of interesting papers. Included among these is one on "Liability Insurance" by F. H. Ellis, of Kansas City, and one on "Electricity in the Irrigation of Oklahoma Farms" by Prof. H. B. Dwight of the University of Oklahoma. Further details of the convention will be announced later.

Census of Underground Conduit.

On account of the general agitation for the removal of wires from city streets and the installation of underground conduit and on account of the lack of complete information on the nature and extent of underground circuits and systems in the United States, a census of underground conduits in this country and Canada has been undertaken by G. M. Gest, a contractor and engineer of New York City. This census has been undertaken at the suggestion of T. C. Martin, secretary of the N. E. L. A. and all data collected will be placed on file at the New York office of the National Electric Light Association where those who are interested in it can refer to it. Cards have been mailed asking certain questions and all central stations and others who have received them should cooperate to make the work of the compiler as complete and accurate as possible. If cards have not been received they will be furnished by addressing G. M. Gest, 277 Broadway, New York City. The questions follow: Have you any conduit installed? About how many duct feet? Have the telephone companies any? About how many duct feet? Have the telegraph companies any? About how many duct feet? Have the traction companies any? How many duct feet? Does the city own any conduit system? About how many duct feet? Have you an ornamental lighting system? About how many posts?

Annual Inspection Trips of Case School of Applied Science Include Visits to Southern Plants.

The schedule of inspection tours of the Case School of Applied Science, originated by the electrical engineering department under the direction of its director, Prof. H. B. Dates, this year includes trips for civil, mechanical and electrical departments. Each trip includes the inspection of certain plants and engineering projects which have been carefully reviewed in advance, the inspection work being required of each member of the senior class of the above courses. A written report covering the trip forms a part of the senior course of spring instruction, and has heretofore seemed of so much value to the electrical engineering students as to make the trips a regular part of prescribed courses in the fututre.

The inspection trip laid out by Prof. Dates for the electrical engineering students takes in the important electrical developments of the South. The party left Cleveland on March 20, stopping at Cincinnati to go through the Bullock Works of the Allis-Chalmers Company and the works of the Triumph Electric Company. Going southward from this point the next stop was made at Ocoee, Tenn., where the hydroelectric plants of the Tennessee Power Company were visited. From here the party went to Chattanooga, Tenn., inspecting the interesting lock and dam development of the Chattanooga and Tennessee River Power Company. Proceeding again southward, the next stop was made at Atlanta, Ga., where the Textile department of the Georgia School of Technology was visited and the system of the Georgia Railway and Power Company inspected, including the substations in Atlanta and the hydroelectric station at Tallulah Falls, Ga. From Tallulah Falls the party went into the territory of the Southern Power Company, visiting the plants oft he company at Great Falls and Rocky Creek and observing the transmission line construction for the 44,000 and 100,000 volt lines. While in this district the sub-stations of the Piedmont and Northern Railroad, the 1500 volt D. C. interurban electric system operated by the Southern Power Company's system, was inspected. From here the party was conducted to Greensboro where one of the steam stations of the Southern Power Company was inspected and a 100,000 volt substation. Leaving Greensboro, the next stop was at Washington, D. C., where the United States Bureau of Standards and the United States Navy Yard was visited. From here the party went direct to East Pittsburgh to go through the shops of the Westinghouse Electric and Manufacturing Co. From Pittsburg a train was taken to Marianna where the largest and most thoroughly equipped mine in the world is located. This inspection officially ended the trip and the party returned to Cleveland and reported for work on April 7th.

The educational features of such trips as above outlined need no comment even though taken without the careful study before and the attention to details given by the directors of the different groups. We believe that the Case school has started a practice which will eventually be adopted by many other technical colleges for such trips cannot help but give students who are about to enter the field of engineering a better insight into their fields as a whole and give them, so to speak, a glimpse of the possibilities of their profession that will be helpful in choosing a definite line of work to take up.

Mississippi Electrical Association Question Box.

Under this heading will appear each month questions and answers to questions from members of the Mississippi Electrical Association. All readers are invited to discuss any question or topic presented. Address all correspondence, including questions and answers, to Clarance E. Reid, Question Box Editor, Agricultural College, Miss.

New Questions.

Question No 17. A small 4-pole exciter is direct connected to a 6-pole revolving field alternator, running at 1,200 revolutions per minute. Alternate quarters of this exciter commutator become blackened rapidly after cleaning and the negative brushes wear down excessively fast. The armature is mechanically centered in the field frame. Will someone please suggest reasons for above behavior?

E. F. M.

Question No. 18. Is it possible to replace brushes in a four-pole generator, where there is only one brush to a set, without shutting down? Is there any objection to this practice, if possible?

Question No. 19. Is it considered good practice to use two transformers connected "open delta" or "V" connection, instead of three transformers, connected in "delta" for 3-phase, step-down transformation? What are advantages and disadvantages of this connection?

Question No. 20. With a 3-phase synchronous motor (rotary converter) running on a generator of about the same capacity as the motor, 3-ammeters are in circuit, a voltmeter which can be applied to each phase, and two indicating wattmeters. The three ammeter readings differ considerably, the three voltmeter readings differ slightly, and the two wattmeter readings differ, sometimes much, sometimes little, depending on the strength of the rotary's field. Why should the readings of the ammeters differ among themselves? Why should the voltmeter readings differ even slightly, when the open circuit readings on all three phases of the generator check very closely? A three-phase power factor meter, without series or potential transformers, is also connected in this circuit. How would the readings of the ammeters, voltmeters and wattmeters be used to check the power factor meter?

Question No. 21. Are the regulation and efficiency of auto-transformers in general better than separate coil-wound transformers of same general design? If so, why? In a 10-kw. auto-transformer of 200 to 50 volts, what would be the current in each part of the auto-transformer?

See questions unanswered—Nos. 10 and 16, in March issue.

ANSWERS TO QUESTIONS.

ANSWER TO QUESTION NO. 2.

The telephone system would be interfered with on account of induction, from the 2,300-volt A.C. circuit to such an extent that good service could not be obtained unless proper transposition was carried out on the entire system. Increasing the frequency to 133 cycles, the 'phone service would be badly interfered with and much worse than if 60-cycle system was installed.

J. T. R.

ANSWER TO QUESTION NO. 3.

Transformers for the 110-volt, 3-phase, 3-wire circuit should be located outside of generating station on pole or platform located at least 50 feet from the building transformers are to supply current for. I do not see any necessity for installing fuse between 2,300-volt buses and the wires leading from the station. However, it is good practice to install an oil switch on the supply lines leading from the station to outside of building. The supply wires leading from building should be provided with 2,300-volt insulation to a point well beyond the building.

J. T. R.

ANSWER TO QUESTION NO. 5.

These wires should be supported on petticoat insulators every 4½ feet; 2,300-volt insulation should be used. Wiring about switchboard should be provided with approved flame proof covering. The above method would be the cheapest, and for all practical purposes would answer the purpose all right, but the best way would be to use an approved lead-covered cable installed in conduit.

J. T. R.

QUESTION NO. 9. On some series transformers recently received, I find the terminals which are to be connected to the meters, short-circuited, with a copper wire, and the instruction tag sent with them states that these terminals should always be short-circuited when the meter is not connected. Why is this?

In series transformers, the iron core is usually worked at very much lower flux density than are power transformers, in order to keep the exciting current very low. The exciting current, being added to the current on the primary side, makes the ratio of primary current to secondary current greater than the ratio of secondary turns to primary turns, so the smaller the exciting current, the less this error in ratio. In any transformer, the flux under load conditions is a resultant of the flux produced by the primary ampere turns, less the demagnetizing effect of the secondary ampere turns. There would be no demagnetizing effect if the instruments were disconnected, the flux therefore would rise to a very high value, and in addition to producing much greater heating than usual in the iron core, might produce high enough voltages in the open-circuited secondary to break down the insulation of the transformer in extreme cases.

The voltage generated in any coil due to changing magnetic flux, equals the rate of change multiplied by a constant. Any condition tending to cause the magnetism to change quickly will cause a high voltage to be generated. If a current of, say, 100 amperes be passed through the primary of a current transformer it will cause a large flux to pass through the iron core which would generate a fairly high voltage if the flux varied as a sine wave, but since the core becomes saturated, the magnetism will not follow the sine law but will be practically constant at the middle of the current wave and will make a sudden drop at the ends. This sudden drop will result in a very high voltage, to prevent which the short circuiting wires are used. When the coil is short circuited there will be a secondary current flowing in the opposite direction to the primary current which will thereby partly neutralize it and prevent the generation of the large magnetic flux and the consequent high voltage. T. G. Seidell. (Ga.)

QUESTION NO. 11. Why is the air-gap between pole-face and armature so much larger in the case of turbine-driven alternators than in the case of other generators of corresponding dimensions?

The steam turbine is inherently a high speed machine for efficient operation. To obtain common frequencies at high speed limits the number of poles to a small number. The high speed also means large output, and therefore a large output per pole and the armature reactions per pole are large. With a short air-gap, a weak field only is needed to give normal voltage, at no load, or zero current in the armature. With load current in the armature, the strong armature reactions would neutralize the weak field, and reduce the field strength, and therefore the voltage of the machine vary greatly, requiring a large increase in the original field current. By increasing the air-gap, the effect of the armature reactions is much reduced; it also makes necessary a strong field current at no load, which further opposes the demagnetizing effect of the armature reactions.

With a short air-gap, it is also found that the heating of the core of the field is very severe, due to the uneven distribution of the lines of force in the teeth and slots; a longer air-gap gives these lines space in which to distribute themselves more evenly, before reaching the pole face. There is then not so much shifting of the lines of force across the pole face, and this reduces the eddy current loss in the pole faces.

QUESTION NO. 12. Where may auto-transformers be used instead of two-coil transformers to advantage, and in general, where may they not be used?

The auto-transformer is cheaper than the two coil transformer, since it uses less iron and also less copper. It also has better regulation, higher efficiency, and a greater output than a similar two-coil transformer. It is better used in all cases where there is no objection to having the primary and secondary circuits inter-connected at one point. That excludes it from use as a lightning transformer, for there is serious objection, obviously, to having the 1100 or 2300 volt circuit connected in any way to the house circuit. For auto-starters and speed regulators for induction motors, it is often used; it has the objection of lowering the power factor, however, when used continuously as a speed regulator, but for starting, when it is in circuit for only a short time, it is invariably used. It is also used very much for series incandescent lighting circuits. J. E. C.

QUESTION NO. 13. Kindly explain how an alternating current motor with no brushes or external connections to the armature, is caused to rotate.

ANSWER TO QUESTION NO. 13.

The class of alternating current motor referred to in Question No. 13 is an induction motor of the squirrel cage type. Current entering the stator sets up a rotating magnetic field and on account of the transformer action, induces a current in the short circuited copper bars of the rotor. It is a fundamental principle that a conductor carrying current and placed in a magnetic field will be acted upon by a force, therefore these bars which have a current induced in them and are in the magnetic field of the stator are acted upon by a force. This force on account of the motion of the rotating magnetic field of the stator and the direction of the E. M. F. induced in the bars, acts upon the bars of the rotor in such a way as to make it revolve in the same direction as the magnetic field. As the speed of the rotor approaches that of the magnetic field, the E. M. F. induced in the rotor bars gets less and less, and less current is taken from the line, therefore the fall of current when this type of motor reaches speed. The speed of the rotor will always lag behind that of the magnetic field. This lag is called the slip and at no load may be as small as 1% of the speed. The slip for small loads is almost proportional to the load. H. J. Pratt, (Fla.)

[On page 121 o fthe March issue of Southern Electrician an article explains how the field of an induction motor revolves and describes a mechanical device that plainly shows the action. This device can be secured from the source mentioned for twenty-five cents.—Ed.]

QUESTION NO. 14. The common impression is that the older a carbon incandescent lamp gets, the more current it takes. I have been informed by an electrician that this is not so, but I have noticed that an older lamp gets hotter than a new one. Why is this, if it is getting less power?

An old carbon lamp will naturally have a higher resistance because of the evaporation of the carbon filament and will therefore take less current. The evaporated carbon is deposited on the inside of the globe as a black film which intercepts the light and transforms it into heat and thereby causes the glass to become hot although the filament itself is probably colder than that of a new lamp.

T. G. Seidell, (Ga.)

QUESTION NO. 15. Why are the manufacturers of some modern direct current generaotrs putting slots between the commutator segments instead of mica? Is not there some danger of carbon and other dirt short-circuiting the commutator?

ANSWER TO QUESTION NO. 15.

If in any case the mica does not wear away at the same rate as the copper bars of a commutator, trouble will result; if the copper wears faster, the high mica will lift the brushes from the copper bars, and cause sparking. If the mica wears faster, the small holes or slots will be filled by carbon and other dust, causing short circuits between bars. The slots which are cut between the bars are wide and deep enough so that the carbon dust is not pressed into them sufficiently to hold it, and it is thrown off by the usual speed of the commutator. R. H. N.

The Fellow Your Mother Thinks You Are.

Whilst walking down a crowded street the other day,
I heard a little urchin to a comrade turn and say:
"Say, Chimmey, lemme tell youse, I'd be happy as a
 clam
If I only was de feller dat me mudder t'inks I am.
She t'inks I am a wonder, an' she knows her little lad
Could never mix wit nuttin' dat was ugly, mean or bad.
Oh, lots o' times I sit and t'ink how nice 'twould be—
 gee whiz!—
If a feller wus de feller dat his mudder t'inks he is."
My friend, be yours a life of toil and undiluted joy,
You still can learn a lesson from this small, unlettered
 boy.
Don't aim to be an earthly saint with eyes fixed on the
 stars;
Just try to be the fellow that your mother thinks you
 are.

New Business Methods and Results

Representing Interests of Central Station, Electrical Jobbers, Dealers and Contractors.

Developing Profitable Summer Day Loads.

With the growth of the central station industry and the employment of more scientific methods of management, more attention is being given to the improvement of the load factor, or in other and as common words, to straightening out the load curve. This reduces the cost of production, since the fixed charges become less in proportion to the kilowatt-hour output. This result is accomplished not by reducing the peak load, but by the addition of a day load. Some stations are so fortunately situated as to have a large proportion of their output used for power purposes, and as a consequence their load factor is quite high, on the other hand, where the current is largely used for residence and commercial lighting, it is decidedly otherwise. Of the two lighting loads mentioned, residence lighting alone has a better load factor than commercial lighting alone, because offices and many stores only use current a very short period each day, while the residence load continues well into the evening. All central station managers who are at all awake, therefore, are constantly seeking new methods by which the excess capacity of their plants during daylight hours can be put to use. In most cases such load is very profitable from the fact that it can usually be taken on with no additional station equipment.

While of course the development of the day load is in order at any time and at all times during the year, special efforts to promote it are usually made in the spring; first, because the revenue of the central station is then decreasing and stimulates sales effort; second, because the excess capacity begins to show up more, and third, because many of the current-consuming devices are easy of introduction at this time. Apart from strictly climatic conditions, we note that spring is everywhere the season of change. We change our residence, remodel our places of business, introduce new processes, clean house, and shake things up generally. The solicitor for electrical devices thus finds a more ready listener then than at other times.

While there is really no strict dividing line, current-consuming devices are usually spoken of as domestic, commercial, or industrial, according to their application. A general discussion of residence appliances was published in the April, 1911, issue of Southern Electrician, and mention is again made of certain developments in this issue. We have from time to time presented details of campaigns and methods of introducing these appliances and solicit any new schemes or any new methods which have proved effective in this work. Just now, however, we shall discuss the question of improvement of the load factor.

There are a number of useful and popular devices which, on account of their convenience and economy of operation consuming a small amount of current, are a decided stimulus to the use of electricity. These include the electric washer, vacuum cleaner, sewing machine motor, percolator, toaster, small water heater, etc. The last three articles have been largely considered asluxuries, their chief value being in the fact that they are educating the public along lines of electric cooking and been the forerunner of the electric range. As a revenue producer, the electric iron easily takes first place, its low first cost making it easy to introduce. Since it is rugged in construction, it can be put on trial without fear of damage, and once in use, it is seldom thrown back on the hands of the station. In many families there is as much current used for the ironing as there is for lighting.

In the introduction of current-consuming devices at this time of year, special stress should be laid, of course, upon those articles which are productive of especial comfort and convenience during hot weather. Here, again, the electric iron furnishes one of the best examples. While, when once purchased they are used more or less during the whole year, the avoidance of discomfort from heat is such a valuable sales argument, that many more of them can be placed during the first hot days of spring than at any other time. These remarks apply to the introduction of electric irons in both residences and laundries, and fans and ventilating apparatus should also be worked up at this time, for a substantial revenue can be gained by taking the initiative in the introduction of fans instead of leaving it entirely to the customer. Every commercial manager should have a complete list of fan users, as nearly as can be secured, and systematically visit them in the early spring, to ascertain their requirements for the summer. It would be a good idea to arrange with some electrical repair shop for the overhauling of fans, and see to it that the fan customers have their fans in good shape for use when needed. There is also a large and productive field for the introduction of exhaust fans and small ventilating sets, for the purpose of keeping the air pure and fresh in dining rooms, resturants, factories, garages, etc.

Another line of domestic apparatus, which is beginning to come into use and for which there is a large field with attractive possibilities for the central station, is electric fireless cookers. Heretofore electric cooking, while of admitted convenience, has never been attempted in competition with coal or gas on the basis of dollars and cents. The very fact that the heat in the coal or gas must be converted into electrical power with an enormous waste of energy, suffering a loss in generator, transformers and transmission lines, renders it evident that it cannot compete with fuel used directly as a source of heat. However, when we are able to generate heat electrically within a closed vessel having heat resisting walls, and are thus able to get several times the cooking value as from the same quantity of heat applied to an open vessel, we reach the point where electric cooking is not only possible, but economical, and electric fireless cookers become not only great conveniences, but profitable investments as well.

A strong campaign should be carried on during the months of April, May and June, for this business. During the summer months less cooked food is required, and the advantage of being able to quickly and easily prepare it becomes at once apparent to a customer. Electric cookers further, especially the so-called fireless cookers, develop little or no heat in the room, and are especially appreciated during hot weather. The many other advantages of electricity over coal and gas when broadly considered as fuels, are unnecessary to enumerate, the greatest advantage that it has over either and both being the fact that its operation may be made automatic. For instance, we find that a four-pound roast requires the initial application of heat for 20 minutes, when using an electric cooker supplied with an automatic cut-out which can be used for such a period or a shorter one. These are features that appeal to the economical housewife who manages her kitchen personally. Among such the electric stove possesses important sales opportunities.

There are other summer loads that should not be overlooked. One of these is the lighting of amusement places and parks. Another is the supplying of current to buildings that have isolated plants where the exhaust steam is used in winter for heating, but where central station power is more economical during the summer. It must not be expected to show every owner of an isolated plant that it will pay him to shut down his plant and take central station service, but in many cases this can be done, especially where the station is prepared to offer an attractive rate for summer service. Another summer load which should be developed is the operation of refrigerating machinery and the furnishing of current to artificial ice plants. A central station with its machinery largely standing idle during the summer, and an ice plant in the same town running at much below its capacity in the winter, is clearly an unnecessary duplication of investment.

There are many other ways by which the load curve can be straightened out, through summer campaigns for various devices and we hope to present the details of several in early issues. Such information and suggestions are most welcome to these columns.

A. G. RAKESTRAW.

COMMENTS BY READERS.

F. T. Williams, Heating Device Specialist for a Large Manufacturing Company, Who Devotes His Entire Time to the South, Gives His Observations On Southern New Business Conditions.

On several occasions the writer has heard remarks that do not flatter Southern central station managers and refer to the backwardness of the South in promoting the sale of the various current consuming devices. We of the South take this friendly criticism as perhaps it is intended, appreciating the fact that the party making such remarks is not burdened with information nor familiar with general conditions in the South, for in traveling a number of the Southern states the writer finds that many central stations have up-to-date show rooms with complete and attractive exhibits. Many of these feature some special device each week. They advertise in their local papers, distribute booklets and descriptive literature on devices, and use cards and posters in the street cars to call attention to heating and cooking devices. Moving picture films are further used to show conditions where electric devices have settled domestic troubles. The display windows are in most cases attractive and effective in producing sales. If one observes closely, another interesting scheme to promote the sale of electric devices is found in the South, I refer to using the back of street car transfers for device advertising. Also several stations have a small holder opposite each seat in the street car where at regular intervals newsy little "Electrics" are placed. You can locate the sales room in any town you happen to visit at night by a large electric sign. In visiting these sales rooms you will find the man in charge courteous and polite, welcoming every visitor, taking care of every complaint and executing orders promptly. Does this look as though the Southern central station is asleep?

The commercial manager now realizes the increase in his monthly report through pushing continually some electric device, for he has come to realize the true basis of such increase, namely, that while one iron only adds 550 watts to the load, 2,000 of them used four hours a week at a 10 cent rate, increases the sale of current over $20,000 per year. The electric iron is now considered by customers indispensible and what has been done with it can be done with other devices; the electric range for instance is soon to come to the front. Commercial managers are ready to push the range as well as the other devices of importance and offer special rates on cooking, realizing that in connection with these loads no transformers nor special meters or increase in the size of feeders, are required to secure the yearly income of $20,000 as mentioned above.

The writer may add here a word for the new business solicitor. In talking to a customer forget the term "watts" and tell her what the device will do and what it will cost to operate, not by the hour but for one operation. Remember the device and its operation is simple to you but "Greek" perhaps to your prospect, so tell her in plain English about the device. The device field is large and if all types are pushed, when the long summer days arrive, instead of your lighting bills showing a decrease, they will remain practically the same as your winter bills. The field in the South is as good as any in this country, it's simply "up to" the sales organizations of central stations to let the public know what they have to sell. Publicity and lots of it will bring results.

Mr. Thomas Rhodes, Commercial Manager Consumers' Electric Light & Power Company, New Orleans, La., Explains His Flag System for Checking New Business—Also Other Schemes.

Since there are in New Orleans three lighting companies, two electric and one gas, in order to secure business it is absolutely necessary to know at any time the type of illuminant or power used at any address. To meet this situation the writer has inaugurated what we call our "flag system," consisting of a card index filed geographically, the contract form as used by us being the card in question.

The operation of the flag system is as follows: As soon as the service at any location is discontinued the solicitor in whose district the premises lie is notified immediately and a small metal tab placed on the right hand corner of the card. Each salesman has his own color so that the office can always tell who is responsible for any given situation.

The salesman on seeing his color on the right hand corner of a card immediately removes same to the left hand corner to designate that he is on the job. He then keeps the office informed as to the exact status of such information. If the premises are vacant, a yellow tab is attached. If the party will not use electricity, but prefers gas, a tab designating this fact is attached. In this way we can at all times tell the exact situation prevailing in any man's territory. We can also tell from this tab system whether we have the right man in the right territory and further, whether either of our competitors are concentrating in any given district.

Another scheme we have adopted is to have the office boy clip from the newspapers any article referring to build-

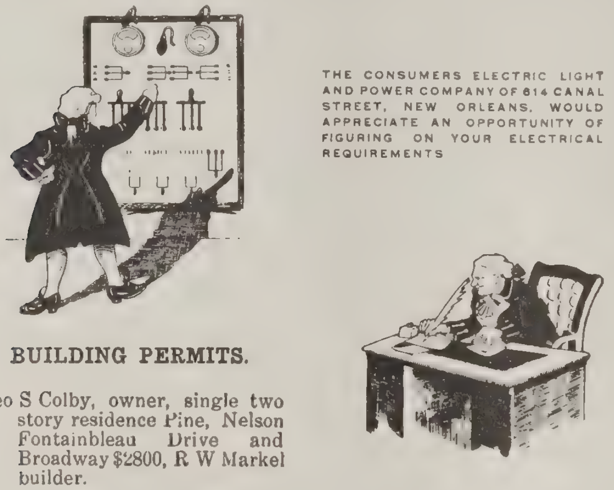


Fig. 1. New Business Scheme Used at New Orleans.

ing proposals or alterations in any district. This clipping is pasted on an attractive card as shown in Fig. 1, and mailed to the owner or architect of the premises. A slogan, "Command Us," and distinct trade mark has been adopted as shown which is used on every possible occasion including envelopes.

A spirit of cooperation with the electrical contractor is maintained. Recently a neat leather covered pocket memo-pad was distributed among the contractors with a personal letter from the writer somewhat as follows: "Accept this little memo-pad with the good wishes of our company. A similar pad is used by our organization to facilitate turning in leads and suggestions to the company. This is simply mentioned so that in case a sudden desire should seize you to put this book to the same usage, the Consumers' Company will not object."

W. E. Clements, Commercial Agent, New Orleans Railway & Light Co., Outlines the Commercial Activity of His Company In New Orleans.

During the past year the commercial department of the New Orleans Railway & Light Co. has solicited and secured much "new business" along lines never attempted before in the history of the company. Some new and original ideas were tried out, and in every case with marked success. Many steps towards the improvement of this end of the business have been taken and the department is now in keeping with the most up-to-date new business methods, the forces being so arranged as to secure the maximum efficiency.

The territory covering the entire city is sub-divided, a representative having complete charge over each sub-division or district, the duties of this man being such that he is practically manager of his territory. In addition to looking after new business, contract renewals, etc., his duties require that he adjust all differences arising and keep his customers well informed as to the latest developments in his line. A separate department also maintains power engineers who are versed in industrial and illuminating engineering, soliciting the large prospective customers and assisting the regular district solicitors. Data is kept on tests showing comparison of cost of operating by electricity versus other motive power and complete engineering records are furnished by these engineers, all this being under the supervision of the commercial agent. In the past year some fifteen or twenty isolated plants were closed down through the efficiency of this department.

Another extremely active branch of the commercial department is the demonstrating of heating and cooking devices. The manager of this department has for some time been conducting a house-to-house campaign for the sale of electric irons and other appliances and remarkable results have been attained, adding considerably to the residence load. A large showroom has just been installed, and a full line of household and industrial appliances are shown under most favorable conditions.

A campaign is also under way to take care of wiring old houses on the installment plan, the company employing local electrical contractors to do this work, carrying the accounts and allowing the customers to pay in installments. In addition to this, the use of electricity by those living in unwired houses, furnished rooms or flats is encouraged by means of the Clement Electric Service Table, shown in Fig. 1, of which a large number have been sold. A handsome electric booth has been constructed, and is sent out to fairs and exhibitions for advertising purposes,—a competent demonstrator always accompanying this booth. Many sales are made in this way.

Considerable advertising is done by the commercial department through a booklet "Railway Topics," thirty thousand of which are distributed weekly by means of boxes placed in the street cars. This leaflet is edited by an experienced newspaper man, and has been of considerable assistance in educating the public in the use of electricity. Jokes and items of interest are introduced to fill in, all of which makes this paper eagerly looked for each week. In addition much advertising is carried in the local newspapers, street car cards, etc., one man being detailed to look after this special line.

It will be of interest to note the progress made in "White Way" street lighting completed in the past year. On Magazine and Dryades streets three light "standards" were erected, each post equipped with 3-100 watt lamps, spaced about 40 feet apart. Quite a number of massive

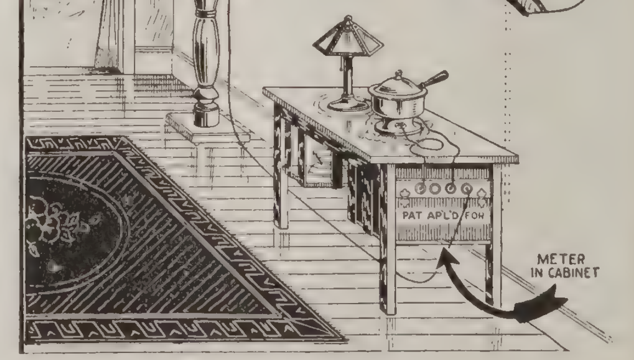


Fig. 1. The Clement Electric Service Table.

5-light ornamental standards were installed and before another year has elapsed the entire frontage in the business section will be transformed into a "Great White Way." Canal street, the main thoroughfare and one of the widest in the country, is already brilliant with its outlined buildings, electric signs and other illuminations.

All employees of the commercial department meet each day and on a regular night each month, a special lecturer is provided to give the men an hour or so of interesting talk,—stereoptican slides will later be provided for practical illustration. A large room in the new office building of the company has been specially fitted up for this work, and is used for no other purpose.

C. E. Ousley, Assistant to President, Kentucky Electric Co., Louisville, Ky., Outlines Successful Window Displays.

Aside from a vigorous and continuous prosecution of new business methods through its solicitors in the lighting and power departments, the Kentucky Electric Company in Louisville has made an active and effective window campaign during recent months. The results are decidedly satisfactory. While this campaign has had an advertising effect which no doubt is reflected frequently in the signing of new contracts for curent, its traceable results have been in increased sales of electrical appliances.

During the latter part of last October, the Kentucky Electric Company moved into a handsome new building on one of Louisville's principal thoroughfares near the center of the retail district, this building being erected expressly for the company and two magnificent windows are by no means the least important features of the structure. Since the dedication of the building as the location for the commercial and executive offices of the company and the installation of the spacious display rooms, the windows have contained attractive displays which have proved magnetic in their drawing power.

The window campaign has been conducted so that each exhibit should be timely, with the result that the public has grown accustomed to watch for the changes in display, showing a continuous interest in the objects exhibited and in the concern back o fthe exhibits. For instance, a window that attracted much attention at the beginning of the year showed an old fashioned cradle, rocked by an electric motor, and nursing the infant year. This idea was carried out by the use of miniature electric sign lamps, made into the figures "1913," coyly tucked in a snow-white pillow with an old fashioned quilt for trimming. Around this centerpiece in motion were displayed those articles which are significant of the electrical era and in contrast with them were placed the household utensils of a former day. An electrolier with a 60 watt Mazda lamp burned brilliantly beside a kerosene lamp. An electric range was pitted against an ordinary kitchen cook stove and an electric milk warmer was placed on a stand beside on old fashioned nursing bottle.

With the appreach of Valentine Day, a pretty decoration was arranged in hearts and ribbons with the suggestion brought strongly forward that electric devices furnish the best "valentines."

A similar idea was carried out in the Washington Birthday window with a huge birthday cake, lighted by a frosted Mazda lamp of 200 watts, placed on a stand before a flag-decorated picture of Washington. Here the suggestion was made that electrical appliances furnish ideal birthday gifts.

In each of these windows care was taken that a liberal showing should be made of the many popular devices used in the electric home and sold in the display rooms behind the windows. From time to time the company has made use of one window to advertise the desirablity of its current for lighting and power purposes, thus reaping the benefit of general exploitation rather than attempting to dispose directly of electrical wares. Every attempt is made to have these displays attractive in appearance and generally some motion is introduced into the exhibit.

Advantage is always taken of these settings to bring to the attention of the passerby a particular point which the company wishes to impress by the liberal use of electric and painted signs and placards. At the time this article is written the company is using its windows for the purpose of attracting Easter shoppers. A flower-garden is made of one window, while in the other an incubator is industriously engaged in hatching eggs. The incubator was set about twenty-four days before Easter and a blackboard bulletin is used to inform the public of the progress of the incubation. It is planned to have the chicks appear about three or four days before Easter.

The best proof of the practical value of these careful window demonstrations is found in the sales reports which show a noticeable increase in sales following the exploitation of any special article in the windows.

How One Central Station Advertises Its Electric Signs.

There have been many advertisements written calling local citizens' attention to electric signs erected by the central station, but possibly none will exceed in cleverness the ads which were published by Mr. C. L. Owen, new business manager of the Springfield Light, Heat & Power Company,

FIG. 1. A SPECTACULAR SIGN ERECTED BY SPRINGFIELD LIGHT, HEAT AND POWER CO.

Springfield, Illinois, just before the lighting of the La Zilia clown sign in that city recently. While not in any sense a large display, the features are clever, and the purchaser is considering two duplicates for other cities.

The sign is shown in Fig. 1, and its action is as follows: First, the figure of the clown appears with his hand reaching into his pocket. He withdraws his hand and tosses a ball, which breaks into colored stars, followed by the first line of reading matter, after which the clown repeatedly withdraws balls from his pocket and tosses them successively to the different spaces, balls bursting each time, followed by the appearance of other words, until the entire story, advertising the La Zilia Cigars, is told. The wording all holds a moment, when it goes out and the entire operation is repeated.

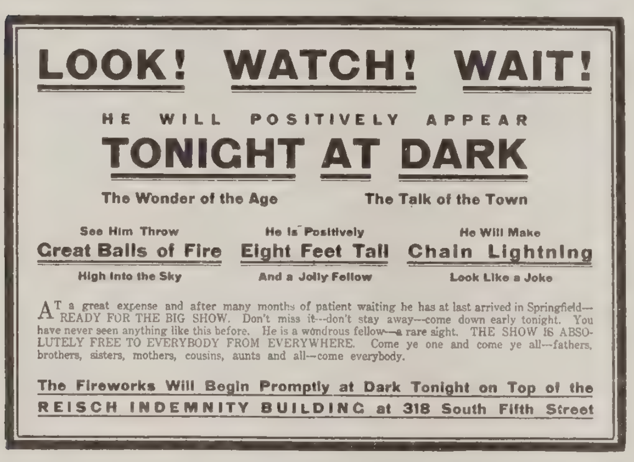


Fig. 2. An Advertisement Used Just Before Sign in Fig. 1 Was Operated.

The flashing is quick and snappy, and, while from the description it would appear to take some time for the operation to work out, in reality the sign completes nearly three cycles every minute. The sign, which is 28 by 20 feet contains approximately 750 lamps, and was furnished by Greenwood Advertising Company, Knoxville, Tennessee, and the flasher and color caps by Betts & Betts, New York City. The sign was sold and erected by the Springfield Light, Heat and Power Company, of Springfield, Ill., and the illustration in Fig. 2 shows the nature of the advertising done just before the sign was placed in operation. Without a question from a central station standpoint, this is good advertising and helps to sell other signs.

An Example of Co-Operative Electrical Advertising In Newspapers.

The idea of having a whole newspaper page devoted to electricity and known as the People's Electrical Page, or by some similar title, is not new. In Bay City, Texas, however, such a page is being operated under conditions which are unusual. The Bay City Ice and Light Company operates as a central station in Bay City, a town of about 4,500 population. When this company was recently acquired by a syndicate, Mr. W. C. Duncan, a central station man who had had excellent commercial experience at Leavenworth, Lawrence, and Parsons, Kansas, was sent to Bay City as manager. He immediately set to work to "liven things up" and undertook the seemingly forlorn task of running an electrical page three times a week in a small town without electrical contractors. His first encouragement came from the newspaper itself, which offered very reasonable advertising rates in consideration o fthe fact that a whole page was to be contracted for. For advertisers, Mr. Duncan went to the large electrical jobbers of Texas with the result that space in the Bay City electrical page was taken by the Southwest General Electric Company, the Tel Electric Company, and the Brown-Woods Electric Company. Editorial and news matter for the page is supplied gratis by the National Quality Lamp Division of G. E. Company, of Cleveland, Ohio.

Mr. Duncan claims distinction for the Bay City Electrical Page on four grounds: First, the smallness of the community; second the lack of contractors, who, in the larger cities are generally glad to cooperate; third, it is believed to be the first electrical page in Texas, and fourth, no other known electrical page appears at such frequent intervals.

Proposed Changes in National Electric Code.

As this issue goes to press certain suggested changes in the National Electric Code are being considered at the nineteenth annual meeting of the National Fire Protection Association held in New York Cit. Among suggested changes that will be of interest to the central station industry may be mentioned regulations as to the installation of electric light and power wires where telegraph, telephone and signal wires are encountered, giving restrictions in pole line construction. An addition to rule 13 is suggested relating to the installation of pole lines in streets, their location, painting, marking of ownership, insulation of wire when passing near a building, and installation of guy wires.

The table of allowable carrying capacities is amended by slightly increasing and decreasing the capacity of some ofthe solid sizes for both rubber and other insulations. The increase in practically all cases is less than 10 amperes while in some cases the present capacities are reduced.

Suggestions are given calling for revision of rule 39 covering outline lighting other than signs on exterior of buildings and giving additional requirements.

Rules 57 and 58 covering armored cables and interior conduit have suggested changes covering the use of armored cord, flexible steel conduit, unlined metal conduits, enameled conduit and conduit with metal coatings.

Another suggestion on which there has been considerable discussion refers to refillable fuses. The suggestion is made that rule 68, section 4, second paragraph, be amended by placing a period after the word "connection" in the third line and omitting the following words: "and to make it difficult for it to be replaced when melted." This would make this part of rule 68 read as follows:

"d. Construction. The fuse casing must be sufficiently dust-tight so that lint and dust cannot collect around the fusible wire and become ignited when the fuse is blown.

"The fusible wire must be attached to the terminals in such a way as to secure a thoroughly good connection."

In all probability this suggestion will have a thorough and interesting discussion at the above mentioned meeting for while refillable fuses have been sold, the principle of their construction has been opposed by the engineers of the Underwriters' Laboratories and by manufacturers of the non-refillable cartridge fuses. The result of the meeting and the consideration of these suggested changes will be announced in these columns.

Questions and Answers from Readers

Readers are invited to make liberal use of this department for discussing questions, obtaining information, opinions or experiences from other readers. Discussions and criticisms on answers to questions are solicited. However, editors are not responsible for correctness of statements of opinion or fact in discussions. All published answers and discussions are paid for.

SINGLE VS. 3-PHASE MOTORS IN FIRST COST.

Editor Electrical Engineering:

(362.) It is sometimes stated that a saving from first cost of transformers and motors is made when single-phase motors are installed instead of three-phase. I would like some reader to explain this if true, figuring that a three-phase transformer is used against the single-phase and also that three transformers are used against the single-phase, and showing saving if any in each case. How will the losses range in each case? W. E. B.

LARGEST PRACTICAL SIZE OF MOTOR.

Editor Electrical Engineering:

(363.) Kindly advise through the question and answer columns what is now considered the largest size of A. C. motor that will operate satisfactorily. What is the highest voltage for which large motors are designed. Give also the special requirements in installing such motors to satisfy the National Electric Code. W. C. G.

GROUNDING SECONDARIES OF TRANSFORMERS.

Editor Electrical Engineering:

(364.) What factors determine in any exact way the size of wire to be used in grounding secondaries? I note what Mr. Canada says in his article on page 124 of the March issue under size of ground wire, yet I do not see that a ground wire equal in size to the line wire would be any protection against a dead ground on the opposite primary sufficient to burn through. In such a case with a ground wire of such a size as to measure less than one ohm resistance, how is the protection secured through the ground wire, when the line wire may be much smaller? Is it ever advisable to ground pole transformer cases and if so where and how should the connection be made? H. L. Williams.

KVA AND KW RATINGS.

Editor Electrical Engineering:

(365.) The writer does not exactly understand the difference between the kva and the kw rating of a transformer. I would like some reader to give an example and explain each rating. Also explain what a rating of 25 volt amperes means for a Westinghouse current transformer, type K. A. H. C. P.

REWIND 133-CYCLE MOTOR FOR 60 CYCLES.

Editor Electrical Engineering:

(366.) I desire to rewind a 5 H. P. single-phase, 133 cycle motor for a 60 cycle, 110 volt circuit and for 1,000 rpm. It is now wound for 110 volts, 2,000 rpm., with 8 poles and 25 turns to a coil. If the stator is wound with the same size wire, 55 turns to the coil, will the clutch operate properly at 1,000 rpm. If not how can it be made to work? E. C.

OPERATION OF SPARK COIL.

Editor Electrical Engineering:

(367.) Please advise what the secondary voltage and current of a regular 6 volt, 2 or 3 ampere induction or spark coil may be of the type that is used for gas and gasoline engine ignition. Explain construction and operation of the coil and the nature of the currents flowing in the windings. George R. McNatt.

CHECKING METERS WITH TRANSFORMERS.

Editor Electrical Engineering:

(368). Please publish the necessary directions for testing a Thompson watt-hour meter with potential and current transformers. Give diagram of connections for the test with a standard wattmeter. The meter to be tested has no constant on the dial, but on the back appears, "80 K. W. H. equals 1500 R of disc." How is this information used in a formula, meter watts = (3600 R K)/T, or is this formula not necessary, it simply being necessary to count a certain number of revolutions and substitute in the following formula, K. W. H. = 80 R ÷ 1500, comparing this value with the value of the checking instrument? If this is not correct how is K found?

We also have a D. C. meter with a figure one on the disc. What does this mean? Please give formula for checking D. C. meters. J. E. O.

Wiring for Starting and Running of Induction Motors. Ans. Ques. No. 342.

Editor Electrical Engineering:

In the March issue, I notice that Mr. Wilkinson refers to question 342 but does not discuss the diagram shown with this question. In view of the fact that this is a subject much talked about by the Underwriters and the scheme as shown seldom approved, it would be interesting to see the arguments of some inspector on this point. I shall give my interpretation of the code and hope that it may have a discussion in these columns. First, I will say that the Underwriters require two sets of fuses, a starting set and a running set for the scheme shown and that if J. M. S. desires to install his motors without a discussion with the inspectors, fuses must be inserted in the wires marked *a*, *b* and *c*. These fuses, if a heavy starting torque requires the wiring shown, should be at least of a capacity twice the rated full load current and wires from service box to the motor of such a size as to stand such a current. The exact size of fuse and wire depends somewhat on the size, voltage and type of motor.

The point of discussion on the code is usually traced to rule 8-b where it reads as follows: "The motor leads or branch circuits must be designed to carry a current at least 25 per cent greater than that for which the motor is rated. Where the wires under this rule would be over fused in order to provide for the starting current as in the case of many of the A. C. motors, the wires must be of such a size as to be properly protected by these larger fuses."

This rule is very arbitrary and means little when carefully studied. For a wire equal in carrying capacity to the fuse is useless from the standpoint of fusing under the current and simply a burdensome expense. Motors taking

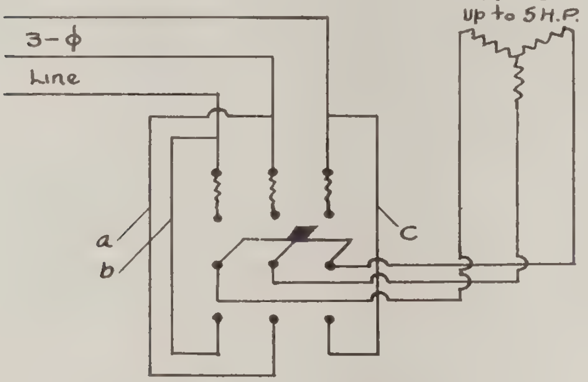


Diagram Shown With Question No. 342.

less than full load currents when starting can, by using fuses of 25 per cent excess capacity, be switched direct on the line through these fuses, and auto-starters are usually used and advised for all other cases. A. L. Temple, (Ga.)

Shunt Motor and Watthour Meter. Ans. Ques. No. 344.

Editor Electrical Engineering:

The writer has noticed some interesting questions concerning watt-hour meters in the January issue and has answered two of them in what follows: (344.) The shunt motor increases in speed due to weakened field, so that the back electromotive force may be built up to a proper point. In the commutator type meter the back electromotive force is practically negligible, even at full load speed, most commutator meters having a back electromotive force of about 1/10 volt. The drop across the armature of the shunt motor is mostly back electromotive force while of the meter armature practically all ohmic (IR). The torque of the meter is proportional to the watts, or on a constant potential direct current system, to the current which passes through the current coils. Therefore as the current increases the field will increase, the torque will increase, and the speed will increase until the back torque due to the effect of the damping magnets, equals the torque of the meter armature.

By referring to page 130 of the "Electrical Meterman's Handbook," published by the National Electric Light Association, 29 W. 39th St. New York, the inquirer may gain a more thorough understanding of the principles of watt-hour meters.

Wattmeter Constant. Ans. Ques. No. 340.

There are several constants, of different significance, applied to watt-hour meters and it is quite a subject in itself. I can only refer the inquirers again to pages 603 to 721 of the "Electrical Meterman's Handbook" where the subject is quite exhaustively treated.

Concerning methods of testing there is a chapter devoted to this subject in the same handbook. I wish to say, however, that the rotating standard method has come into quite general use and has many advantages over other methods.

W. H. FELLOWS, (WASH, D. C.)
Chairman Meter Committee, N. E. L. A.

Shunt Motor and Watthour Meter Operation. Ans. Ques. No. 344.

Editor Electrical Engineering:

The basic principle of motor action—that a wire carrying an electric current, in a magnetic field, is subjected to a force tending to move it across the magnetic field—applies alike to the shunt motor, and the commutating type of watthour meter. In all other respects their principles and operation are decidedly different.

The magnetic field of the meter is produced by the series (current) coils, and may vary from zero to some definite maximum, depending upon the load being metered; the armature is shunted arcoss the line, and the armature current varies only with the impressed voltage. On the other hand, the magnetic field of the motor is produced by the shunt coils, and remains constant, so far as we are concerned in this discussion; the armature current depends upon the load on the motor.

When the field current of a motor is decreased, the speed of the motor increases because the counter electromotive force is reduced, allowing a greater current to flow in the armature winding. This results in a higher torque (since the armature current increases more rapidly than the field magnetism decreases) and consequent increase in the speed of the motor. When the field current of the meter is decreased, the armature current is not necessarily affected, because it is limited by the resistance of the armature winding, and the counter electromotive force induced in the armature winding has no influence in determining the speed of the meter armature. The decrease of the field current reduces the field magnetism, so that a lower torque is exerted upon the armature winding. The rotation of the meter armature is opposed by permanent magnets acting upon the disc on the armature shaft and the torque exerted upon the armature winding is just balanced by the retarding torque exerted by the permanent magnets upon the disc. Thus when the torque exerted upon the armature is reduced the speed will decrease until the reduced torque exerted by the permanent magnets is just equal to that acting upon the armature winding. It will thus be seen that the action of the permanent magnets upon the disc constitutes the principal difference in the operation of the meter and motor.

In order to register accurately at all loads the speed of the meter armature must always be proportional to the product of the current and voltage being measured. Hence since the torque exerted upon the armature winding determines the armature speed, it follows that the magnetic field must be directly proportional to the magnetizing current. If iron is used in the magnetic circuit, this relation between the current in the coils and the magnetic field strength will not be constant, because of the variation in the permeability of iron at different degrees of saturation. Briefly, the magnetic circuit of a meter is air because the saturation curve of air is a straight line, giving the desired constant relation between the magnetizing current and magnetic field strength. C. S. Stouffer. (Ill.)

Comparison of Shunt Motor and Watthour Operation.. Ans. Ques. No. 344.

Editor Electrical Engineering:

In answer to question No. 344 I offer the following: When a direct current motor is running there is always an emf generated in the armature. This emf is opposed to the current from the line flowing through the armature and is known as the counter emf. This counter emf. is the controlling feature of the motor's operation since it limits the armature current. If the motor is prevented from turning and the line voltage applied to its terminals, the current in the armature will be equal to applied emf, divided by the armature resistance, while if the motor is running the current in the armature will be equal to the applied emf. minus the counter emf. divided by the resistance.

The speed of the shunt wound motor, exerting a constant torque, is dependent upon the current in its armature, therefore, increasing the strength of the magnetic field which increases the counter emf., decreases the armature current and speed of the motor, while decreasing the strength of the magnetic field has the opposite effect.

The commutating type of watthour meter is similar in many respects to the shunt wound motor, but its operation is somewhat different. This meter has a field due to the current or series coils, in which is placed a drum wound armature, which, in series with a suitable resistance, is shunted across the line. If the field contains no iron it's strength is proportional to the current in the coils and, as it has only a few ampere turns, its strength is comparatively low. The strength of the armature field is proportional to the current in the armature. The field strength and armature speed being low, the counter emf. is low enough to be negligible and the current in the armature is proportional to the emf. of the line.

The torque is proportional to the series field times the armature field, or the watts expended in the circuit. The damping, which is accomplished by a disc of non-magnetic material rotating between permanent magnets, is proportional to the speed and the speed is proportional to the torque. From the above it is seen that the speed of the meter is proportional to the watts expanded in the circuit.

If iron or steel were used in the field of the meter, as in the case of the motor the field strength would not be proportional to the current in the series coil, due to the fact that as the iron approaches saturation the field strength would not increase as fast as the current.

Fred P. Brien. (Tex.)

Shunt Motor and Watthour Meter Operation. Ans. Ques. No. 344.

Editor Electrical Engineering:

In answer to question 344 January issue, I wish to submit the following. So far as the winding of the commutating type of watthour meter is concerned it is a shunt motor. Otherwise the construction and characteristics of the commercial shunt motor and the meter motor are radically different. Apply a constant potential across the armature of a separately excited motor, and its speed will be determined by three factors. the strength of the field, the load, and the armature resistance. We may leave out of consideration the number of conductors in the armature winding, as this is constant for any one machine. In the commercial type of motor the armature resistance is made low for several reasons, principally that the speed may be fairly constant under varying loads and that the efficiency may be high. In this case the field strength and load control the speed, the effect of the armature resistance usually being negligible. If we put the machine at work and suppose the field current to be increased causing a corresponding increase in the field, the effect will be to increase the counter electromotive force of the armature, and thus cause a decrease in the armature current. This decrease takes place at a greater rate than the increase in field strength because the armature current is determined by the difference between the applied and counter electromotive forces and not by the actual value of either. Consequently there will be a decrease in motor torque, that will cause the motor to slow down until the counter electromotive force has decreased enough to allow the armature current to increase, and in this way bring the torque back to its original value, or to that value necessary to drive the machine at its reduced speed. In this readjustment the counter electromotive force is the controlling factor, the resistance playing a negligible part.

Now consider the motor of the commutating type of watthour meter. The armature current is controlled by the resistance of the armature circuit, which, of course, includes that of the armature proper and its auxiliary resistance. In this case the counter electromotive force is made negligible by making the field weak and the speed comparatively low. Now, under these circumstances an increase in field current, causing a corresponding increase in the magnetic field, increases the torque of the motor armature, without appreciably decreasing the armature current, since the counter electromotive force is so small that its increase has no perceptible effect on the armature current. The motor must then speed up until the increase in torque is balanced by a corresponding increase in the resistance to turning. These conditions apply not only to the commutating type watthour meter, but they apply to any motor in which the field is so weak, or the speed so low, or the armature resistance so great, that the latter becomes the controlling factor in determining the speed. The following may be applied as a general rule: When the drop of potential due to the armature resistance is greater than the counter electromotive an increase in the field causes an increase in the speed; and, conversely, when the counter electromotive is greater than the drop in potential due to the armature resistance an increase in the field causes a decrease in the speed.

E. L. Barnett. (Col.)

The Shunt Motor and Watthour Meter—Ans. Ques. No. 344.

Editor Electrical Engineering:

In the writer's judgment the integrating meter should not be considered as a type of shunt motor. It is an electric motor but different from the shunt motor in several respects besides the one mentioned by H. B. D. The shunt motor has a shunt field connected directly to a source of practically constant emf to which the armature is also connected. The field flux is therefore practically constant and as the armature resistance is very low there is very little voltage loss in ohmic resistance, consequently the armature will necessarily generate a counter emf. nearly equal to the line voltage, the slight difference between the two being that required to send the current through against the armature resistance. If the field be weakened the counter emf. will be reduced with a consequent increase of the current, which in turn will increase the speed. The meter, however, has a very high armature resistance so that the counter emf is negligible in comparison with the ohmic drop, therefore the armature current is constant, or rather, is directly proportional to the line voltage and cannot vary as in the case of the shunt motor. For this reason the torque and speed will decrease when the field is weakened. There is also a tendency to weaken the torque and speed in the case of the shunt motor when the field is weakened but this tendency is overbalanced by the increase of armature current, so that the speed increases although one would naturally expect the reverse effect. If a rather high resistance were inserted in series with the armature of a shunt motor and it were loaded with a magnetic brake like that of the meter it would also run slower when the field is reduced. The torque opposing rotation due to the eddy currents of the meter disk is directly proportional to the speed, whereas that of the average motor load is practically constant. This fact, in connection with the high resistance of the meter armature circuit, explains the different action of the meter and of the motor.

The torque and speed of a meter are proportional to the product of the armature magnetism into the field magnetism and since the speed must be proportional to the armature voltage and field current product $VI = Kn$, in order that the meter may read right it is evident that the magnetism of the field must be proportional to the field current and that of the armature must be proportional to the voltage. This will be the case if the permeability is constant and since the permeability of iron is not constant it cannot be used.

Cost of A. C. Generators. Ans. Ques. No. 345.

Editor Electrical Engineering:

Referring to Question 345, the price of a machine depends chiefly on the size and since the slow speed types are larger than the high speed ones of the same capacity, they will naturally cost more. The direct connected ones are necessarily of the slow speed types (except turbine driven types) and therefore cost more than the high-speed belted ones T. G. Seidell, (Ga.)

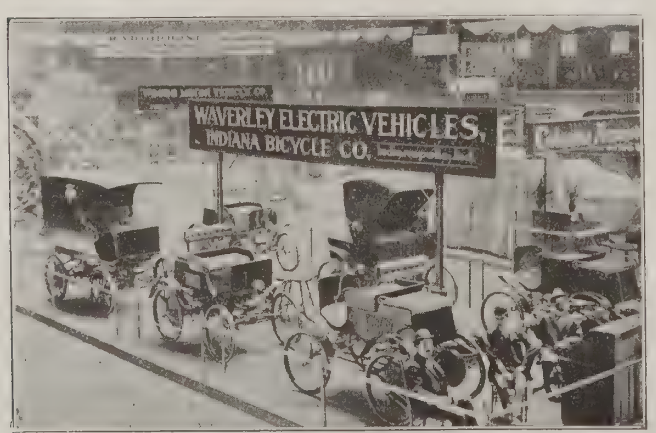
New Apparatus and Appliances

Pioneer Types of the Electric Automobile.

In May, 1896, Columbia, Riker, Burrows and Waverley electric vehicles were exhibited at an electrical show at Madison Square Garden, New York. In May, 1899, a similar show was held in New York at which Woods, Columbia and Waverley electrics were exhibited. A cut of the Waverley exhibit of that year is shown here. The cars exhibited were one Stanhope, four dos-a-dos and one delivery wagon, showing that the Waverley factory was at that time manufacturing cars in considerable quantities and for a variety of needs. The delivery wagon exhibited at this show was sold and delivered to H. A. Meldrum, of Buffalo, the Stanhope to Augustus A. Post, New York, one of the dos-a-dos was delivered in New York, one sent to Putnam, Conn., one to Philadelphia and one to Lincolnshire, England.

In the early winter of 1900, the first exclusive automobile show was held in Madison Square Garden, New York City, by the Automobile Club of America. This has been followed by regular exhibits since that date. The first electric car built at the Waverley factory then known as the Indiana Bicycle Company, in Indianapolis, was delivered to Charles Finlay Smith in January, 1897. This was of the Stanhope design with 36-inch wheels and single tube tire, large herringbone gears, four-pole motor and a battery designed by Mr. Porter, later of the Porter Battery Company.

These early years in the electric industry were noteworthy for the variety of models of electric cars and the wide distribution of these unusual types. Of the Waverley Stanhope body shown in the photograph, about two hundred were built; some fifty of the dos-a-dos type of cars with wire wheels and seats arranged like a jaunting car were built and shipped to various parts of the world. Among theother old type models were cars known as Mail Phætons, Newport Brakes, four, eight and nine-passenger brakes, demi-coaches, surreys, tonneaus, station wagons. The cars on which the Waverley Company had the largest run in its early days were on open piano box runabout and a small type of open road wagon, of which two models in the neighborhood of two thousand cars were built and sold. As early as 1903 three of these cars were equipped with Edison batteries, and another in 1906. These were of the experimental Edison type, put out by the inventor long before the present successful Edison battery was put on the market.



Electric Vehicles Exhibited at New York in 1899.

Among the commercial cars the Waverley Company built many closed and open delivery wagons, one-ton trucks, one and a half ton trucks, two-ton trucks and three-ton trucks. Of the one and a half ton trucks, sixteen were built in 1906, for one brewery, Anheuser-Busch Brewing Company in St. Louis, and are still in successful service. Some of these cars have recently been reported as giving forty-five miles on a charge. Another popular model of this period was the "Chelsea" of which several hundred were built before introduction of the drop sill Waverly Victoria, which was made the basis of later designs in coupes and broughams.

It is a noteworthy fact that none of the open-body designs that were then so popular are built today by any of the leading manufacturers of electric cars. In 1903 the Waverly Company built the first coupe body ever constructed for an electric vehicle, and the popularity of this type of closed car was so great that all the manufacturers soon devoted their attention to closed passenger cars with inside drive, and for the last six or eight years, the demand for coupes, broughams and limousines has steadily increased to the neglect of the smaller open cars formerly built. The station wagons, surreys and demi-coaches of that earlier day were all of somewhat limited mileage and quickly went out of fashion. The improvements in the electrical and mechanical equipment of the leading types of electric automobiles today has made the building of large closed cars entirely practicable, and it is reasonable to expect further developments along this line.

Diehl Small Motors.

The Diehl manufacturing Company, of Elizabethport, New Jersey, through a small motor department, pays especial attention to the application of small motors to the various small mechanical devices on the market requiring a source of power such as the phonograph, electric clocks, advertising display machines and others. The sizes of such motors range from 1/50 to ¼ horsepower with speeds up to 2500 revolutions per minute.

Electrical Vehicle Motors.

The manufacturer of vehicles is growing daily more appreciative of a saving in construction and economy in operation by the use of the slow speed vehicle motor. Long life, noiseless operation and reduction of multiplicity in gearing, owing to the direct shaft drive are both attractions and economies which cannot be ignored. In the Diehl vehicle motors the cylindrical steel frame is wholly enclosed with hand hole covers, fashioned to suit the purchaser in one or more sections. The frame is machined internally to form an accurate seat for the field poles, and may be machined externally to insure uniform diameter, affording convenience in supporting.

Motor Operated Surfacing and Polishing Machine.

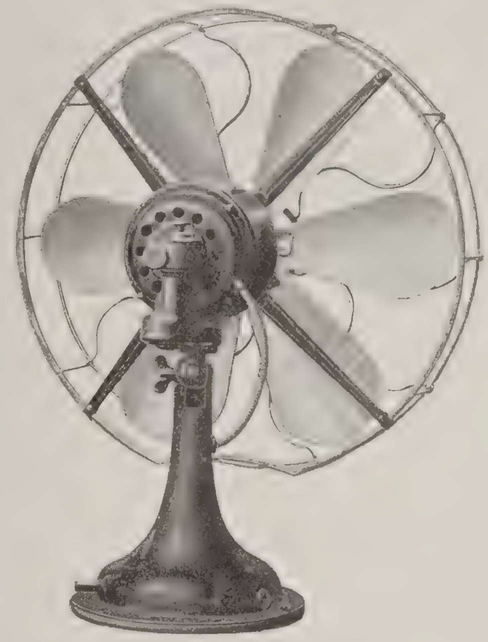
The illustration on page 175, Fig. 10, of this issue, shows a motor-driven scrubbing, surfacing, polishing and finishing machine. By means of interchangeable attachments the machine can be used for sandpapering new or old floors, refinishing old floors, scrubbing, waxing and polishing wood or other kinds of floors, also grinding, surfacing and polishing marble, mosaic, terrazzo, cement, tile, rubber, cork, leather and composition floors of all kinds. By change of handle the machine can be adopted for bench work. Waxing and polishing is done with great speed and cannot be duplicated by hand work, which can be readily understood when considering the weight, speed and friction of the machine. By means of a certain attachment the wax can be spread smoothly, causing it to harden so as to prevent dust, grit, etc., from penetrating same, which is so unusual where waxing is done by hand. The machines weigh from 40 to 75 pounds, and are equipped with a motor of from 1/7 to 1/4 horsepower.

Westinghouse 1913 Fans.

The drawn steel frame fans introduced by the Westinghouse Electric & Manufacturing Company last year are continued for the 1913 season with minor changes. The quiet-running, six-blade type of fan has been extended to include a sixteen-inch size and an oscillating type. There has also been added an induction-motor type of 8-inch fan, this fan being constructed with drawn steel frame like the 12 and 16-inch sizes, and with a dull black finish. The Westinghouse line now includes 8-inch desk, bracket and telephone booth fans, 12-inch and 16-inch fans in both four-blade and six-blade styles of the stationary desk-and-bracket and oscillating types, also 12-inch and 16-inch exhaust fans and a large variety of ceiling, counter and floor column fans.

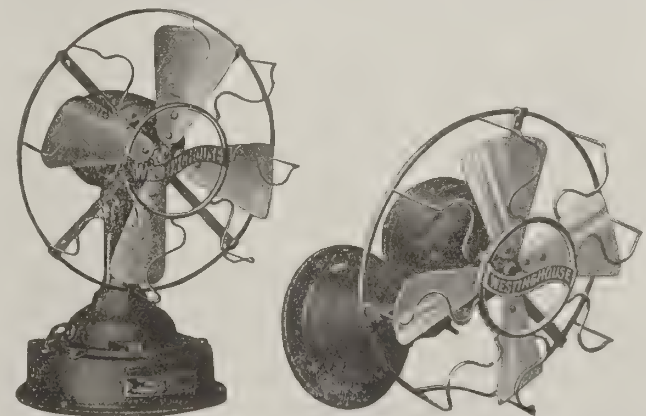
The popular six-blade 12-inch residence type has been extended to include a 16-inch fan which, because of its slow speed, is extremely quiet in operation. The 12-inch size has proved popular in bedrooms, hospitals, professional offices and similar places, while the 16-inch size has been designed especially for theaters, libraries, halls and other public places.

The direct current fans and the 25-cycle alternating current fans are driven by series motors. All the other alternating current fans are driven by split phase starting induction motors. These motors have a single starting winding and centrifugal cut-out switch; the motor will start positively on low speed at its lowest rated voltage with the fan tilted fully forward or backward. The starting winding is cut out after a few seconds, thus saving burnouts and effecting a considerable saving in current consumption.



A 16-Inch Mechanically Operated Oscillating Residence Fan.

Westinghouse oscillating fans are furnished in two types, mechanically operated and air-operated. The mechanically operated fans have drawn steel frames and the oscillating mechanism is entirely enclosed and will not drop oil. It consists of a lever driven by a crank disc, which is operated from the motor shaft by two gear reductions, a worm and a spur. The spur gear is the slow speed reduction. Both the worm wheel and the worm can be renewed without tools. The worm wheel drives through a ball clutch. If the fan guard strikes an obstruction during the course of oscillation, the fan merely stops oscillating without interfering with the operation of the motor, thus preventing the



An 8-Inch Series Type Fan With Converting Device.
An 8-Inch Desk and Bracket Induction Type Fan.

burning out of the motor or the overturning of the fan. The oscillating movement can be stopped instantly by raising the knurled head on top of the mechanism and can be started by pushing this head down. Both operations can be effected while the fan is operating.

In the air-operated oscillating fan the motor frame and the base are of cast iron. The position of a pivoted vane determines the direction of oscillation of the air-operated fan. At the end of the oscillation a lever, geared to the vane, comes in contact with a stop and turns the vane 90 degrees. The fan then swings around in the opposite direction until the lever comes in contact with a second stop, which turns the vane for oscillation in the opposite direction. The location of the stops is adjustable, so that the arc of oscillation can be varied from 30 to 360 degrees in steps of 30 degrees. By removing the stops the fan can be made to revolve continuously in one direction, as the current is carried from the base to the motor by slip rings.

The Westinghouse alternating current ceiling fans are furnished for 56-inch and 32-inch blade sweep and the direct current for 57-inch, 54-inch and 32-inch blade sweep. The alternating current counter column and floor column fans are furnished for 56-inch sweep and the direct-current fans for 57-inch sweep.

Westinghouse 12-inch and 16-inch exhaust fans are furnished either with Westinghouse blades or with Blackman blades. The Westinghouse blades are suitable when the fan exhausts directly into open air and the Blackman blades should be used when the fan operates against slight pressure or exhausts into a short flue. All Westinghouse fans have speed adjustments and will start on any speed.

Sprague Fan Motors.

A fan motor is not essentially a new current consuming device, yet owing to the increased demand for this class of electrical apparatus, it is considered an important factor by the central station for increasing the use of electric current during the summer months. Fan design is now becoming standardized for the most part, the tried and successful features being strengthened by others that service may prove from year to year essential to life or economy.

No radical changes have been made in connection with Sprague 12 and 16 inch universal joint desk and bracket type fan motors, except to perfect the wearing parts of the machine. These fans are made in both the oscillating and non-oscillating type, and a feature that warrants consideration is the fact that a complete oscillator mechanism can be furnished and readily adapted to the non-oscillating type fans manufactured from 1909 to 1913 inclusive. The Lundell single field coil feature is still retained which has made these fans exceedingly popular, that is, the one field coil magnetizing both poles.

Recently a small ceiling fan of 32 inch sweep has been placed on the market, which was developed exclusively for use in bed chambers of hotels and a number of these fans are installed in the Hotel Astor, New York City, finished in white enamel to match the interior decorations of the rooms.

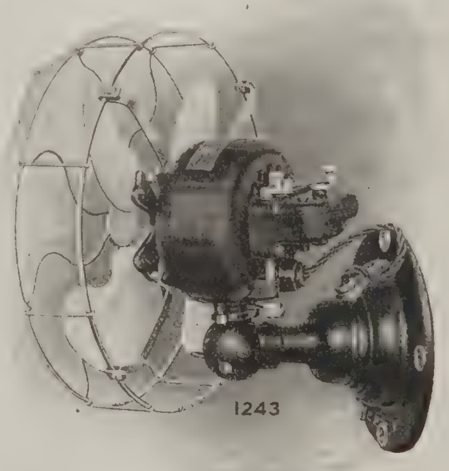
The motors used on these ceiling fans is an adaptation of our standard desk type fan motor. Field castings are malleable iron, covered top and bottom by cast iron brackets, and the whole having a smooth outside surface which can be cleaned easily. The motor is of an inclosed type, series wound, and the windings are well ventilated by means of openings in the bottom bracket, to which access may be had to the commutator for the purpose of cleaning. This fan runs at a somewhat greater speed than the larger type ceiling fans, but is noiseless in operation, and does not require any more current than an ordinary sixteen candle power incandescent lamp. The New York Telephone Company is using in their telephone exchanges a 16 inch desk type fan motor suspended from the ceiling or attached by brackets to the telephone switch boards, which is highly desirable where a fan motor is desired which will not interfere with the general arrangement of the office, but at the same time, will furnish a breeze at any convenient location.

Emerson Fan Motors.

In the fan motor product of The Emerson Electric Manufacturing Co., for the season of 1913, few changes have been made. However, the "Trojan" line formerly made by the Emerson company has been discontinued, and manufacturing and sales efforts concentrated on the higher grade apparatus. This results in a larger stock of the types listed for 1913, a simpler line for the jobber and dealer to handle, and has permitted substantial reductions in the prices of Emerson desk and ceiling fans for alternating current.

Emerson A. C. desk fans are offered in 8, 12 and 16-inch sizes, oscillators in 12 and 16-inch sizes, and special slow-speed quiet residence type motors with 12-inch 6-blade fans delivering a large volume of air with minimum noise. These residence types are made in both swivel-trunion and oscillating styles. A. C. desk fans are all induction motors without brushes or commutator. In the present styles all moving contacts have been eliminated and excellent speed regulation is secured. These fans have the well known "Parker" patented blade which has been a feature of Emerson fans for many years. These motors are all equipped with the distinctive Emerson hardened steel shaft and oil-tight dust-proof bearing which has been employed by the manufacturer for more than a decade. The advantages of this style of bearing are known and appreciated by a large number of purchasers. Its wearing qualities and freedom from oil-throwing have made it popular.

The Emerson oscillators are mechanically operated types with four ranges of oscillation secured readily by a thumb nut at the rear of the motor. The same style of oscillating



Emerson Residence Type Oscillating Fan.

device has been used for three years past. Emerson induction ceiling fans are offered in plain and ornamental 4-blade types with a 2-blade ornamental type in addition for purchasers desiring a more moderate breeze. These are induction fans without moving contacts of any kind, and run on ball bearings immersed in oil.

For direct current the Emerson Company offers 8, 12 and 16-inch swivel-trunnion fans, and 12 and 16-inch oscillators with many of the familiar features of A. C. fans, including the Parker blades, the convenient base, and the same style oscillating mechanism with renewable wearing parts. The 12 and 16-inch fans for direct current are fully enclosed motors with removable shutters, 3/8-inch square carbon brushes and large coined commutators of very high-grade material and careful workmanship. The fans throughout are thoroughly representative of the standards of design and manufacture used in the alternating current fans.

The A. C. and D. C. desk fan motors are offered this year mounted in substantial supporting rings for use as ventilating fan motors, in 12 and 16-inch sizes. These ventilating fan motors have separate three-speed regulating switches mounted on porcelain bases.

Western Electric 1913 Fans.

The pressed steel fans, handled last year by the Western Electric Company, met with marked approval. A few additional types have been made, chief among which are 8-inch induction and 16-inch residence type fans. The 8-inch induction type is made for 50 and 60 cycle frequencies from 100-110, 111-120 and 200-230 volts, and is furnished in the regular standard finishes to which has been added a new white nickel finish in which the 8-inch series fans are also furnished. White nickel is especially adaptable for doctors' and dentists' offices, barber shops, hospitals and for use in connection with bath room fixtures.

A complete new line of 16-inch residence fan has been added for operation on standard voltages, and from 25-30, 40 and 50 cycle frequencies. The 12-inch residence line of fans has been extended to include 25-30, 40 and 50 cycle frequencies and standard voltages. The 32-inch ceiling fans have also been extended to include 25-30, 40 and 50 cycle frequencies, thus enabling the offering of a full line of small size alternating current ceiling fans. A standard finish—black enamel—has been adopted for all desk and bracket type fans.

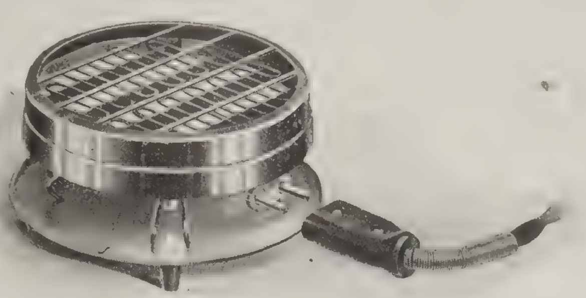
Diehl Electric Fans.

The 1913 Diehl fan motors consist of the usual complete line for electric desk, bracket, ceiling and oscillating types for both direct and alternating currents. This company was among the pioneers in the manufacture of fan motors, it being said that the Diehl ceiling fan was the first electric fan of this type to be placed on the market. This oscillating desk and wall bracket fan is especially familiar to those who travel and use Pullman service, since in these cars the Diehl fan is always found.

The fans this year are in all their main features of design, the same as those of past years, including sizes in Universal swivel and transmission styles 8, 12 and 16 inches.

Acme Breakfast Stove.

The Acme Electric Heater Company, of Detroit, Mich., has recently produced the breakfast stove shown in the illustration here. It is a combination toaster and small stove in which the heating element attains a red heat. By swinging the toaster ring to one side any cooking utensil can be used directly on the red hot element. The stove can be used for boiling or frying and is of such a size as to be especially useful on the table. It is made for voltages of 100 to 125 and consumes 500 watts.

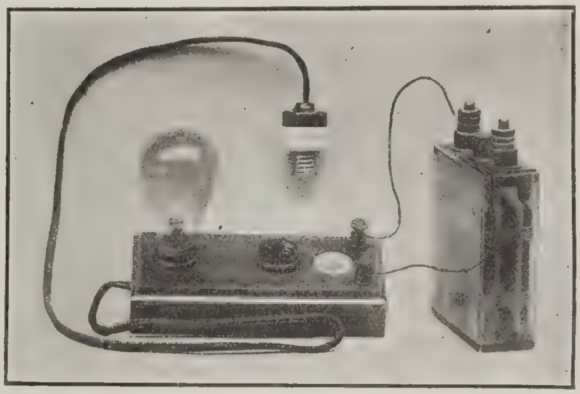


Acme Breakfast Stove.

This company also manufactures an electric iron of simple construction being made of only four pieces which lock together. The cord is a special feature, being so constructed with a flexible protecting conduit that the cord does not wear, cannot kink and will not be burned when in accidental contact with the hot iron.

Witham Charging Board.

The Witham charging board shown below is a device manufactured by E. Marcuson of New York City and used in connection with the charging of portable storage batteries, facilitating the charging of these batteries from any ordinary fixture on a direct-current system. The instrument shows the direction of the current and also acts as a resistance by inserting lamps in the sockets provided.



Witham Charging Board.

This device is convenient for use with automobile batteries as it enables the charging of batteries from any D. C. socket. It can also be used as a lamp stand or a trouble lamp when working about an automobile at night.

A Weather-Proof Lamp Coloring.

A weather-proof lamp coloring has been prefected by C. E. Franche and Company, of Chicago, for use on electric lamps and especially with signs. The coloring takes the place of the so-called color caps and is said to last as long as the lamp without fading, cracking, chipping or peeling. The coloring is prepared in liquid form, the lamps being dipped once to secure any one of eleven colors, ruby, blue, red, blue-green, green, moonlight blue, amber, pink, canary, purple and white frosting.

Electrical Construction News

This department is maintained for the contractor, dealer, manufacturer and consulting engineer.

ALABAMA.

ANNISTON. An application has been made to the city council by the Ragland Water Power Co., for a franchise to supply electrical energy in Anniston. Power will be secured from Lock 4 of the Coosa river, about 18 miles from Anniston. The Ragland Water Power Co., proposes to construct a hydro-electric plant at Lock 4, raising the present dam from 15 feet to an ultimate of 22 feet. 10,000 horsepower will then be developed and transmitted to nearby cities.

FLORIDA.

ARCADIA. The Utilities Securities Corp., has purchased the electric light and ice plant of the Arcadia Electric Light, Ice & Teelphone Co. The plant will be operated under the name of Arcadia Ice & Electric Co.

CHIPLEY. A contract for the construction of an electric light plant will be soon awarded by the Chipley Light & Power Co. The contract will include two boilers, a 115-horsepower steam engine, five miles of wire and poles. Meters will also be required.

LAKE BUTLER. It is understood that a bond issue is planned to construct an electric light and water works system.

MILTON. It is understood that the city council is considering the issue of bonds for the installation of a municipal electric light plant.

PENSACOLA. The city will vote on $100,000 for the construction of an electric light plant.

PORT LAUDERDALE. The Southern Utilities Co. is being organized by J. G. White & Co., of New York City, to finance and manage 30 electric, ice, gas and water properties in fifteen towns in Florida. The properties will include the Arcadia Electric Light, Power & Ice Plant; Fernandina Ice Plant; The Bradentown Electric, Ice & Power Plant; Fernandina Ice Plant; Port Lauderdale Electric, Water & Ice Plant; Fort Myers Electric Light, Water & Ice Plant; Lake City Ice Plant; Live Oak Electric Light, Power & Ice Plant; Miami Ice Plant; Pulaski Ice Plant; Pensacola Ice Plant; Punta Gorda Ice Plant; St. Augustine Ice Plant & Steam Laundry; Sanford Electric Light, Power, Ice, Gas & Water Plant; Tarpon Springs Electric Light, Power & Ice Plant, and West Palm Beach Electric Light, Power & Ice Plant. H. C. Adams, recently of West Palm Beach, Fla., will be general manager of all the properties mentioned.

TAMPA. The Tampa Electric Co., plans to make improvements to cost $400,000. An additional power plant will be erected and a 4,000 kilowatt turbine installed. This will increase the capacity of the present station 125 per cent.

GEORGIA.

DALTON. The city council has given the Georgia Railway & Power Co. a franchise to supply energy in Dalton.

HOMERVILLE. Parties at this place are contemplating the installation of an electric light and ice plant. Machinery, including electrical and ice equipment, is desired. L. H. Locklier, of Homerville, is interested.

LA GRANGE. The Columbus Power Co. is to build a substation at La Grange to cost from $35,000 to $40,000. A distribution system will also be installed.

ROCHELLE. J. G. McCrary Co., of Atlanta, is making surveys and supplying plans for the installation of a municipal electric light plant and water works system.

SAVANNAH. An electric light and ice plant is to be constructed at a small town known as Fairhope on the Satelo river in Mackintosh county, fifty miles from Savannah, by the Fairhope Lands Co. A. B. Offenbacher, of the Savannah Bank & Trust Co., is general manager.

TYBEE. An electric light plant and water works system will be constructed at Tybee Beach.

WAYCROSS. The Ware County Light & Power Co. is to install a 500-kilowatt steam turbine with a battery of three boilers.

KENTUCKY.

HAZARD. The Hazard Light & Power Co. has been incorporated with a capital of $10,000 by W. E. Hemphill, C. B. Wooten and J. T. Lovelace.

MIDDLESBORO. Th Kentucky Utilities Co. has purchased the property of the Middlesboro Electric Co. at a price of $100,000.

PINEVILLE. A large power plant is under consideration for Bell county of such a size as to supply energy for light and power to the coal mines in that section of the state. D. Boone Rogan, president Bell County National Bank, is interested.

LOUISIANA.

JENNINGS. The Southern Heat & Light Co., is to erect a gas plant to be operated in connection with the electric plant now under construction.

NORTH CAROLINA.

BURLINGTON. It has been decided to sell the municipal electric plant to the Piedmont Traction Company. The company will, in taking over the plant, build a large central power plant between Burlington and Graham at a cost of about $400,000. This plant will supply energy in Burlington, Graham, Melbanes, Haw River, Elon College and Swepsonville.

CLAYTON. A distribution system for lighting Clayton is soon to be installed, obtaining energy from the Carolina Power & Light Co., of Raleigh, N. C. A 150-kilowatt outdoor transformer and switching station will be installed. Hubert C. White is consulting engineer.

CONOVER. The Conover Light & Power Co. recently organized, will build electric transmission lines from the Southern Power Companys system at Charlotte, N. C., into Conover and vicinity. Electrical energy will be received from the latter company.

WHITNEY. The Southern Aluminum Co., has awarded a contract to D. H. Hardaway Construction Co., of Columbus, Ga., to construct a concrete dam and hydro-electric plant to develop 45,000-horsepower. The dam will be 1,000 feet long and about 150 feet high, raising the water som efew feet above the present partially completed masonry dam now some seven miles above the site.

SOUTH CAROLINA.

CAMDEN. The Carolina Public Service Co., of Raleigh, N. C., has lease plants of the Camden Water, Light & Ice Co.

ANDERSON. The Southern Power Co. has purchased the properties of the Anderson Water, Light & Power Co., including Anderson Light & Water Works System, Portman Shoals Hydro-Electric Plant.

SPARTANBURG. The South Carolina Power, Light & Railway Co. is to construct a hydro-electric plant at Palmer Shoals, of the Broad river, of a capacity to develop 15,000-horsepower. This company controls a steam power plant at Spartanburg of 5,000-horsepower, and improvements will be made to it.

SPARTANBURG. Reports state that arrangements have been made by a group of Spartanburg capitalists organized under the name of the Manufacturers' Power Co., to construct a water power development on Green river, in Henderson county, N. C. The development will cost about $1,000,000, and the company has obtained a franchise to run its transmission line into Spartanburg to supply cotton mills and other consumers with power. The plans contemplate the construction of a concrete dam, 164 feet high at the mouth of the Big Hungry river, seven miles from Henderson, the power house being located in Green River Cove. The plant will develop approximately 50,000 horsepower. W. S. Montgomery is president; A. L. White, vice-president, and J. A. Loud, secretary and treasurer, all of Spartanburg.

INDUSTRIAL ITEMS.

SHAPIRO & ARONSON, 20 Warren street, New York City, manufacturers of lighting fixtures, announce a new line of Roman Bronze electric fixtures that possess many features of interest to all who have recently visited their showrooms and inspected this line of goods. This line is illustrated on page 98 of the advertising section. These fixtures are said to be a distinct departure from past production and show that it is appreciated now that retail dealers can sell high-priced fixtures if they exhibit them in the proper manner. The confidence of the above company in these facts and the trade, is shown in their selling plan, which will appeal to every retail dealer who has fought the competition of large manufacturing retail houses. Seven salesmen have already started out to cover the trade.

THE GREENWOOD ADVERTISING COMPANY reports a sign business thus far for 1913, about three times the usual amount of other years. Recently a representative of the company during one week in Brenham, Texas, sold a number of signs that will represent something over 3,000 lamps and be the first to be installed in that town. A number of large signs are being placed throughout the country, important among which is the sign of the Trio Laundry Company, at Atlanta, described elsewhere in these columns.

MR. E. O. SESSIONS, of the firm of Woodmansee, Davidson & Sessions, consulting engineers, of Chicago, has announced that on March 1 he retired as a member of this firm. Mr. Sessions is a fellow of the American Society of Electrical Engineers, a member of the American Society of Mechanical Engineers, associate member of the American Society of Civil Engineers and a member of the Illuminating Engineering Society. His future plans will be announced later.

ELECTRICAL ENGINEERING

PUBLISHED MONTHLY

Vol. 45. MAY, 1913 No. 5

PUBLICATION OFFICE
DALTON, GA.

EDITORIAL and ADVERTISING DEPARTMENTS
GRANT BUILDING ATLANTA, GA.

D. H. BRAYMER, Editor.

A. G. RAKESTRAW
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SUBSCRIPTION RATES

Domestic .... $1.00 For Two Years

Canada .... $1.00 Per Year

Foreign .... $1.50 Per Year

Complaints of failure to receive ELECTRICAL ENGINEERING regularly or of any errors of any nature, should be promptly made to the Atlanta office.

Advertising copy or change orders for standing advertisements must reach the Atlanta office by the 5th of the month preceding the month of publication.

Entered at Dalton, Ga., Postoffice as Second-class Matter.

STATEMENT

of the ownership, management, etc., of ELECTRICAL ENGINEERING, published monthly at Dalton, Ga., required by the act of August 24th, 1912.
Editor: D. H. Braymer, Atlanta, Ga.
Business Manager: H. N. Mackintosh, Atlanta, Ga.
Publisher: Cotton Publishing Co., Atlanta Ga.
Owners: W. R. C. Smith, Atlanta, Ga.; C. S. McMahan, Atlanta, Georgia.
There are no mortgagees or other security holders.

COTTON PUBLISHING COMPANY,
C. S. McMahan, Treasurer.

Sworn to and subscribed before me this 15th day of April, 1913.
J. C. MARTIN,
Notary Public, Fulton County, Ga.
My commission expires June 24th, 1916.

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More About Conservation.

With a change of chief executives in this country, a signal is given for political fixers to begin to frame up a defense for or destruction of our national policy. Considerable criticism, which we believe just, has been lately given the present policy of the federal government on the subject of conservation. It is believed that existing restrictions on waterpower sites in the public domain are exceedingly burdensome, oppressive and serious as regards the industrial development of certain sections of the country, and the further progress that requires new capital and additional population in these sections. There is now controlled and under development by private capital waterpowers that exceed in size all such sites now remaining in the public domain, and any further hinderance in the successful development of these sites spells retardation in the progress of the parts of the country in which they are located. Waterpower projects demand a large outlay of capital, their successful operation calls for the actual presence of able men, and the benefit to any section surrounding such activity is plainly evident to those who have been privileged to experience the changed conditions or witness the progress and development that such expenditures of capital produce.

The terms "monopoly," "control" and "corporation" have now become harsh terms to the ears of the present-day public, and are fast giving way to milder terms of equal significance when possible. However this may be, and whatever the name given for the conditions, the public service field to be developed efficiently, and therefore economically, must be free from competition. The duplication necessary to generate electrical energy and serve it to a community by two or more concerns causes uncontrollable waste and insufficient profit to both satisfy legitimate interest and depreciation and invite capital. Competition among utility companies operates against, not for the public good, destroys existing values and tends to create new obligations of no certain stability. On the other hand, freedom from competition enhances the capacity and stability of generating plants and supply systems, and, on account of economies obtainable with greater production, makes possible the rendering of service at lowest prices. The large creative and executive minds in the industry today sincerely believe theirs a natural monopoly and advocate wise legislative control and the formation of state commissions organized in such a way as to be capable of regulating affairs between the public and operating utilities both with or without compeion so that conditions may be fair to all.

On account of the conditions present among the public utilities having to depend upon waterpower for economical development, it would seem most fair to all, including public and utility, that the national government yield its control of the situation to the states, allowing each locality to regulate its own development as a knowledge of local conditions seem to dictate. A damper, however, seems to be in process of being placed upon a possibility of any such liberal policy as this during the present administration, if the following comments by President Wilson appearing in the February issue of "World's Work" are a suggestion of the spirit in which such matters are to be considered:

"Then there is the question of conservation. What is our fear about conservation? The hands that are being stretched out to monopolize our forests, to prevent the use of our great power-producing streams, the hands that are being stretched into the bowels of the earth to take possession of the great riches that lie hidden in Alaska and elsewhere in the incomparable domain of the United States, are the hands of monopoly. Are these men to continue to stand at the elbow of government and tell us how we are to save ourselves—from themselves? You cannot settle the question of conservation while monopoly is close to the ears of those who govern. And the question of conservation is a great deal bigger than the question of saving our forests and our mineral resources and our waters; it is as big as the life and happiness and strength and elasticity and hope of our people."

As an able criticism of these remarks, we present in what follows an editorial comment appearing in the *Bulletin* of the National Electric Light Association: "The members of the National Electric Light Association, this *Bulletin* and the writer of this editorial note are just as patriotic as President Wilson, and just as keenly interested as he is in conservation; but as to waterpowers, they feel and know that the only real, true conservation is utilization; and that it is just what the government under fanatical guidance and prejudice has been steadily blocking, with infinite waste of natural resources, and solely from lack of a proper national policy. Recently, in one or two instances the men trying to lessen a little of this awful waste and the authorities at Washington have managed to get together, so that some of the energy could be caught up from falling water flowing unvexed to the sea; but the painful lack of a safe and sound national policy is just as evident as it ever was. As champion obstructionists and enemies of American enterprise, Gifford Pinchot and his followers hold the palm, even conceding their sincerity of purpose.

"As one thinks of the immense available power still unutilized in this country, it is difficult to repress indignation in these costly days when every nerve and endeavor should be directed against waste. But there is the trouble of the situation. A body of men willing to risk their savings and capital, down to a hundred-dollar share, at once find themselves monopolists, in President Wilson's nomenclature. If one man developed a waterpower he might deserve the designation thus applied as an epithet of shame instead of honor; but where is the one man who sought to monopolize Niagara, or build the Keokuk dam, or harness the altitudinous streams of the Sierras, or reservoir the whelming tide of Southern rivers? The thought, the thing, are so preposterous in their absurdity they need only to be set forth to receive the ridicule of every thinking, reasonable citizen.

"The industry upon which this association is based depends more and more upon the utilization of hitherto wasted resources of energy, and it resents very keenly and forcibly, even bitterly, the suggestion that it is seeking to monopolize when it is trying to give every citizen of the United States cheaper and better service than he ever had before. President Wilson knows that the development of these waterpowers is beyond the intellectual or financial capacity of any one man, in any one instance. He knows that it depends on the ability, energy, skill and capital of hundreds of thousands of good Americans. Then why be rhetorical and cry "monopoly?" Associated capital and savings have to do the work, and are doing it, and they deserve his support, not condemnation. It is easy to approve of big business, as President Wilson has done, and then say that it must owe its successful bigness to competition; but how are you going to apply such a sophomoric theory to a waterpower? Who wants more than one set of central-station circuits in a city? How can you run more than one street car line on Broadway?

"It is respectfully suggested that President Wilson think these things over. This association also suggests that in such matters, on behalf of its millions of customers represented, it be advised of and invited to co-operate in future legislation."

A Needed Reform in Our Mathematical Thinking.

In a recent number of a leading technical journal there appeared an article in which the author gave an illustration of the method of calculating the indicated horsepower of a steam engine. Stating his formula (the usual one), he proceeded to work out his example and derived the amazing result that his engine developed 74.8500480 Hp! The error in this statement (and the word error is advisedly used) is a particularly unfortunate one because it so frequently occurs in engineering calculations and statements, and is so seldom challenged. It is founded upon a well-nigh universal looseness in our mathematical thinking which is easily traceable to the door of the mathematician, to whom should not be entrusted the writing of text books on arithemetic.

To the mathematician a number is a number—a sacred thing. He thinks numbers in the abstract with never a thought of their physical significance. He teaches us that 2 times 2 equals 4. He says that 2.2 multiplied by 4.4 equals 9.18. And of course it is so, we do not question his wisdom when he goes on to the more complex calculation indicated thus: $8.21 \times 6.34 \times 3.1416$ and tells us the result is 163.52467824. Arithmetically it is so. But what about the physical significance? This is the hemisphere of our mathematical training that to most of us is a dark continent. We need a mathematical Columbus to prove to us that the world of numbers is round—not flat, as we have always been taught to suppose.

To abandon metaphor and confine ourselves to fact, the teacher of mathematics makes a serious mistake when he leaves as implied a part of his mathematical statement of a quantity. Apply a test to your friends of the engineering fraternity—of all people in need of clear ideas of number certainly the foremost—and see what your experience will be. Ask them what the difference is between 91 and 91.0. Or go further and ask them if there is any difference between 91 inches and 91.0 inches. A number of them will undobtedly say "no difference" as has been found by trying it on a great many students in engineering.

Try another test. Tell an engineer that he is not able to measure the length of a connecting rod. Go further and tell him he cannot measure the distance between one prick-punch mark on a surface plate and another prick-punch mark on the same plate. Whatever reply he may make it is certainly true that he cannot do it. All that he can do is to get an approximation of the distance, more or less accurate according to circumstances, as will presently appear. For example, suppose we take a surface plate and mark two points on it by crosses scratched with a sharp pointed tool, and try to measure the distance between them. We use a steel scale which, for the sake of argument, we will assume to be graduated with perfect precision. First we take a scale graduated in inches only. According to our scale the distance is 27 inches. Next, we take a scale graduated in inches and tenths of an inch. This tells us the distance is 27.4 inches; it can tell us nothing more. Then we use a scale graduated to hundredths. Now the distance appears to be 27.42 inches. We try a scale graduated to thousandths. This says the distance is either 27.424 or 27.425, we have difficulty in deciding, but finally decide 27.424 to be correct. Next let us suppose that we are equipped with a powerful microscope to read our scale, and a scale graduated let us say to hundred thousandths of an inch. Accordingly, the distance appears to be 27.42448 inches. Will anyone now say that this is the distance? All that we know is that the distance is probably nearer 27.42448 inches than 27.42447 inches or 27.42449 inches. Our last scale gives us a closer approximation to the distance between the points than did either of the others. The meaning of the statement that it is not humanly possible actually to measure the distance between two points will now be clear.

Therefore, if we were careful of our English and if we had been properly taught, we would not say that a distance is 27 inches, but that the distance is 27 inches plus or minus half an inch. That a distance is not 27.4 inches but 27.4 plus or, minus 0.05 inches; that is, that we know the distance to be somewhere between 27.35 and 27.45 inches, but that the scale we used gave us no information beyond this. In other words, a statement of any physical quantity as ordinarily made implies a part which the mathematician takes for granted, that of course we understand. He says that life is too short to say it every time. While this is true, it does not justify us in teaching arithmetic in such a manner that the implied part of a numerical statement is never brought to our attention.

In the light of these remarks, the man who says there is no difference between 91 inches and 91.0 inches simply betrays his lack of mathematical education. For 91 inches means (whether we know it or not) 91 plus or minus 0.5 inches, and 92.0 means 91.0 plus or minus 0.05 inches, and conveys the information that the distance was measured with an instrument graduated to tenths of an inch; and it conveys this information just as definitely as the quantity 91.5 does.

It is not always an easy matter to decide the number of decimal places which in honesty may be retained in a statement arrived at by calculation and its decision requires an examination of the limits of error of the constituent measurements upon which it is based. To illustrate the process, take the calculation of the indicated horsepower of an engine. The measurements required are, piston diameter, length of stroke, number of revolutions per minute, and mean effective pressure as determined from the indicator card. This last requires measurement of length of card, area of card and knowledge of the scale of the indicator spring. Abbreviating somewhat, let us suppose the mean effective pressure can fairly be determined from the card to the nearest pound, a very good degree of accuracy indeed, that the diameter of piston and length of stroke can be measured to the nearest hundredth of an inch and the speed to the nearest revolution per minute. Let us assume as values for these quantities to substitute in the formula H.P $= (P \times l \times a \times n) \div 33{,}000$. Where P equals 26. l equals 72.01, a equals $\pi \times$ diameter (equals 3.1416 $\times$ 18.00) and n equals 100. We then have as ordinarily written, H. P. equals (26 $\times$ 72.01 $\times$ 3.1416 $\times$ 18.00 $\times$ 100) $\div$ 33,000 $=$ 320.8. But as written with the limits of error expressed instead of implied, it becomes H. P. equals [(26 plus or minus 0.5) $\times$ (72.01 plus or minus 0.005) $\times$ (3.1416 plus or minus 0.00005) $\times$ (18.00 plus or minus 0.005) $\times$ (100 plus or minus 0.5)] $\div$ 33,000. First assuming the upper limits of error we have: H. P. equals [26.5 $\times$ 72.015 $\times$ 3.14165 $\times$ 18.005 $\times$ 100.5] $\div$ 33,000 $=$ 328.5; while if the lower limits are used the equation becomes: H. P. equals [25.5 $\times$ 72.005 $\times$ 3.1416 $\times$ 17,995 $\times$ 99.5] $\div$ 33,000 $=$ 313.2.

From this it appears that although we should ordinarily believe the horsepower of the engine to be 320.8, in reality all that we actually know from our assumed measurements and the resulting calculation is that the horsepower has some value between 313 and 328, and that it is probably not very far from 320.

What shall we say then of the statement that the horsepower of an engine has been determined to be 74.8500480? Spacious accuracy of statement is as misleading as wilful misstatement and when our text books of arithmetic shall be written by men having proper regard for the physical significance of the quantities with which they deal instead of by men walking with their heads in the clouds of pure mathematics, we shall take a long step in the direction of rational mathematical thinking.

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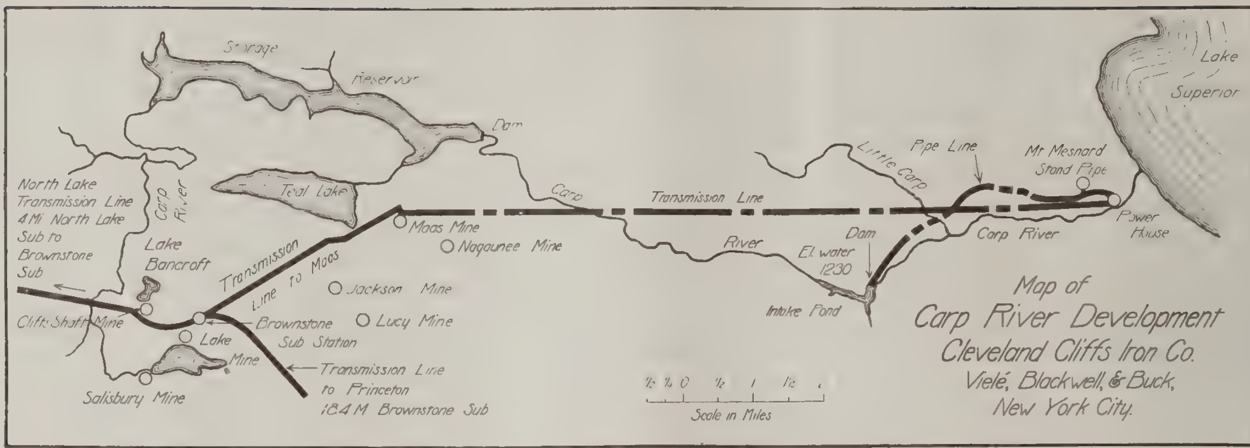
Professor Hydraulic Engineering, University of Tennessee.

Electrical Supplies in Japan.

The sale of American electrical machinery and supplies in Japan during 1912, is reported by Consul-General Thomas Sammons, of Yokohama, to be the largest in the history of this line of business in the Empire. The total sales of electrical supplies for the year aggregating over $5,000,000, the bulk of the imported products coming from America. The importation of all kinds of machinery into Japan increased about $1,500,000 during 1912, the total, in round numbers, being $14,150,000. There are in Japan several British manufacturers who have a fairly large electrical business, but the Allgemeine Co. and the Siemens-Schuckert Co. are the two largest German competitors of the American manufacturers of heavy electrical machinery and supplies.

The principal business during 1912 consisted of the extension of existing light, power, and railway stations. The Tokyo Municipal Railway, for instance, purchased $300,000 worth of apparatus for transforming high-tension current in their various sub-stations throughout the city to the trolley voltage.

A CORRECTION. On page 105 of the March issue it was stated that the Southern Power Company owns the Yadkin River Power Company. These two companies are separate and distinct as to ownership, the latter furnishing power to the Southern Power Company under a contract. Power is served from Raleigh to Durham, N. C., on jointly built transmission lines. The Yadkin River Power Company owns and operates the Blewett's Fall plant and is a subsidiary of the Carolina Power & Light Company, of Raleigh, N. C., which is owned and operated by the Electric Bond and Share Company, of New York City. The ownership of North Carolina properties is plainly outlined on page 11 of the January, 1913, issue.



Map Showing Development, Storage and Transmission System of Cleveland-Cliffs Iron Co.

Hyroelectric Development and Hoist System of Cleveland-Cliffs Iron Co.

(*Contributed Exclusively to* Electrical Engineering).

At a point on the Carp river about two miles south of Marquette, Mich., the Cleveland-Cliffs Iron Company has recently completed an 8,000 horsepower hydro-electric station. This plant has been built to furnish power for the mines of the company in the vicinity of Negaunee, Ishpeming, North Lake and Princeton, and is connected with the old distribution system and the steam turbine plants of the company, of which there are two, each of 1,500 Kw. capacity, one at Mass, and one at Princeton. The Princeton steam plant is seventeen miles south of Mass and the latter is about twelve miles west of the water power plant. All three stations are connected together at the Brownstone sub-station in Ishpeming.

The power is used for practically all the different operations of the company, including mines, mills, etc. Hoisting at the shafts of the different mines is a large part of the load, and thirteen motor-driven hoists have been installed. In most cases these consist of induction motors with simple gear drives replacing the steam end of the old hoists.

At the point of the development described here, there is a fall along the river of 622 feet in about four miles. The general scheme of development consists of an intake dam which diverts the flow into a pipe line about four miles long, laid along the left bank of the river. At the lower end of this pipe line there is a connection to a standpipe and

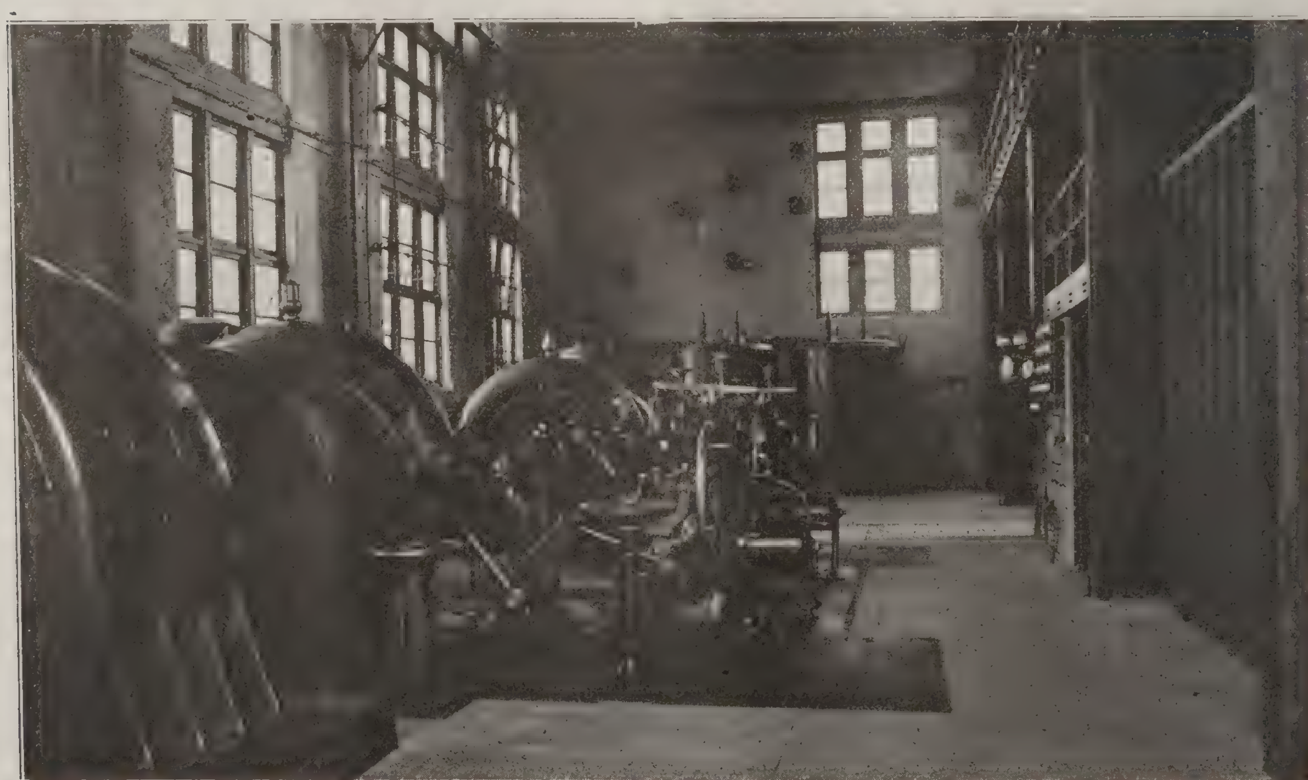


Fig. 1. Generator Room Carp River Hydroelectric Station.

FIG. 2. PIPE LINE TO GENERATING STATION.

also to a penstock about 2,100 feet long, leading down a hill to the power house. From the power house there is a tail race about 1,200 feet long.

The drainage area above the intake is 80 square miles. It is rather swampy, and is all underlain with rock near the surface. There are several lakes which help to maintain a uniform flow. The mean rain fall is 32.2 inches per year, and varies from a maximum of 37.7 inches to a minimum of 26.8 inches. The gross head obtained is 622 feet, the net head after allowing for losses in the pipe line being 580 feet. The development is designed for a continuous stream flow of 100 second feet and for a load factor of 66%. Ten million cubic feet of storage can be obtained from the reservoir above the intake dam. A large storage reservoir a few miles further up the river has just been completed. At this point a dam about thirty feet high creates a pond with a capacity of about four hundred million cubic feet, so that a flow of 100 second feet continuously can be maintained during practically every year.

INTAKE DAM.

The bed of the stream at the intake dam is solid rock and the banks are of gravel and clay. The dam consists of a concrete spillway section in the center 120 feet long and about 50 feet high above foundations, there being a concrete retaining section on each side of this, about 60 feet long to the right and 75 feet long to the left. The intake for the pipe line with the intake gate and racks is on the left hand side. A core wall at each end of the dam runs into impermeable ground.

PIPE LINE.

The pipe line runs along the river bank to a point above the power house and follows more or less closely the hydraulic grade line, except for two long inverted siphons necessary to cross low ground. It consists of 10,700 feet of 60 in. inside diameter wood stave pipe, 8,100 feet of 66 in. lock bar pipe, varying from 5/16 in. to 3/8 in. thick, and 500 feet of 66 in. riveted steel pipe 5/8 in. thick. The wood stave pipe was used wherever the head on the pipe was less than 175 feet. The lock bar pipe was used for the inverted siphons, except at one point, where the head was too high and required plates thicker than could be used for lock bar pipe. Here the 500 feet of riveted steel pipe was used.

Air valves were provided at all high points and blow off valves at all low points along the line. Pipe was laid in a trench and back filled. Specially designed steel connecting pieces were provided at all connections between the wood stave and lock bar pipe, and concrete anchorages and expansion joints were provided also at these points and at all bends in the steel pipe.

At the lower end of the pipe line there is a connection about 460 feet long of 60-in. lock bar pipe leading to the standpipe on top of the hill above the power house. The standpipe is 16 feet in diameter and 125 feet high, the top being 22½ feet above the high water level at the intake. The standpipe was designed so that it would not overflow if a short circuit would occur on the station during full load and at high water. The bottom was placed low enough so that it would be lower than the hydraulic grade line at full load during low water, and it is also low enough so that the water level in the standpipe cannot be drawn down below the inlet if there is a sudden increase in load of 4,000 horsepower up to full load. As a matter of safety an overflow pipe 24-in. in diameter was provided inside the standpipe, but as yet has not proven necessary. During ordinary operation there is practically no fluctuation of the water level in the standpipe. From the junction of the main pipe line and the 60-in. line to the standpipe, a welded steel penstock 60-in. in diameter leads to the power house. This varies from 12 m. m. to 20 m. m. in thickness and was furnished by Thyssen & Co., Germany. Each length of pipe was tested at the manufacturer's shops with a hydro-static pressure of 50% above the working pressure. At the lower end there is a cast steel Y connection with welded pipe branches to the two turbines. There is an expansion joint

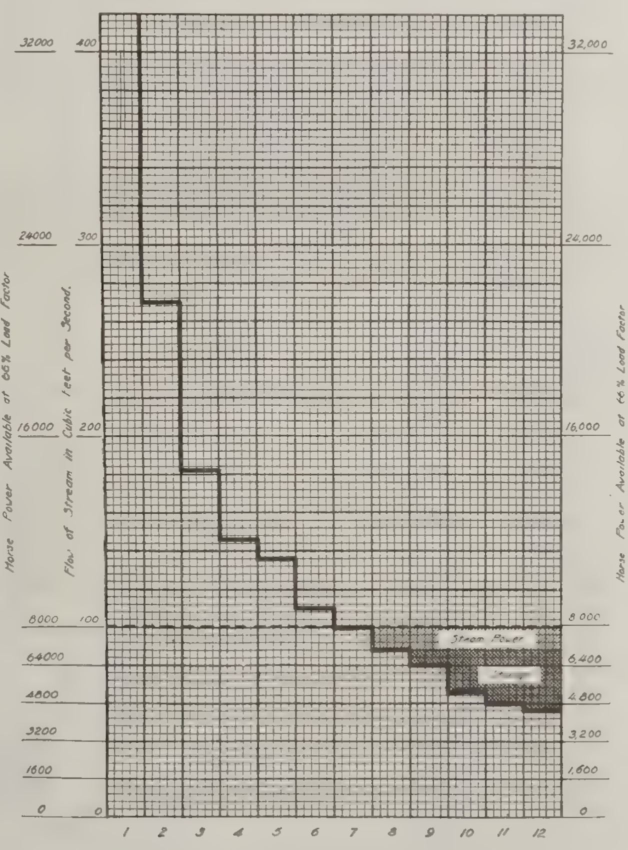


FIG. 3. STREAM FLOW AND POWER AVAILABLE AT CARP RIVER STATION ON AVERAGE YEAR.

FIG. 4. FLY WHEEL MOTOR GENERATOR SET FOR MAIN HOIST.

at the top and another about half way down the welded pipe line.

THE POWER HOUSE.

The power house is a brick, fire-proof building and the installation consists of two 4,000-horsepower horizontal units with direct connected exciters, each unit consisting of a single runner 4,000 horsepower Francis turbine direct connected to a 2500 Kw alternator with separate cast steel fly wheel 5½ feet in diameter. At the inlet to each turbine there is a 36 in. butterfly valve, hand-operated. The runners are of bronze, the scroll case of cast steel tested to 500 pounds per square inch. The flywheel effect is 50,000 pounds at one foot radius, the speed being 720 rpm. To prevent abnormal pressure rises in the penstock, each turbine is equipped with a relief valve which is operated directly by the governor. The guaranteed combined efficiency of the units at full load is, 79.6%; ¾ load 79.4%; half load 73.4%. The guaranteed efficiencies of the turbines alone are as follows: full load, 83%; ¾ load 83½%; ½ load 79%.

At the end of the building there is a bank of three single phase transformers, each with a capacity of 1900 Kva. stepping up from 2300 volts to either 30,000 or 60,000 volts. A double circuit steel tower transmission line leads to the

FIG. 5. THE 500 H. P. MAIN HOIST.

Brownstone sub-station. This is constructed for operation at 60,000 volts, but as the full capacity is not yet required, it is operated at present at 30,000 volts. The conductors are No. 2 solid copper wire, 60,000 volt pin insulators being used. The towers are spaced ten to the mile, and are about 55 feet high.

THE ELECTRIC HOISTS.

One of the principal features of this development is the long pipe line and the high and small diameter standpipe. The electric hoists, especially those at the Negaunee mine, are also of particular interest. At this mine a complete new hoisting equipment was installed on the Ilgner system with Ward Leonard control. This consists of a 350 horsepower 720 rpm fly wheel motor generator set, a 500 horsepower direct connected motor driven main hoist, and a 200 horsepower geared motor driven main hoist with helical gearing.

The motor generator set is shown in Fig. 4. From right to left, there is shown first the 400 Kw D. C. 525 volt interpole generator for operating the 500-horsepower main hoist. Second is the 25,000 lb. plate steel fly wheel, 10 feet 6 in. in diameter. This consists of steel plates securely riveted together and shrunk on the shaft. Third is the 350 horsepower, 2,200-volt, 3-phase, 60-cycle induction motor running at 720 rpm at no load and 690 rpm at full load.

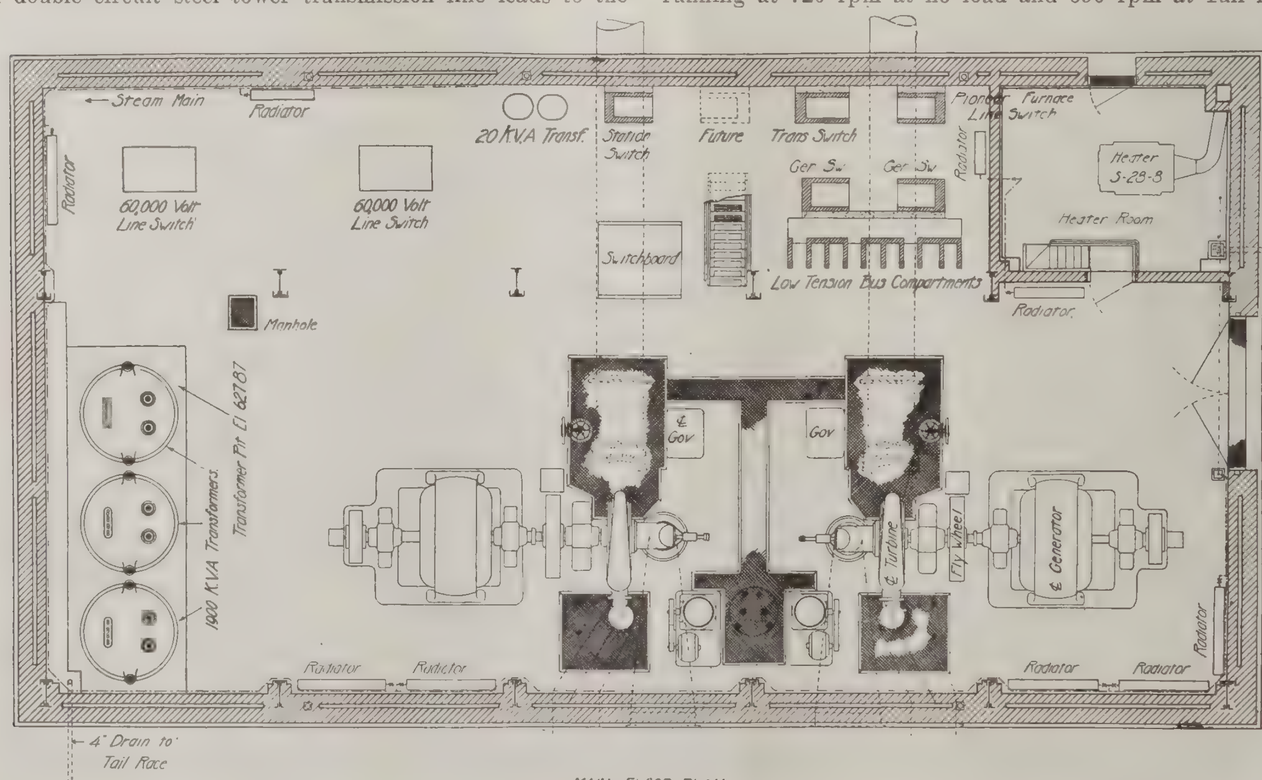


FIG. 6. MAIN FLOOR PLAN CARP RIVER STATION.

Fourth, the 150 Kw. D. C. 200 volt, interpole generator for operating the 200 horsepower man hoist. Fifth, the 25 Kw. 250 volt D. C. exciter for separately exciting the fields of the two generators. Perfect speed control of both hoists is obtained by varying the field of the generators, from which their respective motors are operated.

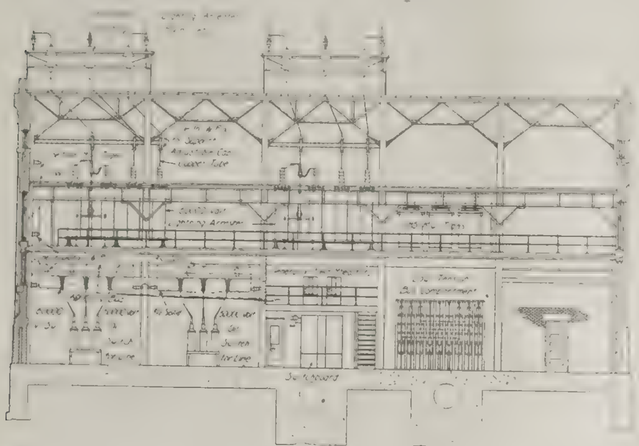


FIG. 7. LONGITUDINAL SECTION OF CARP RIVER STATION.

The 500 horsepower main hoist is shown in Fig. 5. The normal speed is 60 rpm. and the motor is direct connected. The total hoist is 1,000 ft.; the net load 10,000 lbs.; maximum hoisting speed 1,500 ft. per minute; drum 8 ft. diameter; rope $1\frac{1}{8}$ in. diameter and maximum number of trips per hour, 60. The weight of the skip, which is balanced, is 5,000 lbs.

The normal speed of the motor of the 200 horsepower hoist is250 rpm. and is geared to the hoist with helical gearing which is practically noiseless. The normal speed of the hoist is 40 rpm. The net load is 7,500 lbs., the diameter of the drum 8 ft.; total hoist 1,000 ft.; maximum hoisting speed 1,000 ft. per minute; diameter of rope $1\frac{1}{8}$ in. The weight of the cage, which is balanced, is 5,000 lbs.

Four geared hoists driven by 400 horsepower induction motors were installed at other mines of the Company.

FLY WHEEL MOTOR GENERATOR SETS.

The principal advantage of fly wheel motor generator sets for operating hoists is that the demand on the generating station is confined to the average power required by the hoists during a cycle of operations. The armature of the induction motor is equipped with collector rings connected to an external resistance which is varied automatically to prevent the current input to the motor from exceeding a predetermined limit. When a hoist is started resistance is connected in series with the induction motor armature and the set slows down in speed, allowing the stored energy of the flywheel to be utilized to assist in raising the load. As the energy required decreases and during the period of unloading, the resistance is automatically

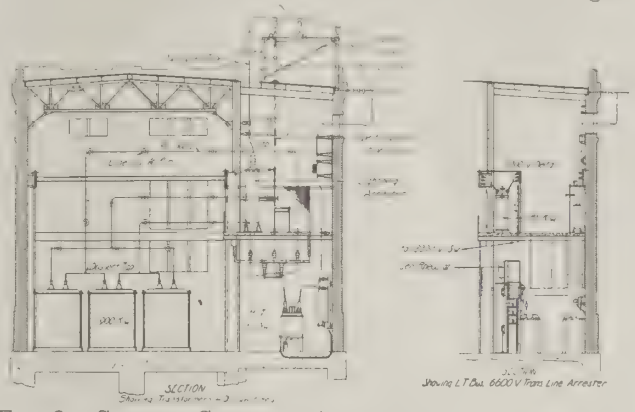


FIG. 8. SECTION SHOWING ARRANGEMENT OF HIGH TENSION EQUIPMENT.

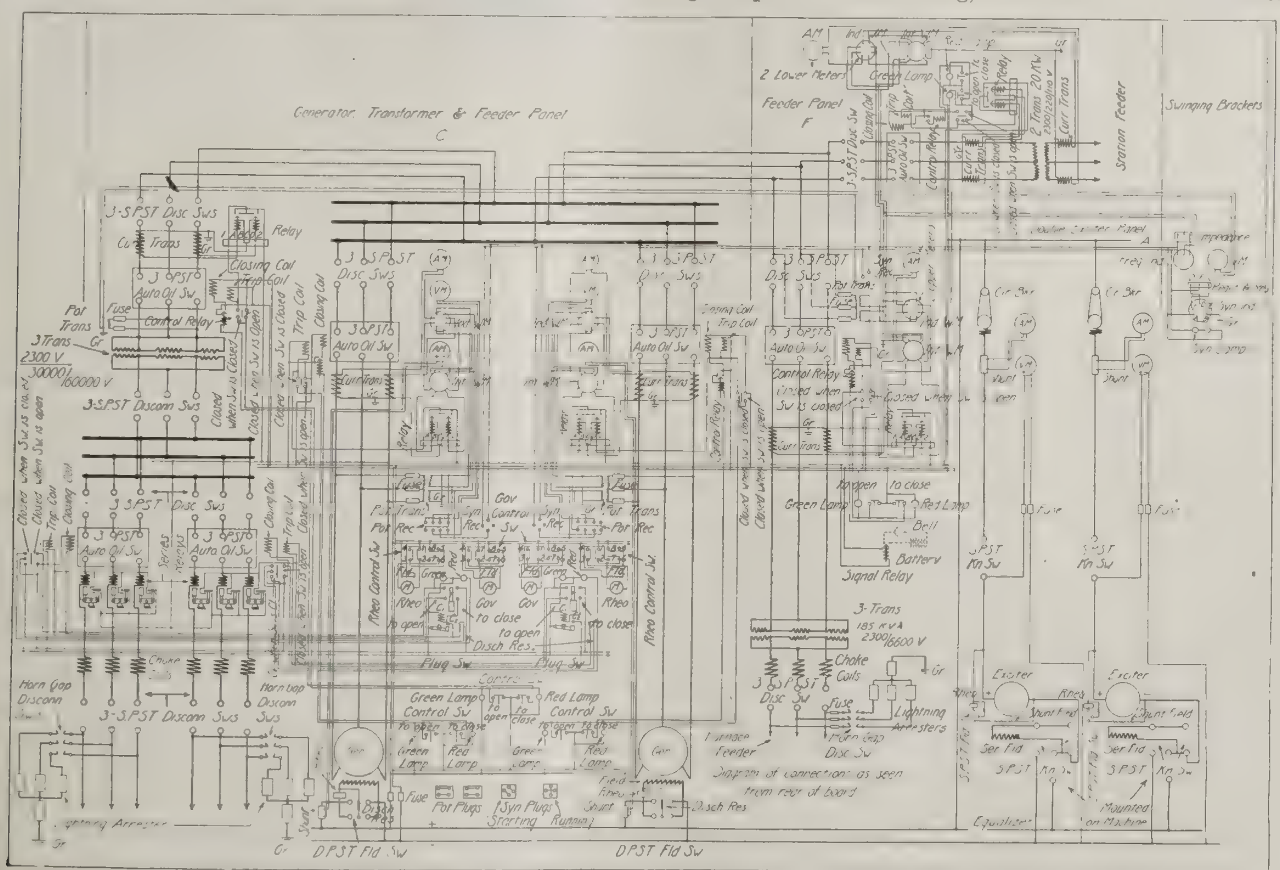


FIG. 9. WIRING OF SWITCH BOARD PANELS.

cut out of the motor armature circuit, allowing the set to speed up to normal, so that the fly wheel may again give up its stored energy when the hoist motor is thrown on. The operation of the motor generator set requires no special attention, and when the adjustments are once made it runs along drawing practically constant current from the system, whereas the direct current hoist motor operated from the 400-kw. generator requires at starting from two to two and one-half times the load drawn from the lines by the induction motor. A generating station is limited in its output by the capacity of the equipment installed, and in many cases it must necessarily place some restriction on the character of the load it supplies. A hoist motor which is large in comparison to the size of the generating plant would, if connected directly to the line, not only limit the output of the power station, but would undoubtedly cause complaints from other customers due to bad speed and voltage regulation. In addition, the load factor of a hoist is very low. It takes an abnormal load at starting, which drops off rapidly during the hoisting period, and is nothing, of course, during the loading period. To protect itself against loads of this character and to make them profitable, it has been customary for power companies to charge on the basis of the peak load demanded, which in the case of large hoists would naturally lead mining companies to install a fly wheel motor generator set with separate direct current motors for operating the hoists.

Viele, Blackwell & Buck, of No. 49 Wall street, New York City, the consulting engineers of the company, had charge of the work. The construction work on the ground was done by the Cleveland-Cliffs Iron Company under the supervision of Mr. O. D. McClure, master mechanic.

All the hydraulic and electrical apparatus of the station was furnished by the Allis-Chambers Company. The fly wheel motor generator sets and the hoist motors were furnished by the Westinghouse Electric & Manufacturing Co.; the hoists by the Wellman-Seavers-Morgan Company.

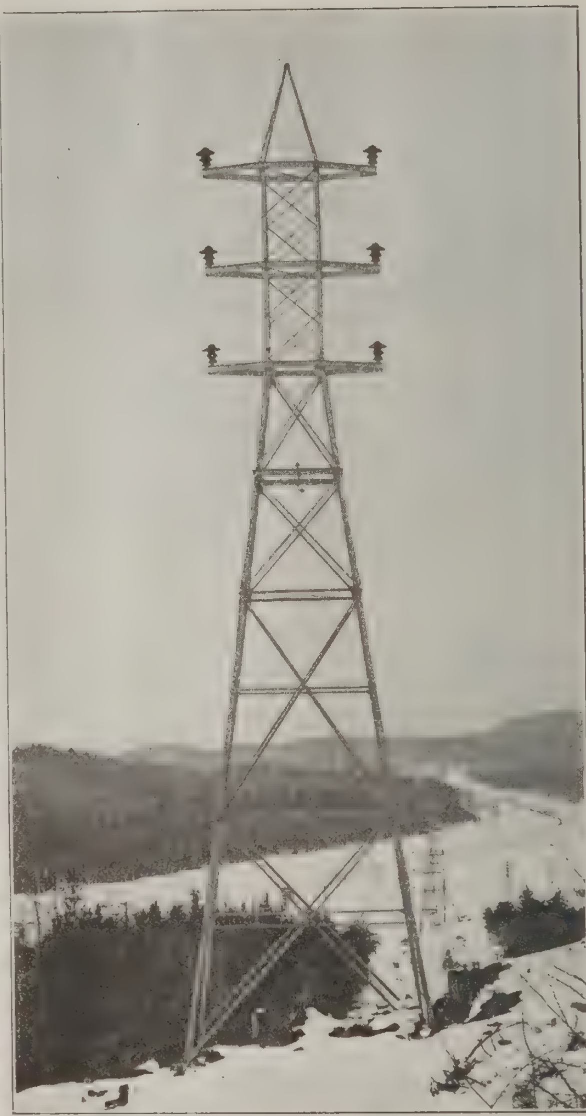


Fig. 10. Type of Double Circuit Transmission Tower.

Testing High Tension Transformers

(*Written Exclusively for* Electrical Engineering).

BY H. G. DAVIS.

Section 2. Tests For Core Loss and Copper Loss, Continued from March Issue.

After the tests for voltage change were taken the tests to determine efficiency were made. Where there are a series of the same size and rating, the tests can be taken on one transformer for the whole range of voltage and then checked at two voltage points for each of the remaining transformers. Core loss and exciting current were taken on No. 1 transformer with the voltage impressed on the 6000 volt winding. The other two windings were open circuited. The frequency of the supply alternator was held constant at 60 cycles for all readings while the voltage was varied from 2000 volts to 7500 volts which is a range from 33% to 125% of the rated voltage of the winding used. To obtain the voltages an auxiliary transformer was used to step up the generator voltage, which was read by using a potential transformer of the proper ratio so as to give a reading on a 130 volt A. C. voltmeter. An ammeter reading and a wattmeter reading was taken for every reading of voltage. The following table shows the values obtained in watts and amperes excitation for each value of voltage read:

CORE LOSS AND EXCITATION READING ON NO. 1 TRANSFORMER.

Volts	Watts	Amperes	Watts I^2r	Core loss Current	Im
2000	1800	.91	.041	.9	.0
3000	3300	1.75	.22	1.1	1.36
4000	5600	4.20	1.3	1.4	3.94
5000	8300	8.30	5.1	1.66	8.10
6000	11800	18.50	25.4	1.96	18.4
6500	14400	25.75	49.0	2.21	25.6
7000	17700	35.50	93.0	2.53	35.4
7500	21600	49.00	177.0	2.88	48.8

The first three columns show readings as taken. The watts as read, are the true iron loss plus loss due to exciting current and resistance of the 6000 volt winding. This resistance at 25°C, which was the room temperature when the reading was taken, was .0737 ohms. Column 4 shows resistance loss in winding $= I^2 \times .0737$ for each current value. The true iron loss will be the difference between the watts reading and the I^2R loss as shownbut it can be seen that this loss is a negligible percent, in fact less than the error which could come in the reading. At 6000 volts which is the rated voltage of the winding the loss due to exciting current is less than one-fourth of 1%. Even at 125 per cent voltage when the exciting current has increased to 2.72 times its normal value, the resistance loss due to exciting current is less than 1% of the reading as taken. The readings of watts as taken can then be considered iron loss only, without any considerable error in the calculations to be made for efficiency.

The current as read during the test shown in column 3 is exciting current and consist of core loss plus true magnetizing current. Column 5 shows core loss current which is watts divided by volts. Column 6 shows true magnetizing current as calculated. Column 6 shows that as the voltage is increased there is a very rapid increase of magnetizing current. This, of course, is due to saturation of the iron. In this transformer an increase of 8.5% in voltage above normal causes an increase of 39% in magnetzing current which shows that the iron is working at a density approaching saturation. This means that the voltage on this transformer should not be increased much above its rated voltage on a given winding because of the rapid increase in magnetizing current. On open circuit at normal voltage on the 6,000 volt winding the power factor of the current is 10.6%. This shows the objectional features of transformers with a large per cent of magnetizing current when not carrying load. The magnetizing current on this winding in percent of full load is 7.5%.

The value of core loss and exciting current were checked on the 12,600 volt winding for this transformer at normal voltage. These values are as follows: Volts, 12,600; Watts, 11,900; Amps, 8.9. This shows that the core loss as taken on this winding is the same as found by test on the 6,000 volt winding, indicating that, for normal voltage on the winding, the iron is magnetized to the same density. This would mean that the turns in this winding bear the same relation as their rated voltages and the magnetizing current is inversely as the voltages. See curves for watts and magnetizing current.

The values of core loss watts and exciting currents were taken at 6,000 volts on the other three transformers with results as shown below:

	Volts	Watts.	Amps.
No. 2	6000	11600	18.5
No. 3	6000	11400	19.6
No. 4	6000	12900	19.6

The watts vary on the three transformers as well as the magnetizing current but this can be due to a slight structural difference in the transformer core or a slight difference in the annealing of iron. The maximum core loss as found on any of the four transformers is .86 of 1% of the transformer rated output.

IMPEDANCE AND COPPER LOSS.

After the core loss was taken, the connections were made to determine the copper loss. In what follows we see that the copper loss consists of two components the ohmic and eddy current losses. Our wattmeter readings give us the values and from the known resistance of the windings we can calculate the ohmic loss at the temperature during test. In making this test the current was forced through the 38,100 volt winding with the 13,800 volt winding short circuited. Under this condition the current in the low tension winding is such as to demagnetize the impressed current and the voltage required to force the current through the primary winding is that required to overcome ohmic drop and reactance drop. Since the low tension winding is short circuited, the current flowing in it requires a voltage which reacts in the high tension winding and adds to the voltage required in forcing current through that winding. The voltage as read is thus the total impedance volts of the transformer or is current times impedance. The current as read was primary current so that the impedance is in primary terms.

The impedance was taken on the high tension winding with the frequency held constant at 60 cycles. It is usually easier to take the readings on the high tension winding for current is small and the voltage is usually within range of a moderate voltage generator. The following table shows the values of current, watts and volts as

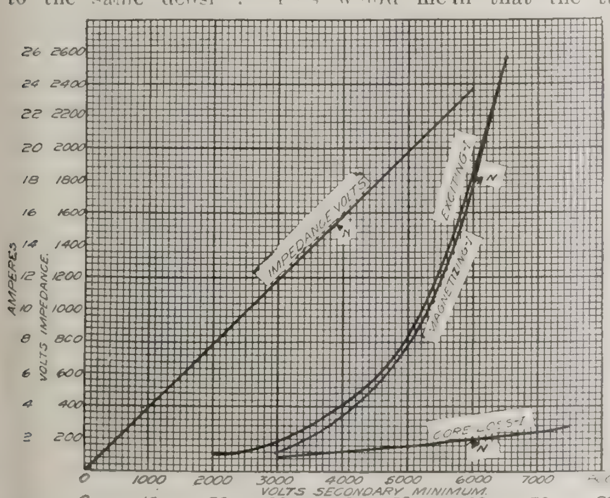


FIG. 1. CURVES FOR IMPEDANCE VOLTS—EXCITING CURRENT—CORE LOSS CURRENT AND MAGNETIZING CURRENT. 1500 KVA TRANSFORMER—60 CYCLES—38100 PRIMARY AND 6000 SECONDARY VOLTS.

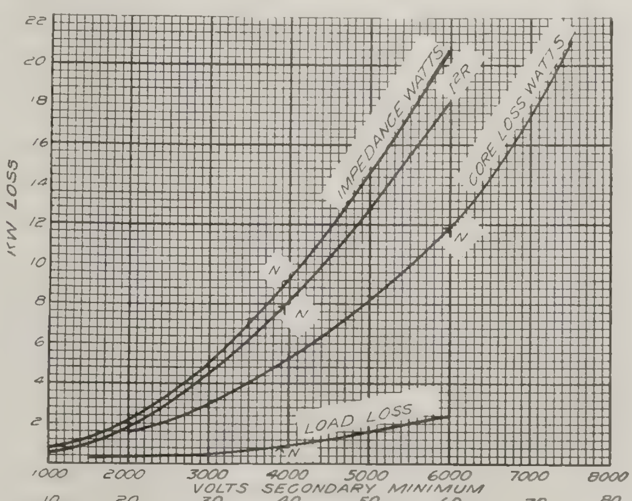


FIG. 2. CURVES OF CORE LOSS—IMPEDANCE WATTS—TRUE OHMIC LOSS AND LOAD LOSS FOR THE SAME TRANSFORMER AS IN FIG. 1.

taken. The normal or full load current is 39.3 amperes on the high tension winding. The table shows a range of current from 25% to 153% of full load current. Temperature at time of test = 30°C.

COPPER LOSS READINGS.

Current	Watts.	Volts	I^2R	Eddy	Z	R
10	700	390	516	184	39.0	5.16
15	1400	590	1160	240	39.3	
20	2400	780	2060	340	39.	
25	3600	990	3220	380		
30	5100	1180	4660	440		
35	7000	1370	6300	700		
39.3	9100	1550	7950	1150		
45	11700	1770	10400	1300		
50	14600	1960	12900	1700		
55	17600	2170	15600	2000		
60	21000	2360	18500	2500		

The watts as found by test (column 2) are the I^2R loss plus the eddy current loss. The temperature at the time of the test as taken from the oil reading was 30°C. From the total resistance in primary terms (see resistance) corrected to this temperature, we get ohmic loss as given in column 4. Thus primary resistance = 2.26 ohms.

13800 volt winding resistance = resistance of 12600 volt winding $\times$ 13800/12600 = .342 $\times$ 13800/12600 = .374 @ 25°C = .381 @ 30° = .381 $\times$ [38100/13800]^2 = 2.9 ohms in primary terms.

The total resistance in primary terms for the two windings used = 5.16 ohms. The total ohmic loss in transformer = (current)$^2 \times$5.16 as in column (4). The difference between watts read and column (4) is the eddy current loss which also includes a slight core or iron loss in exciting the core to the density of the voltage required for impedance. The column under Z shows impedance in primary terms for the total of the two windings. This value = [Volts ÷ current] and should be a constant value if the frequency is constant. $Z = \sqrt{(R^2 + X^2)}$ and $X = 2\pi f L$, where f = frequency and L = inductance of the transformer which is a constant. The curve then of impedance volts against current should be a straight line.

The ohmic resistance at the given temperature in primary terms = 5.16 and impedance = 39. This power factor should be apparently 5.16/39 = .132, but tests show (9100 Watts)/(39.3 $\times$ 1550) = .149. This apparent increase is due to the increase in apparent resistance due to the eddy losses or load losses in the copper as shown in column (5).

Impedance and copper loss were checked for two points by using the 6600 volt winding short circuited instead of the 13800 volt winding. These readings were:

Amps	Watts	Volts
30	1140	5000
40	1550	9100

On the remaining three transformers impedance was checked at the normal current point with the following results:

Transformer	Amps.	Watts.	Volts.
No. 2	39.3	9000	1530
No. 3	39.3	9080	1500
No. 4	39.3	8800	1550

These values checked closely with the curve of No. 1 and showed that the impedance on all four transformers are the same which insures good operation if paralleling is necessary. The readings of watts and volts when using 6600 volt winding short circuited also showed that there was no material difference in the losses when the 6600 volt winding is used instead of the 13800 volt winding.

CURVES.—The curves as plotted show impedance volts against primary current on the 38,100 volt winding—exciting current, core loss current and magnetizing current against voltage on the 6000 volt winding and watts loss against voltage for core loss and against current for impedance test.

The Design of Steam Power Plants

(*Contributed Exclusively to* ELECTRICAL ENGINEERING).

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Analysis of Conditions Determining Selection of Plant Equipment.

IN this article it will be assumed that proposals have been secured from the different manufacturers on the equipment discussed in last issue. We are ready to discuss the features of the apparatus and decide on the machinery that will be purchased.

In selecting machinery many features must be considered, such as the upkeep, accessibility of parts for repairs, first cost, etc. The detail specifications furnished with each proposal should assist in deciding the first two features as well as other minor points, when placed in the hands of a competent engineer. The last item, that is the first cost, is one that should be weighed most thoroughly. The fact that one machine is cheaper than another in dollars and cents, does not mean that it is the cheapest machine to buy. We will see in the argument that follows, that it is possible to buy a machine much higher in first cost than some other, and still prove in the end the best investment.

In taking up in detail the basis for the selection of each piece of machinery, on which as already stated it is assumed that all bids are in, the order will be the same as that in which the specifications were written, beginning with the turbines. It will be assumed that we have received two bids on turbines "A" and "B." Since we can compare the two bids as to the general construction, etc., we will first discuss them from the standpoint of price and guarantees. We will assume the price of "A" on the 2-500 Kw, and 1-1000 Kw turbines including exciters of proper size, to be $38,000. That of "B" on the same units to be $41,500.

The steam guarantees of "A" for 500 Kw machines are as follows: ¾ load—23.5 lbs. per Kw.; full load—22.4 lbs. per Kw.; 1¼ load—22.9 lbs. per Kw. On the 1,000 Kw. machine, the guarantees are as follows: ¾ load—22.9 lbs. per Kw.; full load—21.8 lbs. per Kw.; 1¼ load—22 lbs. per Kw. All guarantees are based on operating conditions named in the original specifications.

The guarantees of "B" on the 2-500 Kw machines are as follows: ¾ load—23.1 lbs. per Kw.; full load—21.9 lbs.

per Kw.; 1¼ load—22 lbs. per Kw. On the 1,000 Kw unit, the guarantees are as follows: ¾ load—22.5 lbs. per Kw.; full load—21 lbs per Kw.; 1¼ load—21.5 lbs per Kw.

It is observed at once that "A" is $3,500 cheaper than "B" although "B's" guarantees are better in every instance. With these conditions in mind, we will analyze the propositions to determine the cheaper installation to select. In order to have a basis on which to figure, we must either go to the "coal pile" or the "switch board" from which to get and refer actual facts. Since this article is treating the plant from the "steam side" or mechanical end, it is proper to work from the "coal pile." Knowing that the plant is to be hand fired, we can expect an evaporization of about 8 lbs. of water per pound of coal burned, which is good average practice. We will not discuss the evaporization from the value of a pound of combustible, treating the proposition in a general way. We next assume that we can purchase good run of mine bituminous coal delivered at the plant for $2.50 per ton of 2,000 lbs. On this basis coal is worth 0.125 cents per pound; and it costs 0.125 ÷ 8 = 0.0156 cents to evaporate one pound of water.

For convenience we will tabulate the guarantees as follows:

FOR 1,000 KW. TURBINE.

	¾ load	Full load	1¼ load
"A"	22.9 lbs.	21.8 lbs.	22.0 lbs
"B"	22.5 lbs.	21.4 lbs.	21.5 lbs.
Difference	0.4 lbs.	0.4 lbs	0.5 lbs.

There is a difference of 0.4 lb. at full load in favor of "B's" bid, therefore at the cost to evaporate one pound of water, we find .0156 cents × .4 = .00624 cents saving per Kw. per hour. While we may not run the 1,000 Kw machine the full 24 hours per day (see reference to load curves in Section 1) the conditions so far as saving is concerned will permit of continuing the argument on this basis. Therefore for 1,000 Kw. per 24 hours the saving will be .00624 cents × 1000 Kw. × 24 hrs. = 149.76 cents or $1.49 per day for the 1,000 Kw. turbine. For 365 days the saving will be 365 × $1.497 = $536.40 per year. Therefore by investing $3,500 more in "B" machine, we will save $536.40 per year, which is 15.3% on $3,500. It will be cheaper therefore to buy the more expensive machine. This argument is not thrown in here to show that it is always best to buy the most expensive machinery, for it is often possible for the cheaper priced machines to have the best guarantees, in which case it is an easy matter to make a selection, provided the first two items mentioned above were decided in favor of the cheaper machines.

It will be impossible to discuss the merits of the two types of machines offered beyond the statement that it will be necessary for each part of the machines to be considered in comparison with the detail specifications and conclusions formed from same. For instance, the devices for speed regulation should be compared, arrangement of bearings, ability to get to parts for repairs, and the oiling devices, etc. should be weighed against each other. It requires therefore, the assistance of a competent engineer to select the machinery as well as to prepare a specification, on which the bids are received. While the specification called for machines to be based on normal ratings, that is machines that have a full overload capacity, above that which each machine's name plate calls for, it is well to see that this is given in the guarantees, by each manufacturer.

The selection of the boilers for the plant will be discussed next. With the specification we have given, prices may be expected on three types of water tube boilers. The Babcock and Wilcox type, the Stirling type, and the Heine type. There are a great many manufacturers making the last named type with slight modifications from the original Heine boiler, and there are other types of water tube boilers such as the vertical, but this class of boiler is not used to a very great extent in this kind of power plant construction. In selecting a boiler, the same as with turbine machinery, we must pay attention to the upkeep and repairs, as the outlay required to keep a boiler in repair after it is installed may be great. Since our specification determines the amount of heating surface we may expect, this point is settled. One of the most important features to be considered is the means of caring for expansion and contraction. For instance it is impossible to maintain a fire of the same temperature in the center and at the sides of the fire box or furnace, therefore we may expect an uneven expansion of the parts under such conditions. If we have solid surfaces supporting the tubes we may expect an uneven expansion or strain. This difficulty may be overcome as in the B. & W. type of boiler where each set of tubes is expanded into a header which rests in a vertical position. With this arrangement the whole front of the boiler is made up of vertical sections placed alongside of each other with about 7-in. centers. Each section is expanded into a main drum above, making a complete unit out of the boiler, but leaving each part free to move independent of the adjoining section. The tubes are arranged in an inclined position at such an angle that perfect circulation is maintained with a minimum amount of water being carried over into the pipe line. The mechanical arrangement of this boiler is such that it can be easily cleaned, and any tube may be replaced very easily. This type of boiler can also be forced 100% and even more above its normal rating which means that we can get a horse power from 5 sq. ft. of heating surface instead of 10 sq. ft. This gives a boiler of double capacity in an emergency case. Also in normal cases we may expect to get a greater evaporation per pound of coal.

The Stirling type of boiler, in point of construction, is entirely different from the B. & W. One of the main criticisms of most engineers on this type of boiler is the "crooked" tubes, which necessitates a large stock of tubes to be carried for repairs. This is not really true since this company carries a full stock of the tubes in each territory in order to serve its customers at the least expense. For accessibility, expansion and general workmanship, this boiler is good, it has no large flat surfaces, and few parts that do not come in contact with the flame path, which insures good results. One feature of this type of boiler that enables it to lend itself to local conditions, is that a greater horsepower can be placed in a smaller space than the B. & W. type.

The third type, or Heine boiler, also has its advantages It has the straight tubes as is found in the B. & W., possesses accessibility for cleaning and repairs, and can be placed in a small floor space if required. The greatest objection to this type of boiler is the large flat surfaces exposed to the steam pressure, which have to be stayed. Of course this objection is admirably overcome by the use of stay bolts and rods tying the front and back together but this adds to the boiler's upkeep expense. The solid flat surface does not lend itself to expansion and contraction as does the B. & W. sectional type.

One great feature that is found in all water tube boilers as against the return tubular boiler, is that it is practically impossible to have a disastrous explosion with the water tube boiler, on account of the very small diameters of the different parts. For instance if a tube should fail in this type of boiler it could not be disastrous and would only cause a short shut down. We will not endeavor to show why this is true, although it is a fact. This feature alone should influence the owner to select the water tube type of boiler over others as it may mean life and property to him.

The main consideration in connection with the boiler installation is the cost of same. We will assume that we have bids on the three above named boilers as follows: $16.00 per horsepower for the B. & W. f. o. b. factory as against about $13.50 to $14.00 for the other two. It will cost about 75 cents per Hp. to erect the boilers on foundations furnished by owners, and an additional cost of about $25.00 to $27.00 per thousand for the brick work in connection with a boiler, and about $45.00 to $50.00 per thousand for the fire brick in the furnaces. On this basis a double setting of the B. & W. type boiler would cost as follows:

800 H. P. @ $16.00	=	$12,800 Boiler
800 H. P. @ .75	=	600 Erecting
60,000 × $25 per M	=	1,500 Brick work
4,000 × $50 per M	=	200 Fire brick
25,000 lbs. @ .75	=	185 Freight
800 H. P.	=	$15,285
Cost per H. P.	=	19.10

Assuming the same number of brick for each installation, this will make the B. & W. boiler about $19 per Hp. erected, and $16.50 to $17.00 per Hp. for the other two types.

We may expect a greater evaporation per pound of coal from the B. & W. boiler than from either of the other two, therefore, let us assume that this boiler will evaporate one pound more water per pound of coal. The specifications call for an evaporation of 30 lbs. per Hp. or 400 × 30 = 12,000 lbs. per boiler. Then 12,000/8 = 1,500 lbs. of coal burned per hour per boiler, 1500/400 = 3.75 lbs. per Hp. per hour. With coal at $2.50 per ton, coal is worth 0.125 cents per pound and 3.75 × .125 cent = .468c per Hp. The saving then is 1 in 8 pounds. or 12½%, which is .468 × 12½% = .058c per Hp. per hour and .058c × 24 = 1.39 cents per 24 hours or 1.39 × 365 = $5.08 per year. Therefore if this type of boiler will give one pound greater evaporation per pound of coal, we can afford to pay even more than $2.00 to $3.50 per Hp. for it, as the saving in one year overbalances this difference.

THE SUPERHEATERS.

In selecting superheaters we have two types from which to choose. The internally fired and the externally fired. The first mentioned type being an integral part of the boiler and gets its heat from the gasses passing from the boiler. The latter may be fired independent of the boiler and placed at a distance from the boiler if convenient. For the conditions of the plant considered, the first mentioned type is the only practical superheater to be used. It is well also to allow this to become a part of the boiler, that is, let the manufacturer furnishing the boiler furnish the superheater. In this way good results can be expected, as all of the boiler companies mentioned make a superheater to be used with their boilers.

Since the specifications gave the service under which the superheater is to work, it will be best to let the manufacturer locate the superheater in the boiler to produce the best results. The superheater is usually placed in the second pass of the boiler, at which point it is not exposed to the furnace flame, but is at a point to catch the furnace gases at a high temperature.

THE BOILER FEED PUMPS.

The selection of the boiler feed pumps will next be discussed. There is very little to be said on this subject beyond the fact that the pump must come up to the specifications given. The greatest feature to be considered is to get a pump that is sufficiently large to supply the boilers at full capacity without excessive speed. For service with the plant running at full capacity of 1,500 Kw. with the auxiliaries we may expect to pump about 40,000 lbs. of water per hour or 40,000 × .002 = 80 gallons per minute. If we decide on 40-ft. per minute piston speed, we find that a pump about 10 x 6 x 10 inches, that is a pump with 10 inch diameter steam cylinder, 6 inch diameter water cylinder and 10 inch stroke will be a satisfactory pump for this service. Of course we would expect slightly different sizes from the different manufacturers, all of which would be near this size. As stated above, the boiler feed pump must not be too small. We could run this size plant on a much smaller pump, but it would cause the pump to run at a much higher speed and necessarily cause more wear and tear on the pump. Since we will be pumping hot water, it will also be necessary to have the pump large in order to insure smooth, even running.

The question may arise, as to why we do not select a modern centrifugal steam turbine driven type of pump. In answer the writer will state that he believes the plant considered a little too small for this type of unit, although he is in favor of this class of boiler feed pump when the plant is large enough to warrant its installation.

FEED WATER HEATER.

The next piece of machinery in order of select will be the feed water heater. From our specification we have two classes to select from, the thoroughfare heater and the vacuum type. The former is built by several concerns and the latter by one concern only. In the thoroughfare heater, we run the auxiliary exhaust pipe into the heater, thence out at top, allowing all the steam to pass through the heater. The pipe arrangement for this heater should be so that the heater could be cut out for repairs. The later type of heater, or vacuum type, has the pipe arrangement so that just enough steam enters the heater to raise the water temperature to the maximum, that is to the temperature of the steam at atmospheric pressure which is from 208° to 210°. The pipe arrangement for this heater is somewhat cheaper than in the thoroughfare heater. Both of the heaters are made of cast iron shells, each have oil separators, and water purifiers. So far as the ability of either heater to do the work designed for it when furnished with the proper amount of steam, there is very little choice between them. The choice then resolves itself into which heater is the cheapest.

CONDENSING MACHINERY.

We now turn our attention to the selection of the condensing machinery. Bids may be expected on two distinctive types of condensers, including the auxiliary machinery accompanying same. That is the condenser run by reciprocating auxiliary machinery and the condenser run by rotating machinery, or we may find a combination of the two for instance, a centrifugal pump for the circulating water and reciprocating pump for the air.

In selecting between these two or three types of machinery, it is a question of maintenance as much as anything else. In a reciprocating machine, that is one that has to stop and start at the end of each stroke, we may expect a great deal of wear and tear consequently an expense for repairs, but with the revolving type of machinery this trouble can be brought to a minimum. At present we are able to buy a complete revolving condensing unit, for instance the circulating water pump, and air pump can be driven by a steam turbine or electric motor connected direct to the shaft of the two pumps. The high speed required for each of these pumps makes them lend themselves to this type of motive power. From an upkeep standpoint, the complete revolving type of machinery has much the advantage over the other type.

There is another feature we must take into consideration in selecting the condensing machinery, namely, the efficiency of operation. In order to determine this, we must note which machine requires the most water to be pumped to maintain the specified vacuum, for this is the item that effects the operating expense. The proper way to determine this point is to determine which machines approach nearest the theoretical temperatures of the vacuum with its condensing water. For instance suppose one machine guarantees to maintain the specified vacuum with the condensing water discharging within 5 degrees of the vacuum temperature and the other type within 2 degrees, or in other words, one machine is absorbing 3 degrees of heat more per pound of water pumped than the other machine. If we assume the initial temperature of water at 80° (see specification Section 1), and final temperature 107° (27½ inches vacuum) or a total difference of 107 — 80 = 27 degrees, then three degrees is 1/9 of 27 or 11%. This means that this type of machine will pump 11% less water than the other machine or can be run 11% more economical than the machine using more water, assuming each machine to be driven with machinery of the same efficiency. Of course in the detail specification received, we must see what the guaranteed efficiencies of the circulating pump, air pump, and the machines driving these are, also what the combined efficiency will be.

It will not be necessary here to show, as in the turbine selection, how we may pay more for one condensing outfit and still be buying the cheaper machine, although this argument holds for this apparatus as well as the turbine and boiler.

The argument above with reference to condensers was given in order to show the advantages one type of machinery might have over the other and since we carried this argument to a percentage stage, it will be an easy matter to see how much more we may pay for the higher efficiency outfit. As the condensing outfit containing all revolving machinery has the advantages in upkeep, as well as the advantage of being able to discharge the water at or near the actual temperatures of the vacuum, we will select this type for our plant.

With this point settled, it is now in order to discuss whether we shall drive the auxiliary machinery by an electric motor or steam turbine. In order to decide this, we have several things to consider. First, will we need more exhaust steam for heating the boiler feed water than we can get from the boiler feed pumps? Second, if we decide we do not need the exhaust steam for boiler feed and consider electric motors we have to take into consideration the fact that if the plant is completely shut down, it would be necessary to start up noncondensing before we could start the condenser. In this particular plant we may expect one machine to be running continuously as we are furnishing lights, therefore we could use motors and satisfy the above argument. Assuming that we will not require the exhaust as mentioned above, we still have another course which may prove even better than the motors. That is to run the condensing machinery by condensing steam turbines. To decide between these two, it is only necessary to see how many pounds of steam the turbine driven condensing outfit will require per indicated horse power (I. H. P.) and the combined efficiency of the motor driving the condenser, the generator and the large steam turbine. For instance we will assume the efficiency of the motor at 85%, the generator at 90% and the steam turbine at 22 pounds per Kw. = 16.5 lbs. per Hp. Then 85% × 90% = 76.5% efficiency between the two electric machines.

For the turbine 16.5/76.5 = 21.58 lbs. and therefore if the condensing turbine driving the condenser will produce one indicated horsepower on less than 21.58 lbs. of steam per hour, it will be the cheaper equipment to install, from an operating standpoint.

We merely bring out these points to show how to select this type of machinery, but from experience we may know that this plant will have to run the condensing auxiliary machinery noncondensing as we will not have enough steam to heat the boiler feed water from the exhaust of the boiler feed pump. In the first section of this article we mentioned this point, stating we would prove the discussion later. To decide this, however, we must find out how much heat is required to heat the boiler feed water to a maximum temperature, and second how much steam is available for this purpose from the boiler feed pump. The first problem is solved thus: We have 40,000 lbs. of water to heat from the initial temperatures of say 75° to 210° or a rise of 145°. Then 40,000 lbs. × 145° = 5,800,000 B. t. u. per hour required. (1° rise of temperature = 1 B.t.u). The second problem is as follows: The pump must handle 40,000 lbs. of water against a head of 180 lbs. (165 lbs. steam plus friction). Then 180 lbs. = 180/.43 = 418-ft. head. Also 40,000 × 418/33,000 × 60 = 8.44 pump horsepower required to run the pump. Assume 90 lbs. of steam per pump horsepower, we have then available 8.44 × 90 = 759.6 lbs. of steam per hour for heating purposes. Each pound has 1050 B.t.u. (approx.) per pound of steam, therefore we have 759.6 say 760 × 1050 = 798,000 B. t. u. available. Therefore we see we have only about 15% enough steam from our boiler feed pump to heat the feed water which proves the statement that we would need a non-condensing steam turbine to run the condenser in order to get sufficient steam to heat the boiler feed water.

Since we have discussed all of the important machinery entering into the plant, and in a position to purchase it, we will take up in the next section of thi sarticle, the arrangement of the machinery and show the general pipe arrangement by illustration.

A brilliant light should be provided in opera houses, ball rooms, public and private theaters, lobbies, dining rooms, and reception rooms in hotels, and in the same character of rooms in private houses.

Practical Information for Electrical Contractors

(*Contributed Exclusively to* ELECTRICAL ENGINEERING)

BY N. R. CLEMENS.

(1). Practical Points on Tablet and Panel Boards.

Tablet or panel boards now on the market are made in many standard forms and capacities to fit the panel boxes made by their respective manufacturers. Practically all are constructed in accordance with the requirements of the National Electric Code. One can thus be reasonably sure that the construction of the tablet boards that have been approved in accordance with the code will be good. Plain, black finished slate is probably the best and most serviceable material for a board and a plain lacquered finish on the copper is probably as good as any. In general, plug cut-outs are to be preferred, and also, snap switches are better than knife switches, particularly where they are to be manipulated by persons electrically unskilled. Tablet boards can be assembled from standard porcelain fittings, as suggested in Fig. 1, held with wood screws.

Panel boxes are cabinets arranged to contain cut-outs or cut-outs and switches for protecting and controlling branch circuits where they branch from a main. The miniature switchboard within the box supporting the cut-outs and fuses, is called the panel board or the tablet board. It has been found desirable, insofar as possible, to group cut-outs in a wiring system, and this accounts partially for the popularity of panel boxes. The first panel boxes were made without gutters, as shown in Fig. 2, and boxes of this type are still used to some extent. Their disadvantage is that it is necessary to carry the wires for each branch circuit to a point of the box opposite the proper cut-out. This is often inconvenient and expensive. To obviate this disadvantage, panel boxes are now most often made with wiring gutters as shown in Fig. 3. With this arrangement conductors can enter the box at any point on the side or top and can be carried in the gutter to a point opposite the cut-out. Panel boxes may be of either the flush or surface type, as shown in Fig. 4. The flush type is obviously preferable, because it extends but little beyond the surface of the wall. Flush type boxes are always used in first-class residence and office building wiring. Surface type boxes are used principally for factory wiring and for conduit installations in old buildings.

Panel boxes of sheet metal are suitable for factory work. The barriers in boxes with gutters are usually of slate or marble. The inside of a wooden box must be completely lined with a non-combustible insulating material. Slate or marble ¼-inch thick or asbestos board ⅛-inch thick can be used. Where iron conduit enters the box, the lining may be of either ¼-inch slate or marble or asbestos, or of 1-16-inch galvanized or painted sheet steel. Boxes should be painted inside and out. An asbestos or steel lining is to be preferred, because slate and marble break readily.

The "trim" of a panel box consists of the door and the frame in which it swings. Trims are held to the boxes

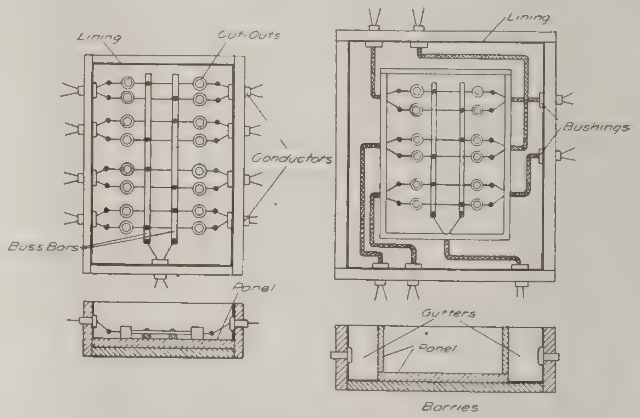


FIG. 2. PANEL BOX WITHOUT GUTTER. FIG. 3. PANEL BOX WITH GUTTER.

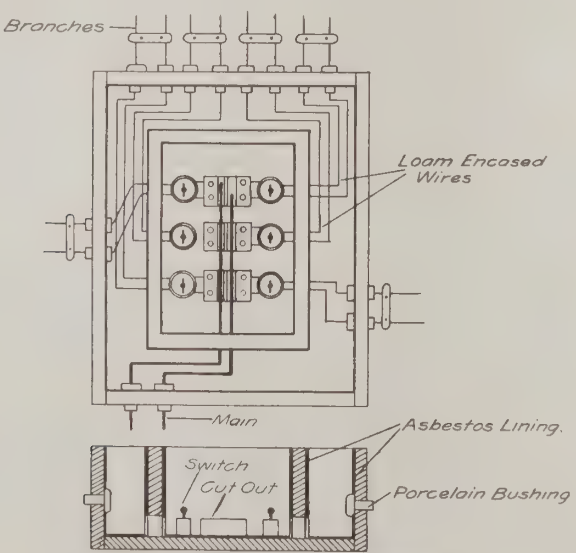


FIG. 1. A HOME-MADE PANEL BOX.

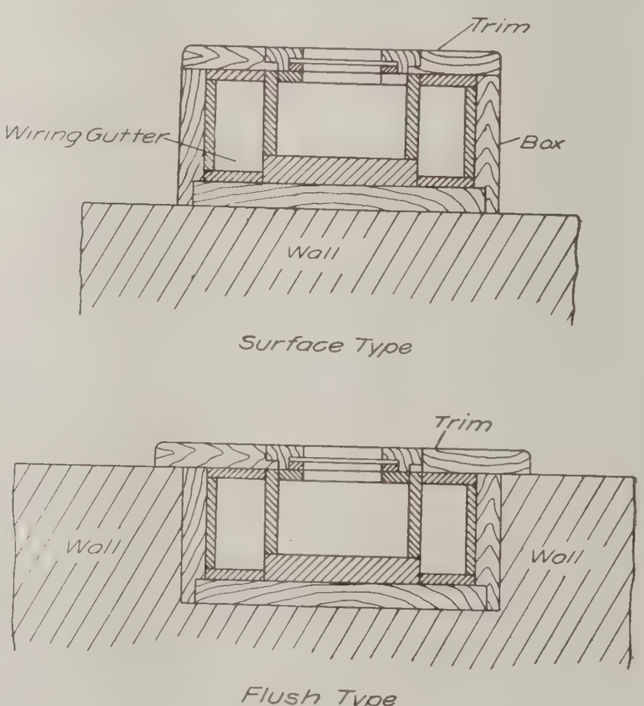


FIG. 4. BOXES OF THE FLUSH AND SURFACE TYPES.

with screws, so that they can be readily removed for manipulating wires. The door should close against a rabbet so as to be dust tight. Glass panels may be used in doors instead of wooden ones, and should be at least ⅛-inch thick. A 2-inch space should be provided between the fuses and the door.

Home-made panel boxes can be constructed where necessary, but it is in most cases cheaper to buy them ready made. The barrier in a home-made box can be of wood, in which case it must be covered on both sides with ⅛-inch sheet asbestos. For a home-made box, standard porcelain cut-out fittings and standard snap switches can be used. They are held with screws to the asbestos-covered back of the box. Heavy wire can be used for bus bars. Fig. 1 illustrates the appearance of such a box and the trim can be made as shown in Fig. 4, which illustrates a box with a barrier. One without a barrier would appear like that of Fig. 2.

(2) Flexible Tubing—Its Application and Properties.

Flexible tubing is used as a protection for conductors, most frequently in non-fireproof buildings, and is usually used in conjunction with other methods of wiring, such as knob and tube wiring, exposed surface wiring on cleats or knobs, or moulding wiring. It is also used at the backs of panel boards and switch boards to protect conductors where they emerge from conduit.

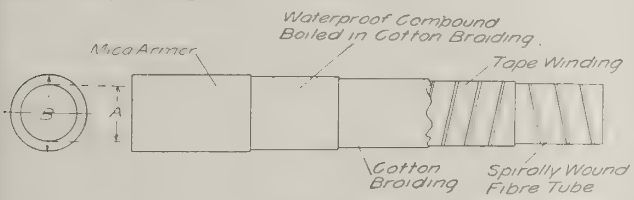


FIG. 5. SHOWING CONSTRUCTION OF FLEXIBLE TUBING.

Flexible tubing must be continuous from outlet to outlet, and must not be installed in damp places or where it will, in any way, be subjected to moisture. It should not be placed in contact with damp mortar or plaster. In open work where exposed wires are nearer to each other than 2½ inches, they should be protected in some way, and flexible tubing may be used. Where wires cross gas pipes, water pipes, conductors at chandaliers, wood work, brick or stone, a short length of the tubing should be slipped on to the conductor. It is also the practice to place flexible tubing on the conductors at bracket outlets and on the gas pipe back of the insulating joint at combination fixture outlets.

At centers of distribution, where the space is so limited that the 5 inch separation ordinarily maintained for 110 volt conductors, cannot be used, the wires can be carried closer together, provided each is separately encased in a continuous length of flexible tubing. Another convenient application is for the protection of conductors that are carried around machinery.

TABLE I. PROPERTIES OF FLEXIBLE TUBING OR LOOM.

A Diam. Inches	B Diam. Inches	Ft. Per Coil	Largest Wire B&S cir. mils.	Wt. Per 1,000 Feet
1/4	17/32	250	No. 14	75 lbs.
3/8	5/8	250	No. 12	110 lbs.
1/2	3/4	200	No. 8	125 lbs.
5/8	7/8	200	No. 4	155 lbs.
3/4	1 1/16	150	No. 2	200 lbs.
1	1 3/8	100	No. 00	275 lbs.
1 1/4	1 11/16	100	200,000	360 lbs.
1 1/2	2 1/16	100	400,000	400 lbs.
1 3/4	2 1/2	100	600,000	440 lbs.
2	2 3/4	Odd Lengths	800,000	600 lbs.
2 1/4	3	Odd Lengths	1,100,000	700 lbs.
2 1/2	3 1/4	Odd Lengths	1,300,000	

In outlet boxes or switch boxes, flexible tubing is required by the Underwriters' from the last porcelain support and extending into the outlet box. In wiring finished buildings, conductors can be fished between walls and ceilings, provided each wire is encased in flexible tubing. Often also in open surface wiring, where the separation distance from the surface wired over, as required by the Code, cannot be maintained, conductors can be encased in flexible tubing. Fig. 5 shows the construction of flexible tubing of one of the common makes, and the table that follows the illustration indicates its properties. There are several different kinds of tubing—the product of as many manufacturers. Any one of them that has been approved by the Fire Underwriters' will give good service in practice.

(3) Toggle Bolts for Electrical Work.

Toggle bolts, which are used for fastening moulding and electrical devices to hollow tile or plaster-on-metal-lath sur-

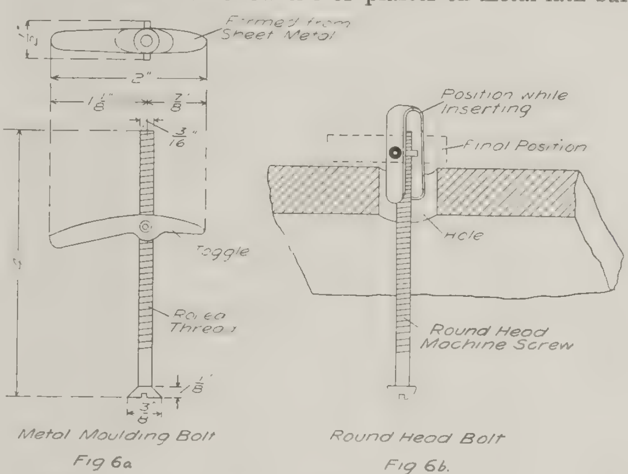
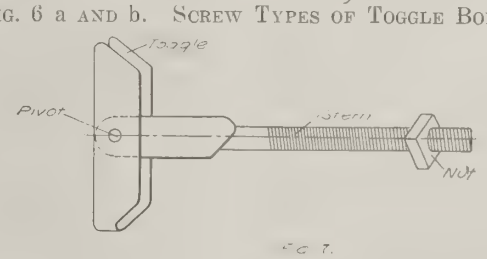
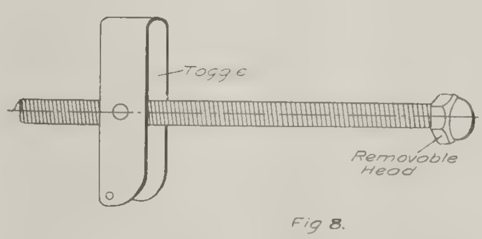


FIG. 6 a AND b. SCREW TYPES OF TOGGLE BOLTS.





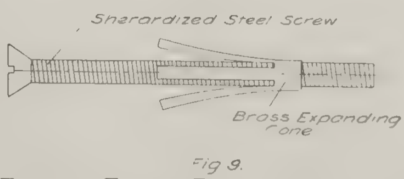


FIG. 7. NUT TYPE OF TOGGLE BOLT. FIG 8. PLUMBERS' TOGGLE BOLT. FIG. 9. CONE HEAD TOGGLE BOLT.

faces, are of two general types. The screw-type, as in Fig. 6, is the most frequently used, but has the disadvantage that if it is ever necessary to entirely remove the screw, the toggle is lost within the wall. Where the object fastened must be removed and replaced, a nut-type toggle bolt, as shown in Figs. 7 and 8, can be used. With that of Fig. 7 it is usually necessary, after the device is in place, to cut off the part of the bolt that extends, so that the thing will look well. The so-called plumber's toggle bolt, in Fig. 8, has a removable, hexagonal cap, so that the device can be inserted in the wall before the object to be fastened is slipped over the bolt. Then, on putting the cap in place, the whole bolt is backed into the wall, hiding the surplus thread from view. Cone head toggles, Fig. 9, are used principally for the erection of metal moulding and have the advantage that the toggle head will readily pass through the hole in the molding backing. Toggle bolts are made in several diameters and lengths. That of Figs. 6a and 9 are made by the National Metal Moulding Co., Pittsburg, Pa. The others illustrated are made by the Chicago Nut Co., Chicago, Ill.

(4). Wire Nails—Their Dimensions and Properties.

The electrician has frequent occasion to order wire nails for certain purposes, and to do this intelligently he must be familiar with the dimensions of each of the trade sizes,

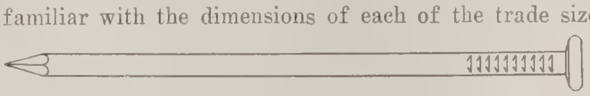


Fig 1 Common Nail- 60 Penny- 6 Inch X No 2

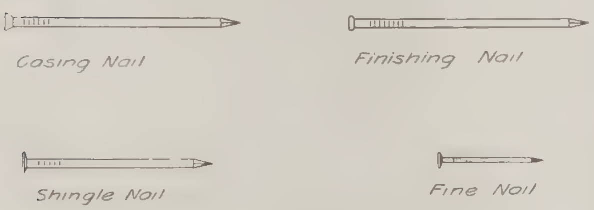


Fig. 10. Nails Used in Electrical Work.

which are usually expressed in "pennies." For instance, a size for D nail is read "a four-penny nail." For these purposes the two accompanying tables will be found valuable, in that they give the length in inches and the diameter and wire gauge for each of the sizes of nails which the electrician is apt to have occasion to use.

Table 2. Dimensions of Common Nails and Brads.

Size	Length	Gage No.	Diam. In Dec's., Ins.	App. Diam. In Ins.	Nearest B&S Gauge	App. No. to Lb.
2d	1	15	.0720	5/64	13	876
3d	1¼	14	.0800	5/64	12	568
4d	1½	12½	.0985	7/64	10	316
5d	1¾	12½	.0985	7/64	10	271
6d	2	11½	.1130	7/64	9	181
7d	2¼	11½	.1130	7/64	9	161
8d	2½	10¼	.1314	1/8	8	106
9d	2¾	10¼	.1314	1/8	8	96
10d	3	9	.1483	9/64	7	69
12d	3¼	9	.1483	9/64	7	63
16d	3½	8	.1620	5/32	6	49
20d	4	6	.1620	5/32	6	31
30d	4½	5	.2070	13/64	4	24
40d	5	4	.2253	7/32	3	18
50d	5½	3	.2437	1/4	2	14
60d	6	2	.2625	17/64	2	11

Wire nails are formed from steel wire of the same diameter as the shank of the nail is to be. Ordinary nails have a "bright" finish. Copper, brass and galvanized steel nails can be obtained. The wire from which nails are made, hence the nail diameters, are measured by the American Steel & Wire Company's guage, which is the same as the Washburn & Moen guage, and which is used by practically

Table 3. Dimensions of Casing, Finishing, Shingle and Fine Nails.

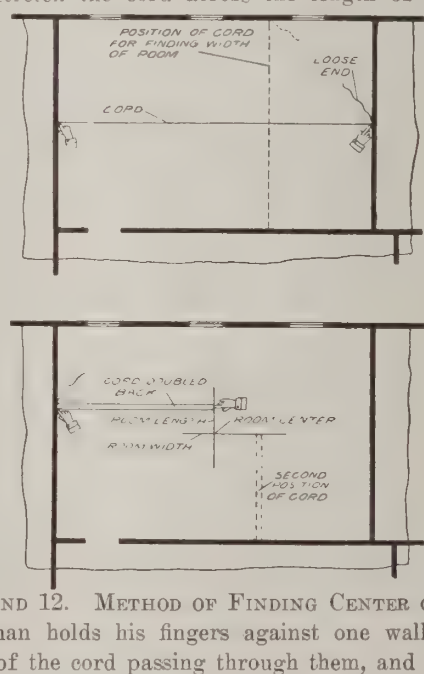
Size	Length inches	Casing Gauge	Casing Approx. No. per pound	Finishing Gauge	Finishing Approx. No. per pound	Shingle Gauge	Shingle Approx. No. per Pound	Fine Gauge	Fine Approx. No. per Pound
2d	1	15½	1010	16½	1351			16½	1351
3d	1¼	14½	635	15½	807	13	429	†15	778
3½d	1⅜					12½	345		
4d	1½	14	473	15	584	12	274	14	473
5d	1¾	14	406	15	500	12	235		
6d	2	12½	236	13	309	12	204		
7d	2¼	12½	210	13	238	11	139		
8d	2½	11½	145	12½	189	11	125		
9d	2¾	11½	132	12½	172	11	114		
10d	3	10½	94	11½	121	10	83		
12d	3¼	10½	87	11½	113				
16d	3½	10	71	11	90				
20d	4	9	52	10	62				
30d	4½	9	46						
40d	5	8	35						
*2d	1							17	1560
*3d	1⅛							16	1015

*These sizes are called "Extra Fine." †This nail is only 1⅛ in. long.

all nail manufacturers, though it is sometimes given a different name. Some of the principal wire manufacturers have decided to call it the United States Steel Wire Guage.

(5) A Quick Method of Finding the Center of a Room for Locating An Electrolier Outlet.

Wiremen usually locate the center of a room by measuring with a rule across it in both directions, and, by taking half of the length and of the breadth, ascertain the center point. The center can be located more quickly and quite as accurately by using a cord, as suggested in Figs. 11 and 12. First, as in Fig. 11, with the helper holding one end, stretch the cord across the length of the room.



Figs. 11 and 12. Method of Finding Center of Rooms.

The wireman holds his fingers against one wall with the loose end of the cord passing through them, and the helper holds his end against the opposite wall. The length of cord between the fingers of the two men is equal to the length of the room. Double back this portion of the cord on itself, as in Fig. 12, and thus ascertain half of the room length, and indicate this half distance measured from one wall, by a line on the floor. Do the same thing for the breadth of the room. The point of intersection of the "length line" and the "breadth line" will be room center. Drop a plumb bob from the ceiling to transfer the center point from the floor to the ceiling.

Protective Devices for Electrical Apparatus

BY C. C. BADEAU.

AN ACCOUNT of the fact that industrial applications of central station power are continually makin g it more important that their service be continuous, such devices as oil switches, circuit breakers and relays are being carefully installed and their operating requirements studied. The vital considerations in the successful design of thoee devices was the subject of a paper presented befsre the recent convention of the New England Section of the N. E. L. A., an abstract of which follows:

For the purpose of this discussion, all electrical machinery will be divided into five general classes: (1) Apparatus for the generation of electriciay, including generators, prime movers, etc; (2) apparatus for the transformation of electricity from one voltage to another, or from one kind of current to another, such as motor-generator sets, transformers, mercury-arc rectifiers, etc.; (3) apparatus for the utilization of electricity, such as lamps, motors, heating devices, etc.; (4) apparatus for the control of the electric current supplied by and to these various classes, such as rheostats, controllers, etc.; (5) apparatus for the protection of the various classes of apparatus enumerated. In what follows the fifth class is dealt with only, that is the devices for the protection of apparatus generating, transforming or utilizing electricity, and does not touch at all that large class of apparatus comprised under the fourth head, such as controllers, rheostats, etc., which are used not for the protection of apparatus, but for the control of the utilized current.

Protective devices may be divided into circuit-breakers, oil switches, relays and protective systems, of which relays, switches and circuit-breakers form a part. Some of the detail characteristics of each one of these classes of devices will be described. Contrary to the general impression regarding protective devices, their main use is not to open the circuit, but to keep the circuit closed, except in such cases that opening is absolutely necessary in order to prevent immediate destruction of the protective apparatus, and when such opening is necessary the device should only open the circuit of that machine which is affected.

The writer emphasizes this point very strongly, as he believes the fallacy that the function of a protective device is open to the circuit on any and all occasions is the basis of a great deal of false design and poor operation. If electric machinery would only stand overloads and short-circuit, the protective device would not be necessary. The electric station is in the business of selling current, and anything which tends to interrupt the continuity of service tends to not only cut the earning capacity of the company, but also to irritate the customer, and it is only because the enormous energies which we are called upon to handle will produce disastrous results on short-circuits or other abnormal conditions that protective devices are needed.

In the beginning, it must be clearly fixed in the mind that all protective apparatus, such as switches, circuit-breakers and relays, are used between or in connection with at least two of the classe sof apparatus mentioned in the first part of this article, that is, an automatic circuit-breaker, if used to protect a generator or the load, is between the generator and its load. If it is on a transmission system, it is between the transformer and the generator, or the transformer and the load. This fact must be considered in selecting the proper protective devices, in accounting for their action, and in designing the same, and the protective device must take into account the characteristics of all of the various classes of apparatus which affect it and which it in turn affects. For instance, the design of a motor circuit-breaker and its operation is not only affected by th echaracteristics of the motor, its size, etc., but is also affected and affected very largely and to a material extent by the size of the plant back of it and the kind of generators used in the station, and in fact, is affected by anything which tends to change the amount or kind of current or its characteristics. So that a circuit-breaker which is suitable for use with a 5-horsepower motor on a 1,000-kilowatt plant may not be suitable for use with exactly the same motor in such a situation that the energy of the plant may be pumped into it on a short-circuit, and a circuit-breaker which is satisfactory for use on a 15,000-kilowatt plant when placed at a sub-station five miles away from the generating station, may not be satisfactory for use on the same plant when placed in the generating station. It is this fact which makes the design of the protective device so varied, and which renders it necessary to obtain full information regarding the conditions before the proper protective device can be recommended.

Since the protective device is the link betwen th various classes of apparatus genrating, transforming, utilizing and controlling electricity, it follows that the successful operation of the station depends on the successful operation of the protective device, and that even after the general system of protection has been once determined, it is necessary to have devices whose details have been carefully worked out and whose principles are right, and I shall endeavor in what follows to give the user of these devices some of the principles which I believe are necessary to the production of any good electric protective device.

The first function which every device of this character has to fulfill is that of carrying the current, whether it is a carbon-break circuit-breaker or an oil switch, whether it is used for the protection of a one-half horsepower motor or a 15,000-kilowatt generator. It is always and invariably used in series with the device it protects and, therefore, is called upon to carry the same current which the consuming, translating or controlling device utilizes, and it is called upon to carry this current just as continuously as does the device it protects. All circuit-protecting devices, therefore, must necessarily be designed in reference to their continuous current-carrying capacity. In this respect there should be a broad line of demarkation drawn between protective devices and controlling devices, as controlling devices are only used intermittently during the starting period, and, therefore, are only called upon to carry the current passing through them for a short space of time. Circuit-breaking and current-carrying contacts which have proved themselves eminently satisfactory for controlling apparatus, are not always or usually satisfactory for circuit-protective apparatus, and the failure of more than one class of circuit-protective apparatus can be traced to the fact that an attempt has been made to employ controller contacts in these devices.

Of course, for carrying the current continuously there is nothing that is more satisfactory than a well-soldered joint; next to that comes a heavily-bolted joint, and a close third, a laminated joint. This is followed by blade contacts, clip contacts, butt contacts, etc., these being mentioned in the order of their efficiency as current-carrying members. As it is necessary to use a joint which can be easily closed and opened, the bolted and soldered joints, although ideal from a standpoint of current-carrying capacity, are impracticable on switching or circuit-breaking devices. The laminated brush, on the contrary, possesses the features not only of being able to make and maintain a good contact, but can be easily removed from the contact to open the circuit, and when rightly made and used, is the best current-carrying member employed, either on carbon-break circuit-breakers or oil switches; in fact, its use has become universal on carbon-break circuit-breakers to the absolute exclusion of all other forms of contact, and there is no reason why its use should not become just as univarsal in oil switches. The Sondit Electrical Manufacturing Company has used the laminated brush for years on its oil switches and believes that it is the only practical current-carrying member for use on such switches.

In any event, whatever kind of contact is used, the purchaser should insist that his contact be of sufficient carrying capacity to take care of the full-load current of the switch with a rise not exceeding 25 or 30 degrees C. A higher rise than this is not only dangerous because it limits the over-load capacity of the circuit-breaking device, but also because it heats the oil, and experiments seem to show heated oil is not nearly so effective as cool oil in quenching an arc. I emphasize the importance of the contacts on oil switches because due to the fact that the contacts on such switches are hidden by means of the oil can, and that the oil can has a considerable rediating capacity, and the oil itself is a good heat-carrying member. Some oil switches have in the past been provided with contacts which were not adequate for their service.

The oil should not be depended upon to take care of a poor contact. The cantact on an oil switch should be just as capable of taking care of its full-load current without overheating the oil as a similar contact on an air switch. It is extremely poor policy and short-sighted buying to purchase for 200 ampere service a switch which would be rated at 100 amperes in air, but when put in oil is rated at 200 amperes, because of the radiating surface of the oil can.

Under this same head of current-carrying members come such details as proper terminal connections, proper size studs, etc., and as all of these points are determined by the heat, a moderate temperature rise at full-load current with no oil in the oil tank, if insisted upon by purchasers, will do much to correct some of the faulty design which is now prevalent in the oil-switch field. Purchasers should specify both the rise at the contacts and the rise at the terminals, so that poor or inefficient contact with a large rise cannot be hidden by using heavy terminals.

After having selected a circuit-breaking device which has sufficient and ample current-carrying capacity, it is also necessary to have a circuit-breaking device which will satisfactorily interrupt the energy which may be put through the device. Volumes could be written on methods of opening electric circuits without destroying the opening device. The subject is still more or less in its infancy. Various theories have been and are contniually being propounded, and the prospective purchaser and user is apt to be confused by talk of oscillograms, tests, baffle plates, oil blasts, etc., which rival concerns in this class of apparatus are continually harping upon. There is no doubt but what some of these schemes have improved the breaking capacity of the switches, although this point still remains to be proven in many instances; but there are a few clear and fundamental rules wich can be laid down which should serve as a guide in selecting the proper circuit-breaking device, considered as a device for breaking the current only and not for carrying the current.

As regards carbon-break circuit breakers for direct current, it seems pretty well proven that if the carbons are of ample size, and if the resistance of the carbons is low at the instant of break (not when the breaker is closed) and if the break is wide enough, that such circuit-breaker when properly mounted will open any short-circuit which may be put upon it satisfactorily.

For alternating current circuits, however, carbon-break circuit-breakers are eminently unsatisfactory, even on low voltage installations, as long, flaring arcs, in part due to the discharge of the circuit, not only burn the circuit-breaker unreasonably, but also the sudden breaking of these arcs at the maximum point of the wave causes a disastrous rise in voltage; this rise in voltage being so much as sometimes to break down the insulation and start a fire. The oil switch, on the contrary, not only breaks the arc in a bath of oil, which prevents any severe burning of the contacts, but also breaks the arc always at the zero point of the wave, thus interrupting the circuit with the minimum disturbance and rise in voltage. When oil circuit-breakers are provided with the proper form of contact for carrying the current, there is no excuse for the use of carbon-break circuit-breakers on either high or low ampereage capacities, alternating current, whether the voltage be 100,000 or 100, the oil switch being in most cases cheaper and in all cases more satisfactory, and when trouble has been experienced with oil switches on heavy ampere capacity work, it is due to the selection of the wrong form of contact.

When the oil switch is used, however, in central stations where there is an enormous amount of energy back of the switch, the problem of interrupting the circuit becomes difficult, and cases of every type of oil switch blowing up at some time or other are well known. It seems, however, that other things being equal, the oil switch which has the strongest oil tank and the greatest mechanical structure, the strongest oil tank and the greatest head of oil over the break at the instant of break will open the most energy. These points which can easily be determined by an inspection of the switch, and if the oil tank is weak, either integrally or in its method of fastening to the main frame, or if the break starts too near the surface of the oil, no matter how deep it pulls into the oil afterwards, it greatly reduces the rupturing capacity.

Most of the tests made on heavy short-circuits so far, while of value to the manufacturers in showing the weak points of their design and enabling them to correct these weak points, are not of much value to the purchaser in determining the relative merits of various types of oil switches, as from an examination of these tests it seems that the short-circuits have so far been either of such a high or of such a low power factor that they were not as severe on a switch as actual service. In fact, certain swtiches which stood up extremely well under very heavy short-circuit tests recently failed completely the same week on a very much smaller short-circuit in a central station.

In general, the best test is of service, and if switches have satisfactorily been used for years on stations with a heavy kilowatt capacity back of them, this should be given due wtight.

It is not always expedient or even the best policy to purchase circuit-breaking devices which can be absolutely dependent upon to break an extremely heavy short-circuit, as the cost of real estate in some sutiatnons would render such an installation prohibitive, and as the possibility of these extremely heavy short-circuits may be exceedingly remote; but nowhere is economy so false as when applied to the purchasing of protective devices, and in no other class of apparatus should price be given as little consideration. The price of even the best and most expensive of these devices is almost nothing compared with the cost of the apparatus which they protect, and a few dollars saved on these devices may not only wreck the station apparatus, but throw an entire section of the city into darkness.

Non-automatic, circuit-protective devices or switches, as their name implies, are not affected by any automatic or abnormal conditions of the circuit which they control, but are simply opened and closed by hand. They are used where it is necessary to provide a means of readily, safely and easily interrupting the circuit at will.

Automatic protective devices operate when an abnormal or pre-determined condition of the circuit occurs. This condition may be an overload, underload, over-voltage, undervoltage, reverse current, etc., and the operation of the circuit-breaker may be instantaneous or its action may be delayed, either for a pre-determined time or for a time which is dependent on the strength of the abnormal condition of the circuit.

Contrlolling the actio nof the various kinds of oil switches and circuit-breakers are devices known as relays, whose function is to cause the switch to open at any pre-determined point or conditoin of the circuit. An entire evening might be profitably spent in the discussion of any one of the various types of relays, such as time limit, reverse current, etc., but I will only endeavor to give a few principles which will govern the selection of relays.

In the first place, let me emphasize again what I have already said,—the relay should be selected, not with the primary view of protecting apparatus, but of maintaining the service, and that the circuit should only be opened when it is necessary to do so in order to prevent the apparatus from being destroyed and the line from being shut down altogether.

Much vague talk about curves of relays and their operating points, etc., becomes clear when it is kept in mind that the primary object of a relay is not to open the circuit, but to keep the circuit closed except in cases of extreme emergency, and that it is only the inability of our generating and transforming apparatus to stand continuous short-circuits, which rendered it unnectssary to use the relay at all, as, if our apparatus would stand these short-circuits, relays and automatic circuit-breaking devices would be regulated to the limbo of lost devices.

In general, the protective systems which include relays can be divided into two classes: First, that which uses pilot wires or an auxiliary transmission system so arranged and balanced that disturbnaces in the main line are reflected in the auxiliary line, and these disturbances operate the proper kind of relays; this is usually used with ring systems and is commonly known as the Mertz-Price system. Second, the system of protection commonly used with radial or parallel distribution, which consist of relays either reverse or straight overload which are set to act selectively, *i. e.*, in a certain pre-determined order. These relays are almost invariably dampened. When so dampened, it is necessary that the damping element or the arrangement which produced the delayed action, be so arranged that no matter how heavy or severe the short-circuit, the selective action of the relays will not be disturbed, this being essential in order to maintain continuity of service, for if the relays on a heavy short-circuit operate simultaneously, no matter what their original time setting was, a heavy short-circuit on a small customer's premises may shut down the entire line reaching through the various sub-stations, clear back to the generating station, and such shut-down may be extremely disastrous.

The lamping element or device which is used on time-limit relays should also be the subject of very close scrutiny, as it is on the relay that the entire protection of the transmission system depends, and the reliability of the time-limit relay depends on the operation of this damping element. Damping elements which are likely to harden, to change in time, or be affected by moisture, temperature or short-circuits, are unsatisfactory.

Electric Water-Power Plants in Japan.

The machinery ordered about a year ago at Tokyo for various large water-power electric companies has been arriving during the past few months and the plants are being completed. The principal ones are as follows: Tokyo Electric Light Co., an extension of about 40,000 kilowatts to their first water-power electric plant which amounted, when it was installed, to approximately 20,000 kilowatts. This extension is now about finished. The Kinugawa Hydro-electric Co., of approximately 40,000 kilowatts. This plant is now about completed and some current is already being generated to Tokyo from its power stations. Katsurugawa Hydro-electric Power Co., this equipment complete being supplied from Schenectady, N. Y., the aggregate capacity being about 40,000 kilowatts. All of the machinery has arrived and the work will probably be finished within the next few months, so that a large amount of power from that source will shortly be brought down to Tokyo. The Inawashiro Hydro-electric Power Company's equipment amounts to about 40,000 kilowatts, was placed about one-half with an English firm (the Dick Ker Co.), and the other half in America (Westinghouse). This apparatus has not been shipped yet, and the company will therefore not be ready for operation until after the end of this present year.

At Yokohama a 3,000-kilowatt steam turbine generator was installed to further increase the capacity of the existing lighting plant. At Osaka there have been many additions to the existing electric railway plants and some small suburban roads have been put into operation in the last four or five months. Osaka is a very active center for the electrical business in Japan, and many suburban roads have been successfully put into operation there. On account of the large manufacturing interests developed, electric power will be largely used there in the future, and as there is a large water-power company, the Ujigawa, which is now nearing completion, and which will bring into Osaka 30,000 to 40,000 kilowatts of current, the prospects are favorable for lo wcost of light and power in that city in the future.

A Practical Design for Iron Core Reactance Coils

(*Contributed Exclusively to* Electrical Engineering).
By R. E. Uptegraff.

REACTANCE coils are becoming more and more in demand as the electrical industry progresses. In connection with the spark gap or horn gap lightning arrester, reactance coils are used to cause lightning discharges to jump the gap to ground. Coils for this purpose usually consist of but few turns of wire in the form of a spiral or helix, and have no iron core. Since a lightning discharge has a very high frequency, these few turns of wire are sufficient to set up a high reactance to passage of same, and at the same time offers little reactance to normal line current.

Reactance coils are also used in some instances with rotary converters to obtain voltage regulation. These are designed for approximately 10 per cent of the rotary voltage, and in nearly all cases have an iron core. A still further use of reactance coils is found in connection with transformers, to increase the impedance of same in order to limit the current through the transformer when a short circuit occurs.

In what follows a discussion of coils having iron cores will be taken up, pointing out features of design. A reaction coil is in reality an impedance coil; but, as the resistance function of the impedance is so small compared with the reactance, it is better known as a reactance coil. As this coil is generally used to set up a relative drop in a circuit, it is usually connected in series with the circuit. The requirements of the coil then are a given voltage across terminals of coils when the given current flows through same. That is the coil is analogous to a transformer having one winding and the exciting current equal to 100 per cent.

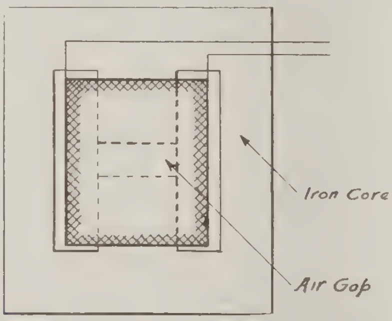


Fig. 1. Showing Design of Iron Core Reactance Coils.

An ordinary closed circuit transformer core can not be used for a reactance coil, as the magnetomotive force required to set up the required flux would be so small, due to high permeability of iron, that insufficient turns would be used to obtain the necessary inductance. Or if the right number of turns for a given voltage were used, for a given assumed flux, the flux would be much in excess of the assumed value and detrimental due to heating of the core. With such a core the volts would not vary with the current in direct proportion, but would depend on the saturation curve of the iron or steel.

It thus follows from the above that, in order to limit the flux in the core to a definite value, the reluctance of the magnetic circuit should be increased. This is obtained by placing an air gap in the magnetic circuit of sufficient length to give the desired flux. In setting out to design a reactance coil after voltage and current are known, assume a current density in iron and copper similar to those used in transformers keeping in mind losses and temperature. The cross section of core should then be found as follows:

The K.V.A. of coil = E I and (E I × St)/(2 × Sc) = the equivalent K. V. A. size of a standard transformer whose cross section may be used. Where St. is space factor of standard transformer and Sc is space factor of coil to be designed, transformer space factor can be found from a standard design and space factor of coil can be found from assumed size of wire.

The approximate value of area of core then equals,

$$Ac. = \sqrt{[(3.5 \times A'c \times E \times 10^6) \div (B \times f \times S.F.)]} \quad \ldots (1)$$

Where A′c = area of conductor; E = reactive volts; B = flux density in gausses; f = frequency in cycles per second; S.F. = space factor.

After having obtained the core area, the turns required to give the relieve volts E is then,

$$T = (3.5 \times 10 \times E) \div (Ac \times B \times f) \quad \ldots (2)$$

It now remains to increase the reluctance of the magnetic circuit by use of suitable air gap. If the iron density is assumed at approximately 11,000 lines per sq-cm., the ampere turns required for the iron part can sefely be assumed as 7% of the entire circuit, thus leaving 93% for air gap.

Knowing the ampere turns for air gap and total flux from assumed induction and area of core, the reluctance of air gap is found from the fundamental formulae,

$$R = M/\phi \quad \ldots (3)$$

Where M = ampere turns, and ϕ = total flux. It must be remembered that ampere turns and flux (3) are maximum values.

After determining R in equation (3), the length of air gap is found from the formula, $R = 0.8l/A$ ....(4)

Where l and A are length and area of gap in centimeters and square centimeters respectively. Owing to fringing of the flux in the air gap, A cannot be taken same as cross section of iron core, but will always be larger. The approximate area of air gap can be found by adding the length of gap to dimensions of core. Reactance coils with iron core can be of any of the forms taken for transformers, if the gap is kept inside the coil as in Fig. 1.

Each piece of porcelain for manufacturing insulators should be subjected to an electrical test for a period of at least one minute. The potential applied to any shell should have no relation to the line voltage at which the shell or assembled insulator is to be used, since the only object is to make sure that the porcelain supplied is of the highest quality and free of defects of any kind. All pieces should be tested so that the portion subjected to the severest service on the line is in close contact with the terminals of the testing transformer.

Requirements of Textile Mill Power Plants

Written From an Engineering Standpoint.

BY JOHN A. STEVENS.

Section 2. Plants Illustrating Points Mentioned in March Article.

A brief description follows of several installations which have recently been made and serve to illustrate the working out of many points discussed in Section 1 of this article.

In Fig. 1 is shown the plan view of the station of The Bristol Mfg. Co., Bristol, Conn., and illustrates a small and a very simple power development. This power house is wholly of monolithic reinforced concrete. The station runs in conjunction with waterwheels and is situated in an irregular corner of the property between a public street and the railroad, and out of the way of valuable manufacturing space. It provides room for expansion of the power plant up to the limits of the possible development of the property. The plant consists of horizontal return tubular boilers and a Copper Corliss engine driving a direct-current generator. The power for the pumps and auxiliaries is taken direct from engine during running hours. The waterwheels are mechanically connected to mill drives and used to fullest extent possible at all times. The motor drive on to same main shaft shafts and supply the varying make-up load.

A PLAIN GOODS COTTON MILL.

An example of a simple station for a plain goods cotton mill is that of The Salmon Falls Manufacturing Company, Salmon Falls, N. H., shown in Figs. 2 and 3. The need was for added steam equipment both to furnish more power and to relay an extremely variable water power development. This was furnished by the building of a concrete and brick turbine house adjoining the old boiler house and installing a 750-K.-W. 3600-r. p. m. General Electric steam turbine connected to a Westinghouse-LeBanc condenser. Arrangement was made for taking the heater make-up water for boiler-feed supply from the discharge of this condenser. The turbine house is built with one temporary end, space being provided for extension both of turbine and boiler rooms. The present boiler house situation was met by placing old worn-out boilers with new Manning type boilers. The method of tying with the old water power development which here proved most practicable was by installing rather large sized motors connected to the main shafting groups, and when water gave out

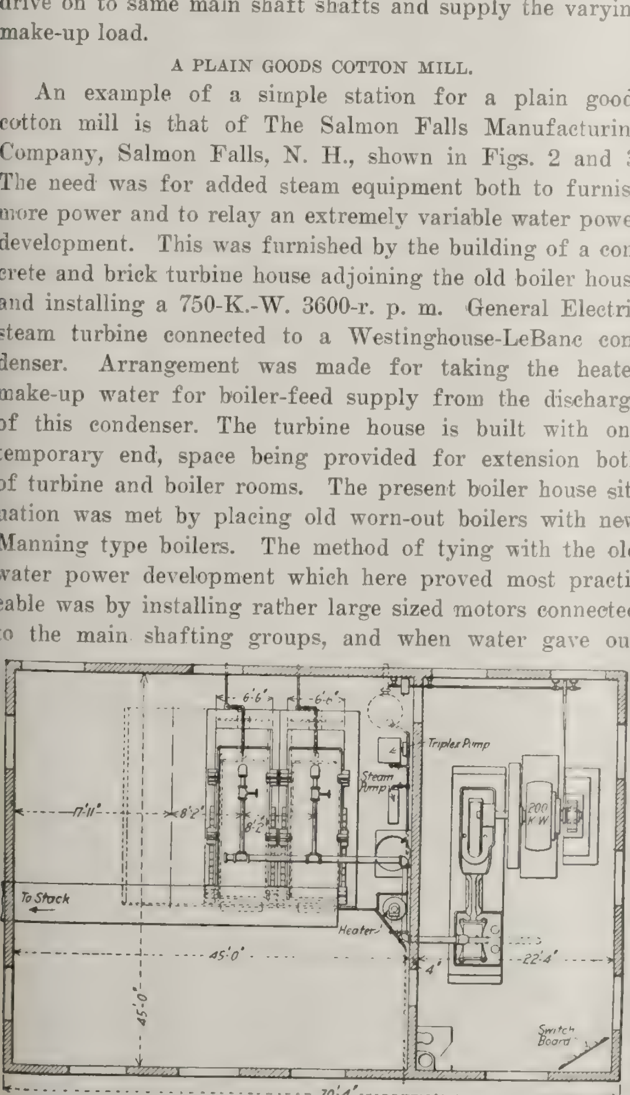


FIG. 1. PLAN OF PLANT OF BRISTOL MFG. CO.

disconnecting from waterwheel by means of clutches, many of which were a part of the old equipment.

As a part of this development, the entire mill group was equipped with an electric lighting system consisting of tungsten lamps. These replaced gas lighting from a gas plant which the owners themselves operated. By this change they secured more and better illumination and a more convenient source of light at reduced cost.

A REVISION OF WATERPOWER DEVLEOPMENT.

A recently installed hydroelectric unit for the Merrimack Manufacturing Company, Lowell, Mass., serves to illustrate certain conditions which frequently have to be met in connection with water power revision in an old textile mill when such becomes necessary. A considerable portion of the power required for this group of mills had originally been furnished from Boyden wheels connected by bevel gears to systems of main lineshafts in mill basements. As is aready the case with any water power development in that locality, this requires extensive relaying with some form of coal burning units and had been provided by means of steam engines geared or driving direct on to certain groups of this main shafting.

Economical Direct Engine Drive. This engine uses steam at pressures from 120 to 200 pounds per sq. in., according to load, and by repeated careful tests was found to have an economic range anywhere between 700 to 2000 i. h. p. and thus is well suited to the extreme variations in load which it has to meet, and exemplifies a simple and efficient means of relaying water power. The direct connection of engine to shaft, does away with transmission losses due to ropes or belts and the heavy up-keep on same. The engine might sometimes preferably be placed midway the length of shaft, but in this instance was placed at one end both better to conform to requirements as to available space and to make main high-pressure steam lines as short as possible.

Waterwheel Equipment. The waterwheels which had originally driven the picker building, and a portion of those on the main lineshaft, were entirely worn out, having been installed in the early 50's and inorder to make use of water power required replacing by a new development. Through improvements in the river bed, its average level had been lowered several feet leaving the wheel pits and tail races of these old wheels in a position where for much of the year they could not take advantage of the full available water fall. There were already in service enough good wheels on good mechanical drives to absorb that portion of water power which can be depended upon at all times and does not require relaying.

New Development Determined Upon. While it is the writer's opinion that the more direct portions of these mechanical drives cannot be improved upon by any system of electric transmission, it was desirable in carrying out the new waterwheel development to do away with the portions dependent upon much gearing and to provide for flexibility, so that this portion of power could be used where mill conditions should demand. To meet these requirements electric transmission again seemed to offer the best solution.

It was decided to drive the picker building by motor and the mill formerly driven by inclined shaft, and to make use of the main feeder and tail race of one of the old wheels so far as possible in the new development. The Holyoke Machine Company furnished the wheels which work normally under from 36 ft. to 39 ft. fall and run at 200 r.p.m., Current is furnished by a 1100 k.v.a., 2300-volt 3-phase alternating current generator, and the greater portion is used on 2200 volt motors.

A STEAM TURBINE STATION FOR PLAIN GOODS COTTON MILL.

A larger installation and one calling for considerable adaptation to local conditions is that of The Boott Mills, Lowell, Mass. This is a plain cotton goods mill doing neither bleaching nor dyeing and employing manufacturing steam only for slashing and a few minor uses. A considerable portion of its power is at times furnished by nine old vertical waterwheels subdivided into four groups and located

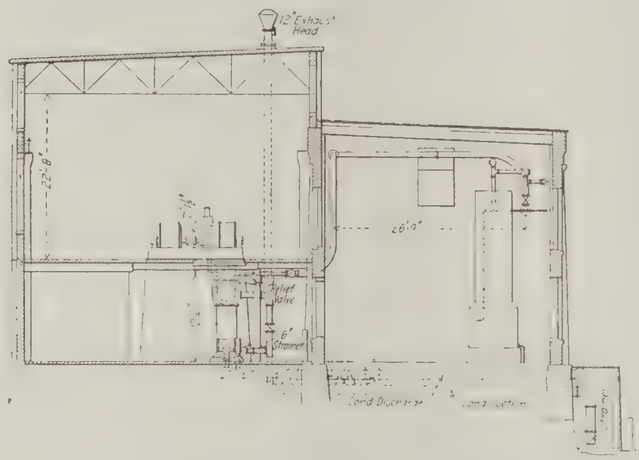


Fig. 2. Elevation of Plant of Salmon Falls Mfg. Co.

in the various mill buildings. The power thus available is not far from 3650 h.p. maximum, and 2920 normal, but decreases to between 1300 and 1400 h.p. during extreme dry weather periods, thus requiring extensive relaying. At the time when the new steam plant development was undertaken, power in addition to that of waterwheels and for the relaying of same, was being furnished by two sets of old twin Corliss condensing engines and by an extensive purchase of current from a public service corporation. The boiler equipment consisted of six B. & W. boilers of 305 normal h.p. each, and in good condition, and a good chimney 200 ft. high. The boilers and engines occupied the lower portion of one of the mill buildings. Serious shortage of power at times of low water made a large increase of steam equipment necessary. The value of the existing boiler plant together with other local conditions made it seem advisable, after careful investigation, to retain the power plant practically in its old location.

Possibilities of Low-Pressure Turbine. The possibility was considered of increasing the available power output by means of a low-pressure turbine taking steam from old engines, but was found impracticable because of the extremely advanced age and light construction of the engines. So far as the writer's experience goes this has proved to be the determining factor in a number of cases where this expedient has been considered.

The engines in many textile mills are now very old, having served the full period generally allowed to constitute the useful life of such a machine and frequently are of much lighter construction than the best engines of a later date. To install expensive new equipment dependent upon and forming a unit with such engines, does not seem justifiable, however desirable it might be were the engines and flywheel of thoroughly good construction. It was finally decided to abandon the manufacturing floors over the space originally occupied by the old engines, to wall off this portion, do away with one of these engines and to convert this space into the start of a modern steam turbine room.

Special Conditions Requiring Adaptation. Crossing diagonally under the end wall of the building and extending well under the space which must be occupied

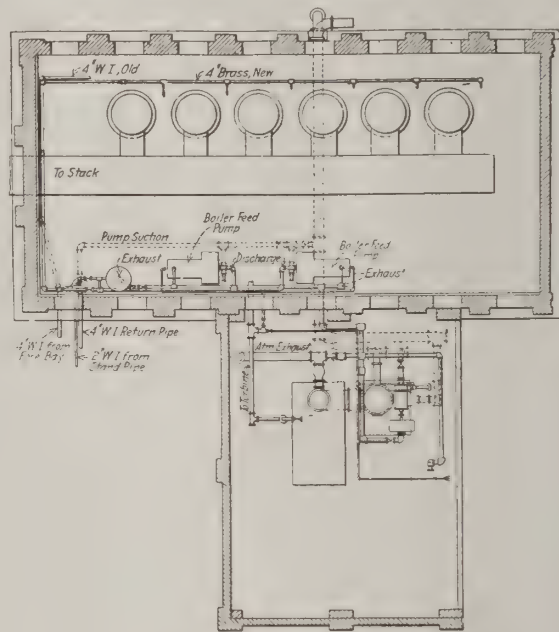


Fig. 3. Plan of Plant of Salmon Falls Mfg. Co.

by steam turbines were the two tail races of one of the group of waterwheels, and the arches of these old tail races were not of particularly good construction or suitable to form portions of foundations for modern large-sized units. The solution of the problem was found by supporting the main generating units on a system of deep transverse girders whose columns were either carried directly to ledge rock or supported on other girders over the raceway and the supports of which were likewise carried to rock.

The supporting of machines on girders made possible the placing of condensers directly under the exhaust nozzles of steam turbines and in the case of the present LeBlanc condenser unit and one future unit, the connecting of the condenser discharge through a water-sealed pipe directly to the tail race, thus considerably decreasing the work which the condenser turbine has to do.

The New Equipment. The first unit of this group a General Electric steam turbine of 3244 K. W. capacity at 80 per cent power factor, running at 1800 r,p.m. has now been in service about a year and half, and has been running constantly in a thoroughly satisfactory manner with no trouble from vibrations or other causes.

The question of securing needed additional boiler capacity has been solved for the present by installing an induced draft fan and economizer, the engine which drives the fan being placed in the basement under the main turbine floor together with the boiler feed pumps, thus grouping all auxiliaries together where they are away from the dust and dirt of the boiler room and under the constant observation of the turbine room attendant. The drips from heating systems in winter and from slashers at all times are returned to a small open heater to which fan engine and condenser turbine exhaust. Water is taken from this reservoir to economizer usually at about 90 to 100 degrees temperature leaving ample range for this economizer. The whole equipment thus forms a compact unit, and even with the light loading which at times results from the steam turbine being in part a relay to the waterwheel equipment, the over-all economy of this steam group has been excellent. A connection for stage extraction of steam for use in mill heating is provided on this machine, and the piping connections necessary in the station are already completed, but as the revision of heating system throughout the mills has not as yet been made, this has not been used.

A STEAM TURBINE STATION.

A power plant recently built by the West Point Manufacturing Company, Langdale, Ala., furnishes an example of a complete new development, situated out of the way of and apart from manufacturing buildings and with unlimited space for expansion to meet possible requirements of a series of mill groups. The primary purpose of this development was to furnish a relay to a water power development. The old power plant at this group was so situated as to have a very limited coal-handling facilities and no room for further extension, while the new location chosen is in a natural amphitheater which offers ready means for handling and storing large quantities of coal by merely dumping from a trestle. There is also an unlimited supply of condensing water close at hand. This is taken from discharge of waterwheels and furnishes an element which is lacking or difficult of access at some of the other mill groups. These two combined advantages of location thus make this the natural point for the start of a central station.

The unit first installed consisted of two 308 h.p. Heine boilers and a 750 k.w. General Electric Company 3600 r.p.m. 2 stage steam turbine connected to a LaBlanc condenser and with generator for 600 volts. As there was good prospect of growth in the immediate future, the boiler house was built large enough for five units and the turbine room made sufficient in size for one additional larger unit. The three extra boilers and a 2000 k.w. steam turbine are now in process of erection in these spaces, as is also a permanent brick chimney to replace the temporary steel stack which served the first installation.

Moisture in Steam Leaving A Turbine. The writer was much interested to obtain as accurate information as possible concerning the quality of this moisture. In order to secure results a set of tests with a turbine running under ordinary mill conditions exhausting to the low pressure system, and with loads varying over a wide range, was made January 19, 1912, by Prof. Charles W. Berry, of the Massachusetts Institute of Technology, using for this purpose a constant pressure superheating calorimeter. The steam at throttle of this turbine was slightly superheated, the amount being about 10 deg., as is the usual condition at this plant.

The quantities of moisture found were as follows:

With Load in K.W.	Moisture per cent.
625	4.07
560	4.48
410	4.98
170	5.49

As would be expected, the per cent of moisture increased as the load decreases, the radiation losses of the turbine remaining practically a constant.

Portion of Steam Chargeable to Power. Adding to this, in the worst case, 5.5 per cent of moisture in steam leaving turbine for manufacturing use, the percentage representing the difference in heat energy between a pound of dry steam at manufacturing pressure of say 6 to 7 lbs. gage, we have about 9 or 10 per cent. Then increasing this by a liberal allowance for all losses and varying conditions, it seems to the writer that the quantity of steam which should be charged to power purposes when being exhausted, does not exceed 12 per cent and that for the ordinary pressure ranges with practically dry saturated steam from boiler this value may be used.

ELECTRIC TRANSMISSION AND RELAY POWER.

Lest it should be thought that the writer unduly favors electric transmission, as most of the examples above mentioned, have to do with the use of this method, it should be mentioned that such is not the case. In these cases flexibility was one of the most important factors and was most advantageously secured through electric transmission. The greater portion of the plants, however, still contains older groups on direct mechanical drives. Where such drives are now in position, are reasonably direct and well constructed, and where loads are fairly constant, their abandoning would certainly in many cases be undesirable.

By relay power is meant the power to supplement the usual or cheapest form of power and to take its place in case of failure. So far as the demands of textile mills are concerned, such power may be subdivided into two groups because of the different conditions affecting them. Relaying almost always serves to relieve (a) either a shortage of water power which can be definitely foreseen and will take place in all plants in a given vicinity at the same time, or (b) to furnish an added source of power available during times of accident to the ordinary equipment. It is then merely a form of insurance against events which can be expected to take place at no regular interval or predetermined time.

Auxiliary Equipment as Insurance Against Shutdowns. When we come to the second form, however, it has in times past been rather usual for textile plants to make little provision for added units to meet conditions of accident. This is due to the long period of shutdown during each 24 hours, allowing for ordinary repairs, and to the greatly increased cost for maintaining such equipment. In order to protect fully a group of independent plants, duplicate equipment would be required for their whole combined output, but this same group, if united together and provided with one source of relay power, could be, practically speaking, fully protected by an equipment very much less than that of the combined plants. The proportionate quantity of such equipment required to give protection would decrease rapidly with an increased number of plants served.

This supplying of low cost power connections, serving merely as an insurance against accident to the ordinary equipment, is a phase of power plant development which it seems to the writer should receive more attention than it has in the past.

The Public Service Station as a Means of Supplying Insurance. The public service corporation would seem to be in a position to undertake this service at rates which would be attractive and profitable both to itself and to those it would serve. With few exceptions, however, so far as the writer knows, little or nothing is being done by them at the present time to develop this form of business. For the most part they at present insist upon a minimum charge which is practically the equivalent of all fixed charges on an equipment great enough to handle the full connected load of each unit served. Such rates are of course in no way attractive to the manufacturer as under these conditions he can as well supply the added equipment in his own station and have it where he can control its use.

Private Stations Serving Groups of Owners. In certain sections o fthe country there is a growing recognition of the advantages of properly located groups of manufacturers combined to produce their power in a single station of large size rather than in individual stations.

There seems no reason why this idea should not prove of advantage in many cases with textile manufacturers. Such stations could be jointly maintained and run by them with very little increased overhead or supervision charges, as there would be no expensive sales, inspection and advertising departments. The securing of relay power in this manner as an insurance against expensive shutdowns should be particularly attractive. There are of course many difficulties in the way of carrying out such a scheme, principal among them that of having a group of individuals ready to act at a given time and the securing of rights of way for transmission lines. In connection with the latter strenuous opposition would sometimes have to be anticipated. The writer does not himself expect to see rapid developments along these lines, but nevertheless, believes that there will and should be a growing recognition of the wastefulness of some of our present seemingly necessary expenditures for duplicate power developments.

It seems reasonable that much more than in the past such portions of power required by textile mills as cannot be made by a by-product of some other process will be produced in large central stations with the coal-burning units well removed from centers of population and so located as to give access to coal cheaply handled.

Fuse Protection of High Tension Rural Lines.

(*Contributed Exclusively to* ELECTRICAL ENGINEERING).

BY H. W. YOUNG, PRESIDENT DELTA-STAR ELECTRIC CO., CHICAGO, ILL.

The increasing tendency toward the extension of high-tension lines into rural or farming communities has emphasized the problem of adequate fuse protection. This protection must be such that it will interrupt the circuit quickly and without permitting the disturbance to communicate back to the generating station. If the arc incident to opening of a high-voltage circuit is not instantly suppressed, it wil result in tripping the station circuit breakers and interrupting the entire system.

In securing reliability of service, the localization of the effect of breakdowns or failures is one of the most important problems. Experience proves that in commercial operation of high-tension systems, overload or short circuits will sooner or later occur. If the generating system supplying the loads has large capacity, the stresses due to the short-circuit currents will reach enormous values and frequently cause serious damage. To meet commercial conditions, the successful fuse must be of weatherproof construction, easily installed, replaced and give an absolute indication of its condition without the necessity of testing, to see if the fuse is blown or not.

Among the recent developments of high-tension circuit interrupting devices is the carbon-tetrachloride fuse, a commercial installation of which is shown in the accompanying illustration. The fuse mounting consists of two petticoat insulators mounted on a steel base in turn secured to the cross arms. From these insulators extend vertical tubular supports at the lower ends of which are suitable clips for reception of the circular fuse chamber. This chamber is made of glass, and contains a short fuse wire held under tension by a spring. The entire tube is filled with a carbon-tetrachloride solution, the insulation strength of which is approximately 250,000 volts per inch.

When the fuse blows the spring contracts, and by means of the special liquid director projects a stream of liquid into the arc, and suppresses it on an average of 13/1000 of a second. The arc incident to melting of the fuse is therefore simply treated as a fire which is quickly quenched by the fire-extinguishing liquid. Owing to the small amount of metal available to melt or voltalize, the generation of gas volume is small and the explosive effect correspondingly reduced.

As an example of the effectiveness of this what might be termed an electric fire-fighting equipment, reference is again made to the accompanying illustration. This shows a set of three 10 ampere, 33,000-volt, fuses which cleared a three-phase line, tapped from a main line having a generating capacity of 15,000 Kva. The fuses cleared the short circuit without damage to the glass chamber and without disturbing the main line. The circuit breakers at the stations were not tripped and the whole trouble was cleared so quickly and effectively that the first knowledge of it at the main station was a report from the customer that no power was available.

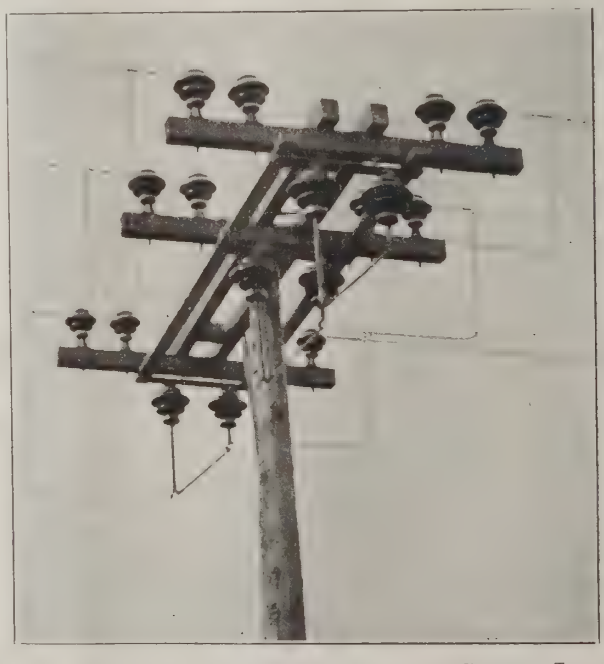


FIG. 1. SHOWING USE OF HIGH TENSION CIRCUIT INTERRUPTING DEVICE.

The development of this new and effective circuit interrupter will render possible many high-tension extensions, which heretofore seemed impossible owing to the high initial and maintenance cost of protective equipment. It is especially well adapted for the protection of outdoor substation where the cost per Kw. must be kept at a low value. Many other forms of fuse mountings are possible both for indoor and outdoor service, and as the high-tension field develops the carbon-tetrachloride fuse will undoubtedly play an important part.

Prof. Vladimir Karapetoff Lectures at Georgia School of Technology and Other Southern Colleges.

Prof. Vladimir Karapetoff, of the electrical engineering department of Cornell university, has recently completed a lecture trip through the South speaking at several colleges, including the Georgia School of Technology, Clemson college, Alabama Polytechnic institute and the University of Tennessee. At each of these places he gave three lectures, one on electrostatic and magnetic circuits, one a general address on the development of personality and the third a lecture-recital on musical expression. This is indeed a wide range of subjects but such a range the capability of this versatile scholar covers. First of all, he is a genial gentleman, second, a distinguished scholar, third a master musician and fourth and in a greater capacity than all these, he is one of the most prominent young electrical engineers in this or any other country.

Prof. Karapetoff was born in St. Petersburg, Russia, in 1876. In 1897 he graduated from the Imperial Institute of Ways of Communication, St. Petersburg, receiving the degree of civil engineer. It was not until two years later that he directed his attention to electricity by entering an engineering school in Darmstadt, Germany. For four years, beginning with 1897 he taught electrical engineering in three different colleges in St. Petersburg and lectured to evening classes of the Imperial Gun Works. In 1904 he

VLADIMIR KARAPETOFF, PROFESSOR OF ELECTRICAL ENGINEERING, CORNELL UNIVERSITY.

was made assistant professor of experimental electrical engineering at Cornell University and is now professor in this department. During that year he married Miss Francis Lula Gilmor of Pittsburgh.

While as will be noticed Prof. Karapetoff has spent most of his time as a teacher he has not gained his reputation as an engineer within the walls of an institution of learning. The following work accomplished during summer vacations and the variety of same, speaks of the popularity of his engineering ability and faculty of successfully doing practical things: In 1893, constructed a railroad in Transcaucasia; 1894, assistant locomotive engineer between St. Petersburg and Moscow; 1894, surveyed a railroad to Archangel City; 1895, maintenance of way and repair of buildings for St. Petersburg-Moscow Railway; 1896, with the Trans-Siberian Railroad on Lake Baikal; 1899, made power plant estimates for the Lahmayer Electric Company, Frankfort, Germany; 1900, working on harbor electric crane equipment for the Allgemeine Elektricitats-Gesellschaft, Germany; 1906, designing electrical machinery for the Allis-Chalmers Company, Cincinnati, Ohio; 1907, special testing engineer, Niagara, Lockport & Ontario Company; 1909, designing electrical machinery for the Westinghouse Electrical & Manufacturing Co., Pittsburg, Pa.; 1910, designing electrical machinery for the General Electric Company, Schnectady, New York; 1911, with J. G. White & Company, New York City.

He is a member of the American Institute of Electrical Engineers, an author of engineering books and books on general topics and a contributor to the technical press.

Mississippi Electrical Association Question Box.

Under this heading will appear each month questions and answers to questions from members of the Mississippi Electrical Association. All readers are invited to discuss any question or topic presented. Address all correspondence, including questions and answers, to Clarence E. Reid, Question Box Editor, Agricultural College, Miss.

Unanswered Questions.

QUESTION NO. 17. A small 4-pole exciter is direct connected to a 6-pole revolving field alternator, running at 1,200 revolutions per minute Alternate quarters of this exciter commutator become blackened rapidly after cleaning and the negative brushes wear down excessively fast. The armature is mechanically centered in the field frame. Will someone please suggest reasons for the above behavior? E. F. M.

QUESTION NO. 18. Is it possible to replace brushes in a four-pole generator, where there is only one brush to a set, without shutting down? Is there any objection to this practice, if possible.

QUESTION NO. 19. Is it considered good practice to use two transformers connected "open delta" or "V" connection, instead of three transformers, connected in "delta" for 3-phase, step-down transformation? What are advantages and disadvantages of this connection?

QUESTION NO. 26. With a 3-phase synchronous motor (rotary converter) running on a generator of about the same capacity as the motor, 3-ammeters are in circuit, a voltmeter which can be applied to each phase, and two indicating wattmeters. The three ammeter readings differ considerably, the three voltmeter readings differ slightly, and the two wattmeter readings differ, sometimes much, sometimes little, depending on the strength of the rotary's field. Why should the readings of the ammeters differ among themselves? Why should the voltmeter readings differ even slightly, when the open circuit readings on all three phases of the generator check very closely? A three-phase power-factor meter, without series or potential transformers, is also connected in this circuit. How would the readings of the ammeters, voltmeters and wattmeters be used to check the power-factor meter?

QUESTION NO. 21. Are the regulation and efficiency of auto transformers in general better than separate coilwound transformers of same general design? If so, why? In a 10-kw. auto-transformer of 200 to 50 volts, what would be the current in each part of the auto-transformer?

See questions unanswered—Nos. 10 and 16, in March issue.

New Business Methods and Results

Representing Interests of Central Station, Electrical Jobbers, Dealers and Contractors.

The Power Engineer—His Field and Opportunities.

The marketing of any product, electrical or otherwise, requires in varying measure two qualifications. These are selling ability and a technical knowledge of the goods and of the conditions under which they are used. Practically all electrical business secured calls primarily for salesmanship, a good deal of it requires a fair degree of technical knowledge, while a certain amount can only be secured by the use of highly specialized engineering ability. Unfortunately, we do not as a rule find these two qualifications developed to a high degree and combined in the same individual, for the simple reason that their highest development can only occur in different types of men. Nevertheless, it is surprising how much business can be done by a salesman almost totally devoid of any technical knowledge of his product, and o nthe other hand it is surprising to find how many good engineers are poor salesmen. These facts do not in any way put a premium upon ignorance, for any salesman will find technical information of great benefit to him, and we would strongly recommend central station solicitors to study up this side of the business all they can. The "natural-born" salesman should, however, work for his greatest development along selling lines.

The principal applications of electricity are in connection with light, heat, power and chemical processes. A salesman can sell current for one of these purposes about as well as the other, but for the sake of convenience central stations of any size usually have separate men on power work, not particularly on account of their technical qualifications, but simply because they become more familiar with power applications, and are more at home in the handling of them than a general solicitor. However, in the sale of electricity, as well as in the sale of other products, we come to a point where no further business can be secured by salesmanship alone. This is the time then to call upon men with a technical knowledge of illumination, power, heating, and electro-chemistry.

In the field of power applications, for example, we can readily see that it takes little if any technical ability to introduce electric power in a factory or shop where the owner or manager recognizes that it is an improvement on the source of power he is using and where the only question appears to be that of the investment required. This is a problem in pure salesmanship, which in its last analysis is simply inducing the party to spend money for the sake of saving more money. Of course, engineering information is desirable even in these cases, and necessary to select the proper equipment and see that it is correctly installed. If, on the other hand, the owner thinks that his present power equipment is as good or better than he can secure with electricity, or if he think the expenditure for new apparatus to be unwarranted, and requires proof, the problem becomes largely one in engineering, and calls for a complete analysis of the factors involved, worked out on a scientific basis. This is something that the average salesman cannot do, and it is not advisable for him to attempt it, for his time is worth more as a good salesman than as a mediocre engineer.

The opportunity for power engineering depends of course upon the size of the central station and the character of the community served. The principal thing which determines it is, of course, whether the additional business secured will justify the expense, since there is no doubt that the employment of a power engineer will result in getting business that the salesman alone cannot get. It goes without saying that wherever there is any considerable amount of manufacturing, that engineering ability is needed. Where the industries are driven by steam or gas, there is need for an accurate analysis of the conditions with a view to getting as much of the business as possible. Also there is sure to be frequent need for advice among existing customers in regard to additions, extensions, new applications, changes in equipment and other engineering problems. There is further a distinct advantage in having a man technically familiar with the subject on hand, even where the problem may be largely one of salesmanship, from the fact that an evidence of knowledge breeds confidence. Entire confidence cannot be expected in the statements of any one whose manner shows that he is treading on unfamiliar ground, and for this reason the simple presence of an engineer may help salesmen greatly in closing up deals.

As to the field for power engineering with transmission companies, that is, those who manufacture power and sell it in bulk to be redistributed, this depends upon the factors we have already mentioned. The difference in conditions is apt to be more in degree than in kind. Where the distributing companies serve manufacturing communities they should, if possible, have power engineers of their own. Very often the transmission company can profitably employ an expert to consult with local men over its entire field. Where transmission companies sell directly to consumers it is usually to large concerns that have their own engineers. The manufacturers of motors and electrically driven machines usually have engineers, whose services are available to central stations having prospective power jobs, and such engineers are of great benefit to small companies who cannot afford power experts. Furthermore, these men have a broader range of experience than the employes of a local company can have. For instance, a central station may have to figure on electric drive for a silk mill, and there may not be a similar case within hundreds of miles. In such a case the manufacturer's engineers would be prepared to give exact technical information on the entire subject and point to cases where electric drives were in successful operation. In general, however, it is better to use local men wherever possible, for they can usually make a stronger impression than men from out of town.

Comments on Articles in Last Issue.

The many interesting articles presented in this department of the April issue gave practical ways and references to what can and has been done in a commercial way to develop central station business. We are proud to say that those articles confirm the statement by Mr. Williams that new business managers in the South are very much alive. We are especially pleased to note that both of the companies in New Orleans are making strenuous efforts of a decidedly commendable nature to impress the value of electric service upon the public. In this and similar instances, there is no doubt but that sales effort is greatly stimulated by competition, and while we deplore the duplication of investment and other fixed charges in maintaining rival electric light companies, yet it makes the new business manager hustle, and is often the means (not especially in the case of New Orleans) of introducing up-to-date methods that would never have been used without competition.

We note with approval that publicity and education are given a prominent place among new business methods. It is of the greatest value to keep the public frankly and fully informed as to the plans and policies of the central station, as well as to enlighten them as to the most efficient uses for current, and the newest electrical appliances. It must be remembered, however, that publicity and education can only arouse interest to a certain point with some people, and that if it be stopped there, much of the fruits of the labor is lost. In general, it may be said that for every person who will act as a result of these methods there is another who will yield if personal solicitation be added. So that in addition to all advertising and circularizing, electrical signs and window displays, the buttonhole interview is essential to pull all the business that there is to be had. It is easy to be spectacular, but harder to keep it up. This is not meant to discourage special efforts, but to warn against arousing interest and then letting it evaporate without taking full advantage of it.

THE APPEAL TO THE EYE.

The show window, the electric sign, and latest of all, the moving picture display, fall into a class of appeals to the eye. We note with interest the varied and interesting window displays described by Mr. Ousley, of Louisville, for it has been learned that the results were all, if not more, than he hoped for. If it be in order to give a word of suggestion here, we would warn against irrelevancy. Try in all cases to have your display closely related to the goods you want to sell, a point carefully touched upon by Mr. Ousley. Much valuable window space is taken up with something entirely foreign to the business carried on, and while people stop and admire, they do not buy, for the reason that there is no appeal to them to do so. Your window is your salesman—make it talk for you. An example of one that talks is shown in this section, this issue, as described by Mr. Hogshead.

The use of the moving picture film is in response to the popular demand for something in motion. Unfortunately, this is not always a sensible demand, for a crowd of people at an exposition will gather around a noisy little miniature railway built on an impracticable plan, while huge and imposing exhibits of iron, steel, coal, or agricultural products and other things representing the real wealth of the country will be passed unnoticed. Men and women will stand out of doors on a wet, cold night and look at moving pictures on a screen, while the same matter will not receive a second glance in an advertisement. A whirligig, a flashing sign or a twinkling light will attract the eye, when a well-arranged show window will not. For these reasons, therefore, an educational propaganda must be developed along popular lines, to some extent at least, and it is quite likely that a judicious use of moving pictures will be of benefit if an analysis is made of the commercial appeal. The question to be decided in connection with the use of motion pictures is whether those people who have a great deal of time to spend looking at them have much money to spend for the things advertised.

EDUCATIONAL LITERATURE.

The magazine idea has been exploited in a number of different ways, and while it is true that any publicity at all is of some value, some is of much more value than oth ers. We are very much inclined to doubt that the promiscuous scattering of a cheap "Electric Magazine" is effiicient advertising. The danger lies in making the publication so cheap that it becomes a mere dodger and hence no value placed upon it. Futhermore to be of any value at all, advertising must have a direct personal appeal. Our readers have undoubtedly seen some of the so-called periodicals gotten up in such a style that they can be syndicated, composed largely of "national" advertising material and a quantity of what is technically known as "filler," and filler it surely is. The result is that no matter how nicely the scheme may be worked up, it bears the stamp o fbeing "ready-made." The same thing is largely true of the so-called "electrical page" idea. This remark is not added to discourage our friend from Texas in his venture; we admire his energy, yet we believe that a page gotten out with no local news matter whatever, but with plenty of "national" advertising, and "national" news as editorial matter, cannot in the nature of things have a strong local appeal. On the other hand, it would seem sensible to expect that a few pointed advertisements with local news items mingled among the regular reading matter of the paper, would be far more effective.

Our suggestion for an electrical periodical would be a live, strictly local paper, with very few, if any, advertisements. It should give each week news of company happenings, notes on the progress of construction work, new installations, personal items regarding employes, and other items of interest to the people of the particular town or city. The advertising matter could be disguised as reading matter, and contain a personal appeal. This we believe legitimate for the class of publication distributed free. For instance, such items may announce demonstrations, describe special window displays, offer souvenirs to lady callers on a certain date, describe new and interesting applications of electricity, and at appropriate times of the year call attention to irons, fans, vacuum cleaners, luminous radiators, percolators, etc. A small amount of humor, anecdotes, etc., may be added to make it readable, making up a paper that a person would be willing to pay at least 50 cents a year for as a subscriber. Then send this paper by mail free of charge to customers only, and employes, charging any others that might desire it, to keep down the waste circulation. In this way the paper would be valued, it would be read, and it would, we believe, bring returns worth many times its cost.

A TACTFUL PLAN.

One of the best ideas that has come to our attention is that of a company in the Middle West that has inaugurated a "Service Department" having its own chief and assistants. The sole object of this department is to improve the service of existing customers. The plan is to call on every customer, according to a definite schedule, for the purpose of inquiring if he is satisfied with the service, and to suggest ways of improving it. While the representative of the company does not approach the customer as a salesman, it can be readily seen that these calls result in the sale of appliances and the extension of the services, for a large part of the educational work carried on by this department is made up of explanations of how various operations can be most economically and conveniently performed by electricity. The representative will also recommend lamps of higher efficiency, where needed, explain the efficiency to be gained by the use of proper reflectors, tell the customer about the Hylo lamps, and the Dimalite, and advise the use of a pilot lamp for the cellar light, and other things which make for good service, but which the company has no pecuniary interest whatever in recommending. This action is sure to have a good effect on the customer, as it shows that the company really has an interest in giving him good service. In general, it may be said that most companies make the mistake of neglecting the customer, and we may safely lay it down as a general rule that it is more profitable to increase the consumption of an old customer by 10 Kw. hrs. per month than to obtain a new customer for a like amount.

KEEPING TABS.

Mr. Rhodes' flag system brings some thoughts to mind. There are many sorts of systems in use by central stations to take care of customer and prospect records. Many of these are too cumbersome to be effective, others require a disproportionate amount of clerical work to keep them up, others are badly arranged, and some do not give adequate information. In general, the natural tendency in systematizing is to go too far. Some one has said that "any bungler can devise complications, but it requires genius to reduce them to simplicity." We may then lay down another general principle, namely, whatever is a bother is of no use.

That the geographical arrangement of customers and prospects is good is becoming an accepted fact. From the standpoint of the central station, the building is the important thing, the occupant simply an incident. There are two or three reasons, however, why the contract form itself should not be used in any index system. In the first place, it is difficult to get a contract form on a 4 x 6 index card without greatly contracting the spaces for writing, and omitting lines for information that should be given. This leads to scribbling on the margins and across the corners, making a mussed-up looking card and interfering with proper filing. Furthermore, going over the cards wears them, and since the contract is an original document it should be filed in the office of the treasurer or auditor, where it will not get soiled by frequent handling.

The most convenient form that has come to our attention for geographical filing is shown in Fig. 1. Customers are subsequently entered in the spaces provided, and one can tell by looking at the card who has occupied the building for years past, how long they remained, the nature of the contract, and the connected load. To avoid a large number of cards in the case of an apartment building, the form shown in Fig. 2 was devised. The rates for domestic service would usually be the same, and it is only necessary to enter the name of each occupant in pencil with the date connected to have a complete record. When a change occurs, the name is erased.

Mr. Rhodes' plan of keeping "tabs" by means of tabs is also good. Another effective plan is to enter all disconnections in a book in order of date. Each solicitor looks over this book daily and notes those occurring in his district, initialing same and reporting as soon as possible. The clerk then makes the proper entry opposite the name, such as "vacant," "will not use," "using competitive service," or "prospect for reconnection." At the end of the month these are summarized for each district and the solicitor is given a list of all that have not been secured, refused or lost to competitors, with a request to report. The next month this is repeated, with additional locations cut out,

Address _ _ _ _ _ _ _ Town _ _ _ _ _ _ _ _

Name	Bus.	Rate	Guar.	Installation	Term	In	Out

Remarks on Other Side

Fig 1.

Location _ _ _ _ _ _ _ Town _ _ _ _ _ _
_ _ _ _ _ _ _ _ _ _ _ Apartments

Apt. No	Location	Name*	In*	Out*	Former Occup't*
1	1st Rt				
2	1st Lft				
3	2nd Rt				
etc	etc				

* To be written in Pencil.

Fig. 2.

Forms for New Business Records.

and so on, each place being kept sight of until the business is either secured or definitely lost.

SOLICITORS' MEETINGS.

Most commercial managers try to get their men together at intervals varying from every day to every month or two. The character of these meetings varies widely. In some cases we find a daily inquisitorial period. In others a meeting once a month or so, held on company time, when the commercial manager gets the men together and talks to them like a "dutch uncle." Again we find evening meetings more or less attended, with papers and discussions and sometimes a lunch. All of these may be effectively made of use, but the best results can be secured, we believe, by aiming at three things; first, to develop salesmanship; second, to inspire loyalty to the company, and third, to furnish a certain amount of elementary technical knowledge needed in the work. Solicitors are neither children to be coddled, nor horses to be driven. If a man has the germ of salesmanship, give him some initial encouragement, help him over a few of the hard places. Impress on him the fact that it is steady work that counts, that the larger the number of door bells he rings, the more business he will get, that a great many more people admire tactful persistency than will be offended by it. In effect, put him out to sink or swim, and the probability is that he will make good, or the reverse, in a short time. A little round table talk before starting out in the morning is good, but it should be brief and confined to things of immediate interest. A general meeting can be profitably held once or twice a month, at which a chance should be given for discussion of the work, occasional papers on live topics, interesting talks by outside men, and other features as opportunity offers. The men should be made to feel that it is their meeting and that its success or failure depends upon them. Where a company section of the N. E. L. A. can be formed, even with but a few members, these meetings can be held under its auspices.

THE THIN EDGE OF THE WEDGE.

The electric service table, mentioned by Mr. Clement, should be very valuable in an educational way. There are many people living in rented houses who would willingly buy a washer, or a cleaner, or an iron, but who will not go to the expense of putting in wiring. This piece of apparatus would seem to take care of many such cases. When these people move, buy or build, they will have a tendency to see to it that they are provided with wiring. It is better to sell tenants of this character some electrical equipment rather than to wait on promise of a permanent location, when very likely the expense of purchasing or building a house may prevent them from the purchase of such electrical equipment. A. G. RAKESTRAW.

Geo. W. Hogshead, Contract Agent, Roanoke Railway & Electric Co., Roanoke, Va., Writes of Scheme to Increase Lamp Sales.

The illustration below shows a window display arranged in the offices of the Roanoke Railway & Electric Company showing the sizes and economical use of tungsten (Mazda) lamps. At the left a 32-candle power carbon lamp is displayed against a 40-watt tungsten lamp of about the same candle power. The card above the lamps explains that the cost of burning the carbon lamp 1,000 hours is $8.00, while the cost of burning the 40-watt tungsten 1,000 hours plus the cost of lamp is $3.50, showing a saving of $4.50 by using the tungsten unit. The center board under the heading, "Mazda Family," shows the different sizes and prices of tungsten lamps. These lamps are connected to a flasher, which causes each lamp to come on separately and then all together. The board at the right shows suitable reflectors for the different sizes of lamps with their cost.

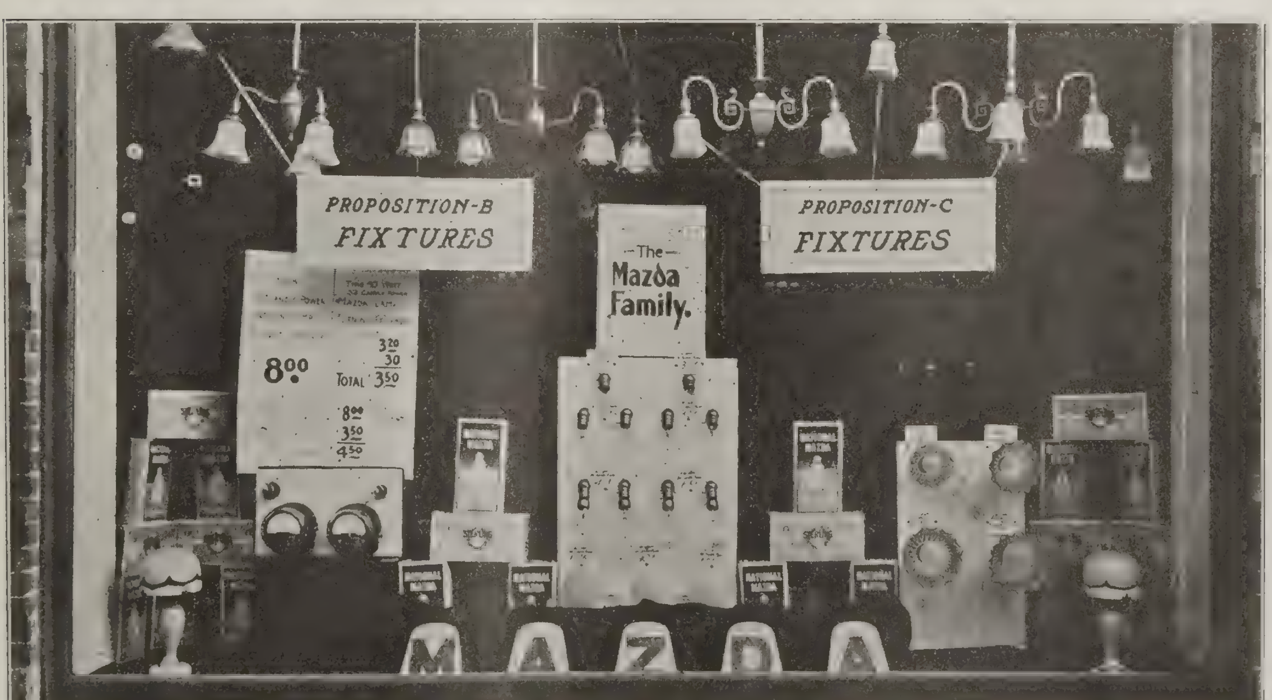
This display has been used about two weeks at this writing, and an increase of lamp sales of about 15 per cent has resulted. The display is complete in itself and the economy of the use of the tungsten lamp so plainly brought out that those viewing the display are at once convinced.

Publicity Committee of Electric Vehicle Association Starts Second Year's Campaign.

The publicity committee of the Electric Vehicle Association of America, through its chairman, F. W. Smith, of the Union Electric Light & Power Company, St. Louis, Mo., has announced the details for the second year's co-operative publicity campaign. The interest in and the popularity of the pleasure and commercial electric is now reflected in the special sales activity exerted by central stations throughout the country as well as in the provisions that are being made to accommodate owners of electrics, such as establishing charging stations and garages, catering especially to repair and charging of electrics, and the employing of a battery expert to instruct owners in the care of batteries, etc.

The prejudice against the pleasure electric due to some of its early faults is now worn away by the satisfactory service of the new models. The interest that has brought this type of vehicle to the front has already gained a permanent hold on vehicle users and dispelled the idea that the electric is a fad. A good shade of the credit in establishing this public confidence in the electric should properly be given to the association for through its publicity campaign of an educational nature the public has been given an assurance that the electric proposition has back of it stability and success.

It is the intention of the committee during its second year to make its advertising more specific and a direct appeal to the purchaser, giving facts, figures and data with respect to the electric vehicle, both commercial and passenger. Two booklets will be published, "The Story of the Electric Pleasure Vehicle," and "The Story of the Electric Commerical Vehicle." These will be in attractive form and



LAMP DISPLAY OF ROANOKE RAILWAY & ELECTRIC CO.

will contain the names and addresses of those subscribing to the campaign fund. Each advertisement will include a coupon with provision for the party in interest to write for these booklets. Following receipt of request the name and address of the inquirer will be transmitted to those interested in commercial or pleasure vehicles, a sthe case may be.

Subscriptions to the association's campaign are largely voluntary, coming from members of the Electric Vehicle Association, manufacturers of electric vehicles and accessories, central stations and others interested. From the standpoint of those interested, the cause is one that will eventually bring a return exceeding the subscription many times. It therefore deserves the consideration of all, inasmuch as the momentum that the interest of last year has acquired must begin to show results in sales and financial assistance is now essential to develop the industry rapidly and thus accelerate the returns.

The 1912 Earnings of Central Station Companies in Georgia.

We present here a table showing the 1912 earnings of the street railway, gas and electric companies of the state of Georgia, compiled by the state railway commission for its annual report which will be issued sometime in June of this year. From this data it is seen that the largest power, light, gas and street railway business is done in and around Atlanta by t heGeorgia Railway & Power Company and its subsidiaries. These include the Atlanta Northern Railway, Decature Electric Company, Atlanta Gas Light Company, Keorgia Power Company and Georgia Railway & Electric Company. In the table figures are given for business of the Georgia Railway & Electric Company, the Georgia Power Company and the Georgia Railway & Power Company, for the reason that the last named company took over the others after two and one-half months of the year 1912 had passed, this being explained in the note following the table.

The companies in Georgia cities which taken together are doing the next largest business to that of the Georgia Railway & Power Company when compared on the same basis of operation as to character of business and range of territory, are located in the cities of Savannah, Macon, Columbus, and Augusta. As shown by the following summation of gross earnings secured in these cities and vicinities in light, power, gas and street railway business, the amount of business done in dollars compares in the order of cities given, while the extent of electrical development and the intensiveness of operations is better shown by dollars per capita arrangement giving the following order of cities: Atlanta, Columbus, Macon, Savannah and Augusta.

GROSS EARNINGS PER CAPITA FOR 5 GEORGIA CITIES.

	Gross Earnings	Population Total	Population White	Dollars per Capita Total	Dollars per Capita White
FOR ATLANTA.					
Georgia Railway & Power Co. and subsidiary Companies	$5,567,919	154,839	102,860	$36.9	$54.2
FOR SAVANNAH.					
Savannah Electric Co.	747,058				
Savannah Lighting Co.	149,024				
Savannah Gas Co.	243,979				
	1,140,061	65,064	33,784	17.5	33.8
FOR MACON.					
Macon Ry. & Lt. Co.	554,742				
Central Ga. Pr. Co.	234,356				
Macon Gas Co.	140,914				
	930,012	40,665	22,510	22.8	41.2

1912 EARNINGS OF GEORGIA'S STREET RAILWAY, GAS AND ELECTRIC COMPANIES.

	Gross Earnings.	Operating Expenses	Net Earnings	Deficits
*Abbeville Electric Light, Water & Power Company	$ 2,400.00	$ 1,800.00	$ 600.00	
Albany Power & Manufacturing Company	44,902.11	15,976.09	28,926.02	
Americus Gas & Electric Company	50,009.41	34,681.45	15,327.96	
Athens Gas Company	30,742.73	20,542.29	10,200.44	
Athens Railway & Electric Company	214,663.52	71,589.98	143,073.54	
Atlanta Gas Light Company	825,849.22	401,505.32	424,343.90	
Atlanta Northern Railway Company	138,438.75	103,215.89	35,222.86	
Augusta-Aiken Railway & Electric Corporation	483,838.46	219,446.71	264,391.75	
Central Georgia Power Company	234,356.78	40,950.29	193,396.49	
Chattanooga Railway & Light Company	22,733.77	16,683.27	6,050.50	
Citizens Electric Light & Power Company	25,495.86	20,293.88	5,201.98	
City & Suburban Railway Company	36,647.12	21,683.49	14,963.63	
Clarksville Railway Company	1,400.00	1,734.00		$ 334.00
Columbus Power Company	249,951.04	62,791.83	187,159.21	
Columbus Railroad Company	310,158.20	210,458.92	99,699.28	
xConsolidated Ice & Power Company	44,521.44	41,376.55	3,144.89	
Covington & Oxford Street Railway Company	8,522.05	6,430.56	2,091.49	
Decatur Electric Light, Power & Water Company	15,437.48	13,440.49	1,996.99	
Fairburn & Atlanta Railway & Electric Company	27,622.38	15,707.88	11,914.53	
Gainesville Railway & Power Company	35,304.37	18,759.31	16,545.06	
Gas Light Company of Augusta	118,517.18	73,889.76	44,627.42	
Gas Light Company of Columbus	43,492.06	29,927.37	13,564.69	
aGeorgia Power Company	20,938.01	4,396.19	16,541.82	
aGeorgia Railway & Electric Company	880,651.55	399,304.51	481,347.04	
bGeorgia Railway & Power Company	3,686,604.85	1,563,853.12	2,122,751.73	
Kennesaw Paper Company	11,668.16	11,907.86		239.70
Lumber City Light & Power Company	3,140.00	2,861.00	279.00	
Macon Gas Company	140,914.91	89,417.76	51,497.15	
Macon Railway & Light Company	554,742.04	361,880.63	192,861.41	
Mutual Light & Water Company	93,431.44	47,838.85	45,582.59	
North Georgia Transmission Company	3,973.44	5,120.00		1,146.56
Oconee River Mills Company	32,604.96	16,803.94	15,801.02	
Panola Light & Power Company	8,868.87	5,964.04	2,904.83	
Putnam Mills Gas Co.	7,838.78	3,382.52	4,456.26	
Rome Municipal Gas Company	25,421.24	17,025.79	8,395.45	
Rome Railway & Light Company	190,779.35	107,792.72	82,986.63	
Savannah Electric Company	747,058.26	512,218.07	234,840.19	
Savannah Gas Company	243,979.27	111,339.70	132,639.57	
Savannah Lighting Company	149,024.03	138,900.31	10,123.72	
Tifton Ice & Power Company	32,869.35	26,629.00	6,240.35	
Toccoa Falls Light & Power Company	12,900.00	4,980.00	7,920.00	
Towaliga Falls Power Company	38,416.41	21,921.39	16,495.02	
cValdosta Lighting Company	40,075.21	34,118.65	5,956.56	
Valdosta Gas Company	12,398.88	11,042.20	1,356.68	
Valdosta Street Railway Company	8,791.35	6,745.04	2,046.31	
Villa Rica Electric Light & Power Company	3,094.06	2,628.72	465.34	
Ware County Light & Power Company	78,213.29	78,558.83		345.54
Wofford Shoals Light & Power Company	5,088.74	2,706.83	2,381.91	
Totals	$9,998,490.38	$5,032,242.97	$4,968,313.21	$2,065.80

*Figures shown above only represent operations from January 1 to July 7, 1912, on which latter date plant burned. xFigures represent operations from January 1 to July 31, 1912. Company sold to Valdosta Lighting Company and that company operated properties subsequent to August 1, 1912. aOperations January 1 to March 17, 1912. Merged on that date with Georgia Railway & Power Company. bCommenced operations March 18, 1912. cCommenced operations August 1, 1912.

FOR COLUMBUS.					
Columbus Railroad Co. ...	310,158				
Columbus Pr. Co.	249,951				
Gas Lt. Co. of Columbus ..	43,492				
	603,601	20,554	12,902	29.3	46.7
FOR AUGUSTA.					
Augusta-Aiken Ry. & Elec. Corp.	483,838				
Gas Lt. Co. of Augusta	118,517				
	602,355	41,040	22,648	14.6	26.5

There were reported to the commission 48 street railway, gas, electric light and power companies for 1912, being three more than for 1911. Only four of the 48 companies showed a deficit for 1912 operation, while altogether a healthy increase was shown in both gross and net earnings for 1912 over 1911 by all of the companies, the following being the increases:

For Georgia Companies:	1911	1912	Increase Pr. Ct.
Gross Earnings	$8,868,233.22	$9,998,490.38	12.7
Operating Expenses	4,455,017.97	5,032,242.97	13.0
Net Earnings	4,413,281.31	4,968,313.21	12.6

The term "net earning" as referred to i nthe above table and figures and as considered by the state commission is the excess of the income over the operating erpenses. From the net earnings as given taxes, interest and other fixed charges must be deducted before the dividends are distributed to stockholders.

Operative Costs of Electrical Wagons.

The following statement covers the operative costs of electric delivery wagons in the service of the Commonwealth Edison Company at Chicago for a period of three years, beginning with January, 1909. Out of 43 electric wagons in use at the end of the three year period, December, 1911, only 30 are considered, the capacities of the wagons included in the report being as follows: Two machines of 800 pounds; 4 machines of 1,500 pounds; 4 machines of 2,000 pounds and 20 machines of 3,000 pounds. Nineteen of the cars referred to were equipped with Edison batteries, the others having lead batteries.

The above figures show that the general expense including supervision, wheel tax and state license and casualty insurance is $16.48 per month and 2.1 cents per mile. The operating expenses including driver's salary, washing, oiling and minor charges for repairs, garage expense and other operating costs total $141.79 per month, or 18.3 cents per mile. The fixed charges including the interest at 6 per cent, taxes at 1½ per cent, insurance at 2 per cent, depreciation at 10 per cent, total $30.72 per month, or 4 cents per mile. The fixed charges on garage, land and buildings are $5.90 per month, or 0.8 cents per mile, making a grand total of $194.88 per month, or 25.2 cents per mile.

Electric Plants and Telephones in Central China.

According to Consul-General Roger S. Greene, of Hankow, China, there are now three electric light plants at Hankow, one for the Chinese city and two (one of them very small) in the foreign concessions. There is a telephone service operated by the German postoffice in the foreign concessions, and a Chinese telephone service in the native city. The Chinese telephone service connects with the neighboring cities of Wuchang and Hanyang. In Wuchang there is a small electric plant, mostly for official use, but a municipal system is contemplated. In Changsha, the capital of Hunan Province, there is a fair electric light plant, and there is also a telephone system, though the latter is little used by private persons. In Kiukiang there is no electric light plant. In Nanchang there is a small electric light plant. In both cities there are telephones, but no system that is in general use with any considerable number of subscribers. It would be exceedingly difficult, if not impossible, for a foreign company to get any public-service franchise, and the number of Chinese merchants with whom a joint Chinese-foreign enterprise could be conducted is still very small.

DATA ON OPERATING ELECTRIC WAGONS IN SERVICE OF COMMONWEALTH EDISON COMPANY, CHICAGO, ILL.

	Number of Wagons Owned By Company	Number of Wagons In Service	Oil and Other Supplies.	Energy at 4c per KWH	General Repairs	Tire Expense	Battery Expense	Total	Miles Traveled	Average K.W.H. per Mile	Average Miles per Day per Wagon in Service	Days in Service per Wagon
January, 1909	1	1	$10.75	$13.68	......	......	......	$24.43	617	.555	26.8	23.0
February	2	2	17.96	23.92	$2.10	......	......	43.98	1197	.500	24.9	24.0
March	3	3	15.26	42.28	......	......	......	57.54	2329	.454	30.6	25.5
April	3	3	16.60	35.56	......	......	......	52.16	2073	.429	26.6	26.0
May	3	3	.85	37.76	......	......	......	38.61	2215	.426	29.5	25.0
June	3	3	2.00	37.64	......	......	......	39.64	2269	.415	29.1	26.0
July	3	3	39.46	52.92	......	......	......	92.38	3136	.422	32.3	27.7
August	5	5	13.90	61.48	3.21	$1.50	$74.90	154.99	3660	.420	28.4	25.8
September	5	5	.50	70.60	7.59	1.50	17.06—Cr.	63.13	4175	.423	32.4	25.8
October	6	6	3.50	85.16	13.24	3.25	16.70	121.85	5080	.419	32.3	26.2
November	6	6	49.80	85.96	28.39	207.25	39.74	411.14	5094	.422	34.0	25.0
December	6	6	15.20	68.80	7.08	......	......	91.08	4119	.418	27.5	26.0
January, 1910	8	8	8.26	77.64	186.56	123.00	26.81	422.27	4627	.419	25.4	22.5
February	10	9	7.60	115.64	42.28	......	......	165.52	5353	.540	26.7	20.0
March	10	8	10.75	115.56	211.83	117.51	410.79	866.44	6620	.436	30.5	21.7
April	10	9	28.87	129.76	57.53	......	......	216.16	7296	.445	31.1	23.4
May	10	9	23.55	131.56	91.66	......	102.72	349.49	6995	.470	29.0	23.8
June	12	12	23.08	169.48	184.22	64.00	......	440.78	9919	.427	31.4	26.0
July	12	12	153.44	182.32	29.11	290.64	2.78	658.29	9226	.494	30.7	25.0
August	12	12	53.24	172.80	56.56	......	150.61—Cr	131.99	9552	.452	30.2	25.0
September	14	13	45.13	171.92	115.32	1.50	280.46	614.33	9888	.435	30.7	23.0
October	14	14	96.96	197.00	153.84	317.50	419.87	1185.17	10891	.452	30.5	24.1
November	16	14	27.98	234.04	313.71	122.32	9.02	707.07	10762	.544	30.1	22.3
December	17	15	70.68	262.40	318.31	176.04	9.14	836.57	10715	.612	28.8	22.0
January, 1911	16	15	256.50	234.08	184.24	48.79	213.06	936.67	10584	.553	28.0	23.4
February	17	15	62.36	239 96	193.61	46.35	301.99	844.27	9449	.635	26.4	21.1
March	19	17	36.20	289.28	249.56	200.61	132.83	908.48	12311	.587	27.7	25.0
April	20	17	146.72	295.32	435.12	44.21	.....	921.37	12671	.583	29.7	21.4
May	20	17	218.46	276 00	279.01	96.27	98.83	968.57	14055	.491	31.9	22.1
June	22	18	114.52	295.12	652.35	84.36	730.82	1877.17	15171	.487	32.8	21.1
July	22	18	.55	332.60	194.41	122.03	16.00—Cr.	633.59	15197	.547	33.1	20.9
August	24	19	44.58	328.68	512.08	301.10	1362.06	2548.50	17307	.475	32.8	22.0
September	26	20	56.89	307.80	78.52	299.63	205.85—Cr	536.99	16589	.464	33.6	19.0
October	28	23	12.51	361.08	166.39	332.12	113.46	988.56	19102	.476	31.6	21.6
November	30	26	217.39	390.56	481.77	416.68	139.43	1645.83	19863	.492	30.9	21.4
December	30	28	235.34	429.24	316.67	267.86	16.79	1265.90	20731	.518	30.0	23.0
Totals	......	414	$2137.34	$6358.60	$5566.27	$3686.02	$4112.68	$21.860.91	320,838			
Average cost per car in service per month	......	......	$5.16	$15.36	$13.44	$8.91	$9.93	$52.80	775	.495	30.5	22.6
Average cost per car mile	.. ..	.....	0.7c.	2.0c.	1.7c.	1.1c.	1.3c.	6.8c.	....	......	......	....

Questions and Answers from Readers

Readers are invited to make liberal use of this department for discussing questions, obtaining information, opinions or experiences from other readers. Discussions and criticisms on answers to questions are solicited. However, editors are not responsible for correctness of statements of opinion or fact in discussions. All published answers and discussions are paid for.

WHAT IS MEANT BY UNBALANCED CONDITIONS.

Editor Electrical Engineering:

(369). Kindly explain in your columns what is meant by the term, "unbalanced conditions" in a three-phase alternating current circuit. Does it refer to unequal currents in the phases or to conditions when the phase voltages and currents are not equally displaced with reference to each other?

H. E. L.

WHAT LENGTH MARKS DIVISION BETWEEN LONG AND SHORT TRANSMISSION LINES FOR CALCULATION PURPOSES.

Editor Electrical Engineering:

(370). Kindly discuss in your columns headed Questions and Answers when a transmission line on account of its length must be considerd long and a more accurate formula used in calculations than for short lines. That is, at which length of line must the effect of inductance and capcity be considered. In the following case to determine the size of wire, what formula would be used, and would this line be considered long or short for purposes of calculations? 2,000 Kw is to be transmitted 75 miles at a voltage of 30,000 over a 3-phase, 3-wire, 25-cycle transmission line with wires spaced 18 inches, a power factor of 85 per cent and a loss of 3 per cent.

W. S. D.

GENERATORS SURGE AND PUMP.

Editor Electrical Engineering:

(371). The writer has two generators that operate in parallel, one a 100 Kw., A.C., 2,300-volt, 60-cycle, 3-phase, 32-pole machine carrying about 20 amperes per phase and direct connected to a Harrisburg 4-valve automatic 14 x 16 engine running at 230 rpm. The other unit is a 75 Kw., A.C., 2,300-volt, 60-cycle, 3-phase, 28-pole machine carrying about 15 amperes per phase and direct connected to the same type of engine 12x14 running at 258 rpm. When the generators are synchronized, the current of the machines will surge and pump terribly. What can I do to remedy this trouble?

V. K. Stanley.

WHAT CAUSES THIS ACTION ON CABLE.

Editor Electrical Engineering:

(372). We have a 400,000 circular mil cable carrying direct current of 250 volts in the return air-way of our mines. Some time ago we cut the rubber insulation at different points on these cables to attach weather proof sockets for lighting air-way. I now find that at these points that the entire outer layer of this cable, which is stranded, has been eaten through and it is in worse condition where friction tape was put on than where left bare at the joints. All of this corrosion is on the positive cable, the negative not being bothered at all. The negative side is grounded. Kindly explain the probable cause for this corrosion and what remedy can be applied to prevent further action.

W. E. C.

WHAT IS ECONOMICAL SIZE OF CONDUCTOR?

Editor Electrical Engineering:

(373). Please give a formula for finding the size of wire that will conduct 30-horsepower 400 feet by 3-phase, 60-cycle, 110-volt current, power factor 80 per cent and a drop of 6 volts. Also show what is the most economical size of wire by considering the copper loss in the line and the investment that is necessary, showing the factors that must be considered to install and operate the line at the lowest cost to a generating station. Consider 220, 440 or any other economical voltage and show why it is selected. The writer desires to know the principle of the calculation so that any conditions that are not given may be assumed in the calculations.

W. L. E.

WHY DON'T MOTOR COME UP TO SPEED?

Editor Electrical Engineering:

(374). We have installed a new General Electric motor, 10-horsepower, 3-phase, 60-cycle, 220 volts, which refuses to come up to more than half speed on no load or any load. The motor is rated at 850 rpm and is used with a starting device in the line. What could cause this action?

V. K. S.

CONNECTIONS FOR POWER FACTOR METER.

Editor Electrical Engineering:

(375). When two A. C. generators are run in parallel, where should connections be made for a power factor meter? Give diagram of connections and indicate those cases when such a meter is essential.

R. E. W.

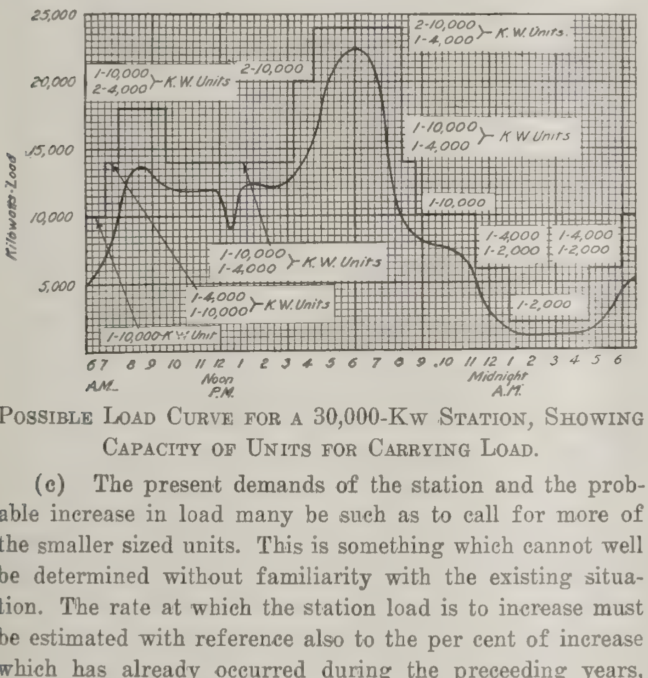
Units for 25,000 Station—Ans. Ques. No. 328.

Editor Electrical Engineering:

Some of the points entering into the consideration of proper size for boiler and generating units in a central station as mentioned in question 328, where it is desired to provide capacity sufficient for future needs, will be as follows: (a) Nature of the current to be supplied; (b) Present maximum and minimum demands; (c) Probable rate of increase in demand; (d) Space available for location of spare boiler and generating units.

(a). The nature of the current to be generated will probably have as great a bearing upon the size of generating units as any other one consideration. Where a portion of the load is to be distributed for residence lighting, another portion for street lighting and still other current for street railway service, the central station must either care for such systems separately or provide, in its substations, such frequency changers and motor generators as shall be necessary to supply suitable current for these demands. Sixty-cycle A.C. current is best suited to the residence lighting demand, and may often be best generated as such at the central station. If desirable, however, 25 cycle current from the central station may be sent through frequency changers and the desired frequency obtained. For street railway and street lighting service 25 cycle A.C. current from the central station will serve to best advantage with the aid of rotary converters at the substations for supplying the D.C. railway requirements. The nature and extent of the above requirements must first of all be considered in determining the number and size of the generating units.

(b). Assuming the station requirements to be such as to permit of the generation of all 25 cycle current, the size of the units will then be dependent to a large extent upon the maximum and minimum loads to be carried during the various hours of the day. The station load during the late night hours in a city of the size referred to will be very light, hence, for reasons of steam economy, it would be highly desirable to have one generating unit at least which may be operated at something like its rated capacity during these hours. Assuming a load curve as in the figure (which is based on a 30,000-Kw. station capacity), the station load factor is seen to be about 40 per cent, which may be taken as a good operating condition. A station with such a load would use a 2,000-Kw unit to good advantage during the night hours, while the load during the other hours of the day would be cared for nicely by two 4,000 Kw units and two 10,000 Kw units.



POSSIBLE LOAD CURVE FOR A 30,000-KW STATION, SHOWING CAPACITY OF UNITS FOR CARRYING LOAD.

(c) The present demands of the station and the probable increase in load many be such as to call for more of the smaller sized units. This is something which cannot well be determined without familiarity with the existing situation. The rate at which the station load is to increase must be estimated with reference also to the per cent of increase which has already occurred during the preceeding years, with a view also to the local conditions which will tend to increase this demand for current.

(d). The available space in which it is desired to locate generating units in the power plant with reference to size of building and arrangement and number of auxiliary units will also have a more or less important bearing upon the size of the generating units which shall at first and eventually be installed.

In regard to present practice relating to the capacity of boiler units, here again local conditions will have an important bearing. Where stokers and furnaces have been chosen of proper design to successfully burn the particular grade of coal which is most available in the vicinity, the modern type of water tube boilers may be operated in excess of rating at all times, and with forcing, may be relied on to care for two kilowatts of turbine output for each boiler horsepower of rating. In other words, the above 30,000-Kw condensing station would require 15,000 horsepower of boiler rating. General practice would indicate that such a boiler installation should be made up of 500-horsepower units, of which there would then be thirty.

Coal vs. Wood as Fuel. Ans. Ques. No. 359.

Referring to question 359, one cord of dry pine weighs about 2,000 pounds, and is equal to 800 pounds of average soft coal, while the same amount of green slabs would be equal to about 680 pounds of coal. One cord of the green slabs at $2.25 would be equivalent to the amount of coal at $3.75 per ton that you would get for $1.28. A cord of the dry pine at $3.00 will give you the same amount of heat that you could buy for $1.50 if you bought coal. Hence, unless you can buy the pine for $1.28 and $1.50 per cord, it will be more economical to use the coal.

E. H. Tenney (Missouri).

Connections for Machines. Ans. Ques. No. 343.

Editor Electrical Engineering:

It makes no difference whether the field rheostat is connected on the positive or negative side of the field coils as long as it is in the circuit. Neither does it matter in this case on which side of the circuit the ammeter is placed since under normal conditions there will be exactly the same current flowing in the one as in the other. Ordinarily there will be no excessive rush of current on closing the circuit of a D. C. generator with normal load.

Cost of A. C. Generators. Ans. Ques. No. 345.

Without entering into detail, the cost of electrical machinery in general depends upon the size of frame upon which it is built. This is true whether it is a generator or a motor, or whether A. C. or D. C. For instance we may have a 2 H. P., 1100 rpm., a 3 H. P., 1600 rpm., and a 5 H. P. 2500 rpm motor, all built on the same frame and there will be but a small difference in cost.

The low speed machines are always the most expensive. Moderate speed are the most in demand, because the slow speed are expensive and the very high speed machines are subject to lubrication troubles and often require too high a speed reduction for the pulleys and belt spans to be practicable. Direct connected machines are always much larger and more expensive than belt driven machines of the same capacity and are used only where the buyers are willing to spend the extra money to be free from belting and shafting, etc. Herein lies the advantage of the steam turbine that it can use high speed alternators.

Wattmeter Constant. Ans. Ques. No. 349.

On the dials of old wattmeters we often find these words: "multiply by 5," or "multiply by 10," or other figures as the case might be. This is probably what is referred to by Davis B as the constant of the meter. The meaning is of course that the apparent reading is to be multiplied by this amount. Public service commissions have abolished meter dials with these constants, and now require that all meters shall be direct reading.

There are other constants used in testing meters, as the watt-hour constant, the watt-second constant, and the so-called "test-constant" used by the manufacturers of the meter in their formulæ. D. C. meters can be tested by the use of an ammeter, a voltmeter, and a stop watch, when the power represented by one revolution of the disc is known. A. C. or D. C. meters can be tested by an indicating wattmeter and a stop watch in the same way. Both these methods are open to slight inaccuracies due to the fact that the power lost in the shunt or the series coils of th emeter is included. The usual way of calibrating meters is with a portable rotating standard furnished by the manufacturers, with which the meters can be tested where they are used, as well as in the laboratory. For further information on meter testing, would refer the questioner to the "Standard Handbook for Electrical Engineers."

A. G. Rakestraw.

A Wattmeter Constant. Ans. Ques. No. 349.

Editor Southern Electricians

In reply to question 349, a wattmeter constant is a number by which the dial reading is multiplied to give the true reading of the meter. It is usually either marked on the dial or on the revolving disc. A reliable but rough method for testing recording wattmeters may be made by loading the meter with a specified number of lamps of which the power consumption per lamp is known. If a more accurate test is desired, the recording meter is usually checked by comparing it with a standard indicating wattmeter, or rotating standard.

The meter is connected on a load of lamps, or other convenient resistance, a mark made on the meter disc so that the revolutions may be easily counted and the revolutions taken for 40 to 60 seconds, the observer using a stop watch. Another observer reads the standard instrument, the load being kept as nearly constant as possible throughout the test. The meter watts may then be calculated from the following formula: Meter watts $= (3{,}600\ R\ K)/T$.

Where $R =$ number of revolutions in T seconds; $T =$ time in seconds of R revolutions; and $K =$ constant of meter.

The actual watts are obtained from the standard meter, hence, the percentage by which the meter is correct is found by dividing the number of watts given by the formula by the number of watts given by the standard meter. If the meter is found to be incorrect it can be regulated by the damping magnet. Shifting the magnet in will cause the meter to run faster and vice virsa.

Edward Odee.

Why Did Motor Reverse? Ans. Ques. 350.

Editor Electrical Engineering:

The nature of the load might have been such as to cause the motor to turn backward when its power supply was crippled by the breaking of one of its wires, as it could then run single phase only. A motor with a purely single phase winding will run naturally one way as well as the other, depending only on which way it is given a start. It will not start of itself.

If a three-phase motor is loaded lightly and one of the wires should be broken while the motor is running, the motor will then operate snigle phase and will continue to carry the load if the fuses will permit. If the motor is heavily loaded and the fuses are of the proper capacity, the two fuses carrying the load will blow. If there are no fuses to protect the motor it will continue to carry the load or will "lay down," in either of which cases it will probably be badly burned. If, however, the load is heavy enough to stop the motor, and the reactive torque of the load is sufficient, it may, when the motor is stopped, turn it backward with force enough to bring it into synchronism with its single phase power supply, and if the reverse load was light enough, the motor might run this way indefinitely. Such a case is, however, purely theoretical on the writer's part, nothing of the sort having come under his observation. Such conditions might be fulfilled in the case of a motor driving a turbine pump, for instance.

The writer has noticed on a hoist how the load the motor was hoisting, would turn the motor backward if an open circuit developed in the motor wiring. There was no chance in this case, however, for indefinite action. Also, in the case of a 250 hp induction motor driving an air compressor, the setting of the valves in the compressor was such that when the power supply of the motor was interrupted from any cause the compressed air, in the air receiver feeding back through the compressor, would run it as an engine and turn both the compressor and motor backward until the air pressure was exhausted or power supplied to the motor.

Motor and Steam Engine in Parallel. Ans. Ques. 353.

In a few particular instances coming under the writer's observation some very satisfactory results were obtained by connecting a steam engine and motor, both to one line shaft. In one case the steam engine was used in this way to relieve a distribution system of peak loads. The line shaft carried a load of 500 hp which could be carried by either the motor or steam engine alone. By properly setting the throttle, the steam engine could be made to carry any part of this load, keeping the ammeter needle of the motor circuit at any desired position. There was no hitch of any kind in this method of operation.

In another instance, where the steam engine had been replaced by electric power, the engine was still left in service to relieve the motor of occasional overloads. The engine governor was set so as to throttle the engine at the normal speed of the motor, but would cut in when the motor speed tended to decrease by reason of an overload, and thus relieve the motor of the overload. The action was automatic, and the results were entirely satisfactory.

Floyd S. Lorentz, (Montana).

Engine and Motor in Parallel. Ans. Ques. No. 353.

Editor Electrical Engineering:

When two machines are operating in parallel they will divide the load in proportion to their capacities if they have the same regulation, but not otherwise. In the case mentioned by W. T. S. the parallel operation would be good or bad, depending on the relative regulation of the two machines. To illustrate, suppose that the motor has very close regulation (that is, the speed does not vary much with the load) while the engine regulation is poor due to the governor being not very sensitive. Then when the full load comes on the line shaft, it will slow up slightly and thereby cause the motor to take more current and the engine more steam, but the effect will be far greater on the motor because it is more sensitive to change of speed than the engine. In extreme cases the motor would take practically all of the load and become overheated.

This point may become clearer if we assume numerical values. Suppose we have both machines direct connected to a shaft of 300 r. p. m. normal speed. Suppose also that the motor speed at full load is 298 and that of the engine is 294. Then when the shaft is running at 298 r. p. m. the motor is fully loaded and the engine is about one third loaded. Any further reduction in speed of the shaft would result in overload and damage to the motor and since we must reduce the speed to 294 if we would utilize the full capacity of the engine, it is evident that it is not possible to load the engine without overloading the motor. If the engine should have the closer regulation the conditions would be reversed. In this case no damage would result, but the motor would be of very little service.

To get good service from the combination, we must adjust the regulations of the machines until they are equal. The regulation of the engine depends on the governor construction and adjustment while that of a D. C. motor depends on the resistance of the armature circuit and the relative value of the shunt and series fields, if compound. In general, increasing the armature circuit resistance or the number of series field turns will make the regulation less close. The same effect can be obtained with an induction motor by increasing the rotor resistance.

To make the proper adjustments, the motor should be put in service with meters in circuit and readings taken at intervals during both light and heavy loads. Indicator cards should also be taken at the same time to determine the engine load and the relative loads of engine and motor noted. If the ratio of motor load to engine load remains constant, the regulation of each machine is the same but if one tends to take a larger part as the total load increases, then that machine has too close regulation. The regulation of the motor will probably be closer than that of the engine and the best way to remedy matters would be to make some changes in the engine governor.

Since the speed of a synchronous motor is absolutely constant (varying only with the frequency of supply) such a motor could not well be used in parallel (mechanically) with an engine.

T. G. Seidell, (Ga.)

Motor and Steam Engine in Parallel. Ans. Ques. No. 353.

Editor Electrical Engineering:

There are periods in the growth of nearly every manufacturing plant when a limit to the supply of driving power is reached and it is absolutely necessary to secure additional power from some other source to meet the demands of increasing loads. If the drive is electric, the matter is simplicity itself, as motors may be added along with the natural growth of the enterprise and the lack of power never reach an acute stage. However, with steam the addition of machinery takes on a different aspect. The engines and boilers may be pushed far above their rated capacity, but there is a limit to the endurance of any machinery, and disaster must result from any excess over this limit. Frequently a steam plant, when a condition of acute overload is reached, is found to be far behind with orders, and it is almost suicidal to attempt changes in the boilers and engines which might necessitate a shut down. Many other reasons might arise why it would be inadvisable to add immediately to the engine and boiler capacity, and yet the mill be greatly in need of additional power for continuous use or to assist over severe peaks. A similar case is that in which the steam plant is adequate for all ordinary operations but is not able to carry certain periodic overloads that occur from concurrent peaks on individual machines.

A case of the latter type was brought to the attention of the writer a short time ago and means of relief from several sources were investigated. It was found that A. C. electric power was available at reasonable rates and steps were taken to isolate certain machines, or groups, and use induction motor drives on these groups. However, it was found that excessive loads came at different points in the mill and of course it was not thought advisable to buy electricity at times when the steam power was sufficient of itself. Taking into account all factors of operation and power supply, it was thought best to place the additional electric power directly on the main line shaft. The question now arose as to what would be the operating characteristics of an induction motor belted to a line shaft operated by a steam engine. Although adverse to practically all advice from other engineers, the writer placed in operation an induction motor on this steam driven line shaft, assuming the performance would be practically as follows:

The motor would be belted on the shaft in such a pulley ratio that with the engine running under normal load, the motor speed would be synchronous and exciting current only would be consumed. The engine governors would be damped to such an extent that increase in load above normal rating would decrease engine and line shaft speed by an amount proportional to the slip of the motor, allowing a definite proportion of the peak load to be carried electrically. Assuming engine of 150 Hp, motor 50 Hp, the following results would obtain approximately at varying load:

Engine	Motor	Speed of line shaft Percentage	Total Load
150 Hp.	0 Hp.	100.00	150 Hp.
160 "	20 "	98.44	180 "
170 "	40 "	96.90	210 "
180 "	60 "	95.35	240 "

Thus allowing for the normal overload capacity of both engine and motor, we would expect a marked gain in the power available on peaks without undue strain on either prime mover and at only 4.65 per cent diminution in speed at the greatest load. Upon the above assumption, the writer placed the motor in operation and made quite a number of tests with ammeter, wattmeter and tachometer and in every case found the motor to behave very nearly as would be expected.

The only difficult feature of this method of operation is that of securing the proper damping effect on the engine governor as it passes from the normal full load rating to that of an overload. Of course the governor must be so adjusted that at no time and under no conditions of load, the engine can drive the motor above synchronism as in that case mechanical power would be absorbed electrically and thrown back on the supply line. Contrary to predictions, there was no tendency toward "hunting" or an unstable condition of balance between the two differing types of power. While the engine is running with full pressure in the boilers and under normal load, the motor consumes practically no current, but as soon as steam pressure drops or a peak comes on, the motor instantly assumes its proportionof the load, or in fact, about two thirds of the power required above the rated output of the engine, as it was designed to do.

The shop consists of many machines each subject to violent overloads, consequently previous to the motor installation the engine had been subject to very wide variations in load. The motor assumes nearly all of this surging since its installation and gives to the entire plant (engine included) a smooth, steady operation. On account of the quickness of the electric unit, the trip relays had to be set rather high, the motor taking a load probably double its rating before the engine governors could operate. These surges of current in the motor seem to have no detrimental effect however, and there is no sign of a distress or the least overheating. On one or two occasions, steam has been allowed to go down so much that the relays were tripped but otherwise there has been no interruption of service.

A system as above outlined is particularly suited to some instances as the motor acts really as an auxiliary steam plant, ready to assume part of the load at any instant, and yet differing from the steam plant in that little expense is incurred while sufficient power is to be secured from the original unit. However, certain restrictions on this type of drive must be noted in this connection, namely: (1.) The frequency of the supply system must be constant, as one cycle variation on a 60 cycle current means either an overloaded motor, if the frequency rises, or an overloaded engine if the frequency drops. (2.) The engine must be brought up to speed before current is thrown on the motor. (3.) An ammeter should be placed in circuit permanently in order that the motor load may be noted at any time. (4.) Steam should be kept at very nearly constant pressure. (5.) It is preferable to use the motor on that end of the line shaft most distant from the engine to smooth out tortional and fractional strains and losses. (6.) If the motor is found to take more than its calculated proportionate part of the overload, the engine governors should be changed accordingly.

Basing his remarks on the above test, the writer sees no reason why a central station may not enter a new field of opportunity and lend assistance to many plants in which operating characteristics are similar to those noted, not only at an increase in revenue but with the hope of eventually securing electrical drive throughout the plant.

D. R. Shearer, E. E. (Tenn.)

Steam Engine and Motor In Parallel. Ans. Ques. No. 353.

Editor Southern Electrician:

In regard to running an engine and motor in parellel, I have never known of this scheme being tried, but if the engine is equipped with a good governor, and the motor has the same percentage of speed regulation as the engine, I can see no reason why they should not run successfully in parallel.

As an aid in determining whether or not the motor and engine speed correspond, assuming that the engine runs 250 revolutions per minute at full load, and 225 revolutions per minute at no load, then the speed regulation is 2 per cent equals $(5 \times 100)/250$. Assume the motor speed to be 1,000 revolutions per minute at full load, its speed at no load should be 2 per cent higher, or 1,020 revolutions. The next step is to proportion the pulleys according to speed of motor and line shaft. The diameter of pulley on line shaft should be (speed of motor $\times$ diameter of motor pulley) $\div$ (speed of line shaft) or the diameter of motor pulley should be (speed of line shaft $\times$ diameter of pulley) $\div$ (speed of motor). It should be understood that the motor can have any speed, providing it has the same per cent of speed variation as the engine.

If this should be tried, I would be pleased to learn of the result of it through the columns of Southern Electrician.

C. A. HARMON.

Lighting Equipment for Small Plant. Ans. Ques. No. 354.

Editor Electrical Engineering:

In answer to question 354 perhaps the following may be of some interest to C. R. K. The size and kind of plant I would install in the town he mentions is as follows: Use only new, first-class machines of some standard make. Install a gas driven generator about 50 Kva, 2300 volts, three-phase. I would build my lines above the telephone lines and get in the alleys where possible. As for the lighting system, if for street lighting series incandescent is preferable, but in some factories arcs are better.

The best arrangement as to rates is to use the meter system with a minimum of $1.50 per month, charging 20 cents per kw hour for first ten kw hours, after that 15 cents. This may seem a little high to some but the writer has found the rate about right for a small town. It is difficult to make a flat rate if operating 24 hours in the summer. However, for lighting rates the following are fairly good resident flat rates. First light $1.00, after this 50 cents per month. For business lighting, first light $1.00, after this 75 cents per month. The writer is not prepared to give a fair rate for street lighting as he handles this load in combination with other power supplied the city. F. N. Irvin, (Tex.)

Why Did Motor Reverse. Ans. Ques. No. 350

Editor Electrical Engineering:

Referring to your Question and Answer columns of the February issue, I would offer the following answers: Mr. W. C. B. asks why his motor reversed. We assume that it was a constant speed induction motor of the squirrel cage rotor type. Assuming, then, that at the time of the break one of the two phases opened was at the same instant, at that point of the cycle when the magnetic energy had a maximum value, it at once becomes evident that the rotor will be left after the break with a certain definite polarity, with respect to the particular phase under consideration. With speed and load conditions such that when this polarity comes into the field of the still active phase, the polarity of that phase for the instant is such as to produce a torque counter to the original direction of the rotor rotation, it is evident that there will at once be a tendency for the motor to reverse due to the counter toque. If then the above mentioned conditions are in proper phase relation with respect to each other, as pointed out, and the action is sufficiently strong, the motor will reverse. There are undoubtedly other means by which this peculiar phenomenon could occur.

3-Phase Motor on 3-Wire Circuit. Ans. Ques. 352.

The motor would have no torque, and therefore would act practically as a short circuit, either burning itself out at once or blowing out fuse.

Motor and Steam Engine in Parallel. Ans. Ques. No. 353.

Install a motor slightly larger than the overload on the engine. Have pully ratio such that belt will be slack on both sides when motor is running at its no-load speed. Furnish a compound starter so that by varying the excitation of the motor field its speed will tend to increase, thereby causing it to take load from the engine.

William Mangum (N. Y.).

New Apparatus and Appliances

Work of the Western Electric Company in Restoration of Telegraph, Telephone and Electric Light Service After Recent Floods.

The results of the recent Omaha tornado and the floods in Ohio and Indiana have tested electric service to the utmost and destroyed millions of dollars of equipment. The first unusual demands for special service came to the Western Electric Company from tornado-stricken Omaha where the telegraph and telephone lines were seriously interfered with. The company was notified that 8,000 poles, 25,000 cross-arms, 100,000 pins and 32,000 feet of telephone cables ranging in size from 25 pair to 400 pair, were immediately needed. The southern demand found the organization keyed up for a quick response, and on the day the order was placed, 20 carloads of poles, 100,000 pounds of copper wire and all of the above cable went forward. The company's stock of 25,000 cross-arms at Minnesota transfer was drawn upon, the poles went forward from the yards in Michigan and the balance of the equipment from the Chicago stock. The next call was for cable for the Chicago district, for the Western Union Company. This emergency cable, to the extent of 235,000 pounds, went forward at once by express from New York, almost every through passenger train leaving the east for Chicago up to the time traffic was suspended being pressed into service to carry its quota of this cable.

In the meantime, the floods began to make themselves felt in Indiana and Ohio, where, within a few days, not only telegraph and telephone service, but electric light, street railway and railroad service was completely demoralized. Again came the call for emergency line material. First of all, the company's stocks of cable, cross-arms, wire and line construction material of every description located in its distributing houses at Cleveland, Pittsburgh, Indianapolis and Cincinnati, were drawn upon; and then the outlying houses were notified to be ready with their assistance when it was needed. Complete stocks were available at Boston, New York, Philadelphia, Richmond, Atlanta, Kansas City, St. Louis, Minneapolis and Dallas—these houses constituting a chain of reserve depots surrounding the stricken district, while further west were the other distributing centers of the company which might also be called upon to help. Meanwhile, it was seen at the company's executive headquarters in New York that, with all these reserve stocks depleted, they must be immediately replenished. Accordingly, telegraphic orders were issued to send east from Washington 50,000 cross-arms, and requisitions were placed upon the company's sources of supply to increase the stock of copper wire available for shipment to upwards of over a half a million pounds and for the drawing of several hundred thousand pounds of copper wire and the furnishing of from five to ten million feet of rubber-covered wire and outside distributing wire.

It was expected that, following the subsiding of the waters, there would be like demands upon the company for reserve telephone exchange equipment. The first of these calls came in as expected early but the company was ready with men and apparatus to meet this phase of the emergency. The first call on the New York office was on the morning of March 31, when word came to move a force of telephone installers and switchboard material with the greatest possible speed to Marietta, Ohio, where the lower floors of the Bell Telephone Exchange building had been flooded to the ceiling, the terminal and power equipment completely submerged and telephone service entirely suspended. Before the day was over, tools and material were in transit on taxicabs to the afternoon Baltimore & Ohio express for Wheeling. With this material went a number of men with the Superintendent of Installation. Their numbers were augmented by others from Philadelphia, Pittsburgh and other Pennsylvania points, and on noon of April 1 the entire party in motor boats, which had been chartered for the occasion, started down the Ohio river for Marietta, this being the only means of approaching the stricken district.

The dispatch with which this particular case was handled by the Western Electric Company in performing its part in the restoration of the telgraph and telephone service of the country is a compliment to its organization and methods.

The Silk Cord.

The Electric Development Association of Boston, Mass., is meeting with decided success in the publication of their organ, "The Silk Cord," devoted to popularizing the use of electricity. Of the last issue 40,200 copies were distributed among the varions central stations now members of the association in New England. The price made to these companies is 4 cents per copy or 5½ cents per copy mailed postpaid to lists of addresses furnished. This cost is made possible through the co-operative nature of the organization, the manufacturers and jobbers paying a part of the cost. "The Silk Cord" is ably edited by Zenas W. Carter, secretary of the association.

March Cover of Silk Cord.

High Tension Switch Operation Under Winter Conditions.

One of the most difficult tests with high tension air brake switches, is to determine the effect of sleet or ice. Severe sleet storms are rather infrequent, and when they do occur it is often difficult for the switch manufacturer to get on the scene in time to secure essential data. The obvious next best thing to do is to duplicate as nearly as possible the effects of a severe sleet storm as affecting the switch operation and the accompanying illustration shows a switch used in such a test. This switch is of the 3-pole type, manufactured by the Delta-Star Electric Company, Chicago, Ill., mounted on a temporary 4-pole structure, although in actual service installations, but two poles are necessary.

Fig. 1. Three-Phase High Tension Switch Under Severe Ice Conditions.

With a temperature of 25 degrees above zero, and wind velocity of 25 miles per hour, as recorded by the weather bureau, a heavy spray of water was directed on the switch for approximately 2½ hours. The ice deposit secured was very heavy and resulted in many long icicles extending from the insulator petticoats to the channel iron switch mounting. The operating mechanism connecting the three rotating switch arms is located within the central channel iron mounting base and therefore was not affected by the ice formation—only the exposed elements being coated.

Fig. 2. Showing Action of Contacts Breaking Ice.

Under the conditions illustrated in Fig. 1, the flash-over occurred at potentials from approximately 51,000 to 57,000 volts. This value was somewhat variable, due to the fact that as the voltage was raised and leakage began, the icicles would begin to melt and stream. During the test a spray of water was kept playing on the switch, thus keeping the ice wet. The combination of ice formation, streaming icicles and steady water drizzle was probably equal to the worst winter conditions.

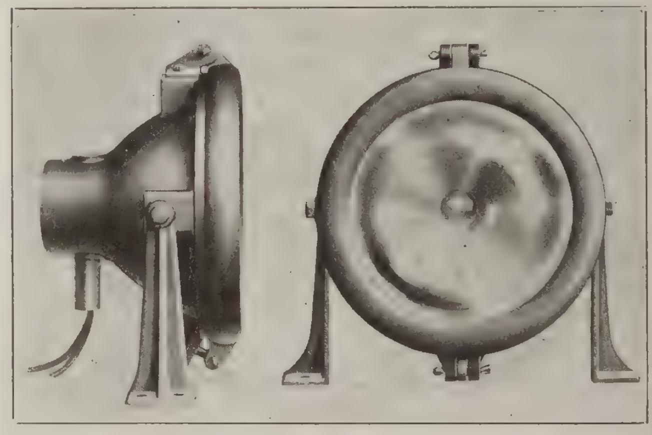
After the break-down or voltage tests were completed, the switches were operated by closing and opening the swinging arms, thus breaking the ice at both the main and auxiliary contacts. Fig. 2 shows the action of the main and arcing contacts. It will be seen that the main contact has opened the arcing contacts still remaining in circuit and in position to take the arcing or burning incident to final opening.

Obviously, the problem of carrying capacities, voltage break-downs, clearances, etc., are relatively simple, as this simply depends on spacing, size of contacts and the type of insulator used. The real problem in outdoor switches is to adopt a construction which will meet the conditions, as presented by severe winter service. Additional tests on this type of switch will be conducted in the near future and the results obtained used in further developments.

New Lamps for Street and Suburban Cars and Mine Locomotives.

A line of lamps for electric railway, steam and mine locomotive service has been announced by the Esterline Company, of Lafayette, Ind. The lamps are of the glass reflector type similar in construction to those made by this company for penetrating fog in marine service and marketed under the trade name of "Golden Glow."

The design and construction is said to differ radically from other existing types, in that the reflector, instead of being a metallic or an enameled surface as is commonly used, consists of a molded plate glass parabola, ground accurately to size and shape, then polished and silvered like a French plate mirror. The glass is given a greenish yellow color which is about the color of molten gold. It has long been recognized in light house and marine work that a golden-yellow light will penetrate fog and mist to a much greater degree than will a white light. The use of the special reflector also renders the light from the lamp much less dazzling since it removes the actinic rays from the light, rendering it soft and mellow. Experience shows



The Golden Glow Head Light.

that, not only is the light much less dazzling to pedestrians, but it is also less fatiguing to the motorman or the engineer.

The lamps as designed for street railway, interurban, electric and steam locomotive service are built in two types. Fig. 1 illustrates the hood type lamp, designed for mounting on top of the car or locomotive. In the dash type of lamp, a part of the lamp is recessed into the surface on which it is mounted. The housings for the reflectors are of metal, and the glass parabola is securely held in place with no possibility of its becoming loose or damaged. The illustration shows the lamp with the bulb removed, standard spherical incandescent bulb being used with a standard Edison base.

The lamp body is ventilated in such a manner that while water and dust cannot enter, it permits of a ready dissipation of the heat, so the lamps will not sweat. On account of the great efficiency of the reflector, the heat as well as the light, is reflected so the front glass will not remain coated with snow or ice in even the coldest weather as the reflected heat keeps the glass free from snow and ice. The wires are led into the lamp at the rear, from below, through a length of iron conduit. In the hood type lamp this conduit is cut to a given length, but in the dash type, an opening is left so the regular wiring conduit can be led to the lamp.

The Simplex Wiring Computer.

Electrical engineers and wiremen will appreciate the wiring computer which the Simplex Wire & Cable Co. has recently devised. The computer is mounted on stiff thick celluloid of a convenient pocket size. It consists of a circular slide rule particularly adapted for wiring calculations. By a single setting of the computer the following results may be obtained: The size B. & S. gage of a wire is readily determined by setting the disc to correspond to a given distance of distribution for a desired voltage drop and the current which the wire is to carry; or given the size B. & S. gage, the current to be carried and the distance of transmission, the resulting voltage drop may be read directly upon the computer. In like manner, the current may be found at one setting for a desired voltage drop with a definite sized wire and distance of transmission. Finally, the distance to correspond to specific conditions of voltage drop, the current and size of wire may be found by a single setting of the disc. The setting of the disc is very simple and directions for attaining these four different results are given explicitly at the foot of the card. Much laborious figuring is avoided by its use. On the reverse side of the pocket guard are handy tables of wiring data and table of decimal equivalents of fractions of an inch. Anyone who desires one of these wiring computers may secure same by communicating with the Simplex Wire & Cable Company, 201 Devonshire Street, Boston.

Century Invincible Motors.

The Century Electric Company, of St. Louis, Mo., has recently developed a line of split-phase motors which will be known under the trade name of "Invincible." These motors have been designed to suit small power motor demands in the industrial and domestic fields where the character of the apparatus does not require a motor of as heavy starting torque as possessed by the repulsion induction motor already developed by this company. The design of these motors has been liberal so that they can render a satisfactory service when surrounded with other than the most favorable conditions.

This line of motors is built in the clutch and clutchless types, the latter being designed to develop a static torque equal at starting to that of full load, requiring four or five times full load current to do it. This type is adapted to apparatus where a starting torque in excess of full load is not required as in fans, blowers and centrifugal pumps. The clutch type will start a heavier load than the clutchless type, but requires the same starting current. A three-piece centrifugal clutch is so arranged that when a predetermined speed is reached this clutch expands and engages with a disc on the motor shaft. In the overload capacity of the motor, the momentum of the rotor and certain slippage of the clutch, an advantage is possessed that enables the starting of a load requiring considerably over full load torque at the start.

The standard winding is for 110 volts, a motor of this design being suitable for a voltage between 104 and 115 volts. Other voltages can be furnished as well as motors wound for frequencies between 25 and 140 cycles.

The Westinghouse Ozonizer.

The value of ozone as an air-purifying agent has now become established, the particular fields of application being in offices, clubs, school rooms, churches, theaters, dwellings and similar places. Ozone is also said to be a preservative against mould and putrefaction in foods, and in pulmonary diseases to give relief and often effect a cure. The ozone oxidizes the various animal and vegetable substances, attacks bacteria and germs in the air, rendering the air sterile and healthful, a fact that makes the ozonizer particularly useful in hospitals, dispensaries and operating rooms.

Westinghouse Ozonizer.

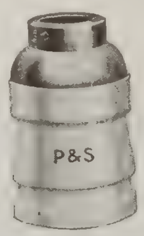
The ozonizer shown here consists of a step-up transformer, tubes for generating the ozone, and a regulating switch, all contained in an easily portable case. The function of the transformer is to raise the voltage of the supply circuit to that required by the ozone generating tubes. These tubes are of glass of special construction, having an outer coating of metal made to adhere closely to the glass by a special process. The inner wells of the tubes are lined with a metal mesh which forms the ozone generating surface. The outer coating is connected to one terminal of the high-tension winding of the transformer, and the inner coating is connected to the other high-tension terminal. The uneven distribution of potential by the metal mesh on the inside of the tubes produces a large number of tiny brush discharges which generate ozone. On top of the case is a knurled knob connected to the regulating switch located inside the case, which is connected to the generating tubes in such a manner that, by turning the knob to the positions indicated on the dial, the number of tubes in operation may be regulated from one to four, with a corresponding change in the unit of ozone.

The ozonizer is designed for connection directly to the lamp socket, as it only takes 18 watts at maximum production. Its operation is practically noiseless, so that it can be left running in the sleeping room without the slightest disturbance. Although the voltage is stepped to a high value, the circuits are so thoroughly insulated and all exposed metal parts are electrically connected together, so that no difference of potential can exist between them even though a part of the circuit should become grounded on the case.

The ozonizer described is made by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

P. & S. Keyless Socket.

The illustration presented here shows a new keyless socket of Pass and Seymour design, embodying their interchangeable feature, the shade holder groove permitting its



A New P. & S. Keyless Socket.

use with proper shade holders. It is a socket designed to stand much wear and tear and exposure to fumes and gases.

An Historical Exhibit of Telephone Apparatus.

An exhibit of historical and modern telephone apparatus and electrical supplies has recently been inaugurated at New York by the Western Electric Company. The exhibit is in three sections. The historical section shows the development of the telephone from its earliest stages up to the present time. The smoked glass records of sound waves made by Alexander Graham Bell, in 1874, using the human ear as a transmitting diaphragm and thus proving that diaphragms would transmit sound waves; parts of Bell's original telephone of 1876, mounted to make a complete model, and numerous instruments showing the gradual improvement in design, are exhibited to great advantage in large glass cabinets with placards giving a description of each article. Included in the historical collection, which is composed partly of apparatus loaned by the American Telephone and Telegraph Company and partly of Western Electric apparatus, are the switchboards used by Mr. Bell in opening the New York—Chicago line in 1892, and the receivers and transmitters used at the opening of the New York-Denver line in 1911.

Electrical Construction News

This department is maintained for the contractor, dealer, manufacturer and consulting engineer.

ALABAMA.

BIRMINGHAM. A proposition has been submitted to the city council by the Birmingham Water & Light Co., to furnish the city with electrical energy for primary power, 24 hour service, at one cent per Kw. hour and 6 mills for secondary power during nine months in the year.

BIRMINGHAM. The National Power Co. has been incorporated with a capital stock of $1,000,000 by W. W. Wallis, President; M. J. Harper, Secretary; and W. B. Burton Treasurer.

BIRMINGHAM. The Alabama Power Co. has issued a statement outlining the capacities and locations of the eleven dams which will be constructed of a size to develop 1,227,000 horsepower for distribution by transmission lines throughout Alabama.

GAINESVILLE. The Board of Public Works has awarded contracts for the construction of an electric light plant and extensions to water works system to J. B. McCrary Co., Engineers, of Atlanta. The work will cost about $9,000.

MONTEVALLO. The Montevallo Ice & Light Co. has been organized by Brown Bros. Lumber Co.

TUSCALOOSA. It is said that a contract for construction of a power plant for the Birmingham, Tuscaloosa Railroad and Utilities Co., at Tuscaloosa, has been given to the General Electric Co. The project will involve an expenditure of about $5,000,000. F. S. Morris, of Morris Bros., Bankers, is at the head of the railroad company.

FLORIDA.

DAVENPORT. C. C. Farmer of Davenport, G. Klink, Adam Schoeberlin, and I. I. Goldsmith of Aurora, Ill., have organized a company to be known as Davenport Light & Ice Co., and will establish an electric light and ice plant together with a bottling works for carbonated beverages.

PENSACOLA. The Pensacola Electric Light Co. is to make extensive improvements to its power plant and street railway systems.

PENSACOLA. The city council has appointed a committee to investigate the cost of installing a municipal electric light plant. A. E. Langford is city clerk.

ST. PETERSBURG. W. W. Barton of Tarpon Springs, has made surveys for an electric railroad from St. Petersburg to Indian Rock.

GEORGIA.

ATLANTA. The Franklin Light & Power Co. has been organized with a capital stock of $150,000. This company will operate a transmission system and supply electrical energy to towns in Franklin, Hart, Madison, Jackson and Elbert counties. The offices of the company will be in Atlanta.

ATHENS. The Athens Railway & Electric Co. is extending its lighting system throughout the city and will shortly install a 1,000-Kw. turbine in the steam plant.

AUGUSTA. The hydro-electric plant to be constructed at Stephens Creek by the Augusta-Aiken Railway & Electric Corp., is to have a power house building of steel and concrete 58 x 39 feet to cost approximately $20,000. The entire cost of equipment will be around $80,000.

CONYERS. A development to be constructed on the South river near Conyers, by the Panola Light & Power Co., is to cost about $60,000. The dam will be 600 feet long by 25 feet high and cost $25,000, the power house about $10,000 and the equipment being of a capacity to develop about 1,000 horsepower. The date for bids has not been announced.

ALBANY. The Albany Transit Co., C. W. Rawlson, president, recently organized, has completed 4 miles of track, a new substation and will operate from pay-as-you-enter Brill one-man cars. Power is to be purchased fro mthe Albany Manufacturing Co., and be used through a 200-Kw. flywheel motor generator set in the new substation. The system has cost about $64,000. The engineering and construction work was in charge of H. W. Foote, formerly with the engineering organization of the Eastern Tennessee Power Company, at Cleveland, Tenn. The system will be in operation about May 1st.

LaGRANGE. A substation and distribution system will be installed at LaGrange by the Columbus Power Co., of Columbus, Ga., an expenditure of about $35,000.

ROYSTON. The water rights, partially completed plant and franchiseowned by J. B. McCrary & Co., of Atlanta, are to be turned over to the Franklin Power Co., for 1494 shares of stock.

WAYCROSS. Application has been made to the state railway commission for issuing $180.000 in bonds by the Ware County Light & Power Co., of Waycross, Ga. The proceeds of $50,000 are to be used for the purchase of a 500-Kw. steam turbine with a battery of three boilers, the remainder to pay outstanding indebtedness.

KENTUCKY.

PADUCAH. The Kentucky Southwestern Railway, Light & Power Co., plans to construct a power house and two substations. The cost will be approximately $160,000. W. A. Calhoun is consulting engineer and F. M. Smith general manager at City National Bank Bldg., Paducah, Ky.

LOUISVILLE. The city council and mayor have approved ordinances granting a new natural gas franchise and authorized a merger of four electric and two gas companies. The consolidation will be made and be under the management fo H. M. Byllesby & Co., of Chicago. The properties to be combined, it is understood, are Louisville Gas Co., Louisville Lighting Co., Geo. H. Fetter Lighting and Heating Co., Standard Gas & Electric Co., and Mississippi Valley Gas & Electric Co.

LOUISIANA.

SHREVEPORT. A. T. Curtis, general manager of the Shreveport Division of the Southwestern Gas & Electric Co., has stated that the damage done to the power plant recently will be repaired.

MISSISSIPPI

HATTIESBURG. Improvements will be made to the power plant and distribution system in Hattiesburg, by the Hattiesburg Traction Co., a Doherty property of which C. Z. Stephens is local manager. An 1800 turbine with condenser and cooling tower also switchboard equipment, additional power and feeder lines and a 200-Kw. railway generator will be installed.

NORTH CAROLINA.

DURHAM. The Henry L. Doherty Co., of New York City, has purchased the controlling interest of the Durham Traction Co., which operates an electric lighting and ice plant and the railway system in Durham. R. L. Lindsay is to remain as manager.

ROCKFISH. An electric light plant is contemplated by the Raeford Company to be installed in Rockfish and supply electrical energy in Lumberton.

SPENCER. The city will vote on May 6th to issue $50,000 in bonds for an electric light and water works system.

ST. PAULS. Tt St. Pauls Light & Power Co. has been incorporated with a capital stock of $50,000 by Opie Odom, Z. M. Odom and John W. Baggett. A hydroelectric development of 100 Hp. will be constructed.

WINSTON-SALEM. It is said that the controlling interest of the Fries Manufacturing and Power Co., of Winston-Salem have been purchased by the Southern Power Co., of Charlotte, N. C., the former company operating light and power plant and street railway systems in Winston-Salem.

WILMINGTON. The Tide Water Power Co. is to erect a substation at Winter Park and install a 500-Kw. rotary converter and transformer in its Wrightsville Beach Station.

SOUTH CAROLINA.

CAMDEN. Plans are now complete for the construction of an electric light plant and water works system, the cost of the electric light plant being estimated at $35,000 and of the water works $80,000. R. W. Mitcham is engineer.

TENNESSEE.

NASHVILLE. Plans and estimates of costs of structure have been prepared by the Board of Engineers for improving the Mussel Shoals Section of the Tennessee River for navigation combined with water power. Three dams are planned between Florence and Decatur, Ala., the first to have a head of 64½ feet, the second 35 feet, and the third 35 feet. A power house is to be provided with each dam, it being estimated that approximately 105,000 horsepower will be developed. Proposals are now being received from parties who desire to co-operate in the combined water power and navigation development and these proposals will be received until June 24th at the U. S. Engineer Office at Nashville, Tenn., by the Louisville Gas & Electric Co.

ROGERSVILLE. The Hydroelectric Power Co., recently incorporated, is soon to start work on a water power development four miles east of Rogersville.

TEXAS.

GALVESTON. An ornamental street lighting system is to be installed to cost approximately $14.000. 57 ornamental lamps carrying five lamps are to be used. The system will be installed on the boulevard and the work done by Max Levy.

SAN ANTONIO. The San Antonio Gas & Electric Co. and San Antonio Traction Co. have prepared plans for extensions and improvements to their system which will call for an expenditure of about $300,000. The traction company will expend about $200.000 for the purchase of new street cars and double tracking of its present line. The remaining amount will be used to improve the electric lighting system and make extensions to gas mains.

PERSONALS.

RANDOLPH TROY general specialist on ozonators for the General Electric Company has recently made an extensive trip throughout the south investigating conditions and making arrangements for the exploitation of ozonators. He speaks highly of the co-operation and hospitality extended him by southern central stations and is enthusiastic over the possibilities from the fact that a large number of managers are awake to the load the ozonator furnishes. Some of the European countries are doing an annual business of several million dollars in air and water purification by means of ozone and have been actively engaged in such pursuit for a number of years. In this country the ozonator business is rapidly increasing in the east and west with every indication of the south following close in their footsteps. The ozonator is now a well developed piece of apparatus and excellent results attend its use in almost any place.

Messrs CHAS. F. HOWE, CHAS. CALDWELL, of Macon, Ga., and C. D FLANIGEN, of Athens, Ga., have just returned from a trip to Panama where considerable time was spent in investigating the engineering features of the canal. An enjoyable and profitable trip is reported.

MR. EARL F. SCOTT, who for the past four and one-half years has been in charge of the engineering department of the Atlanta office of the General Fire Extinguisher Company and been responsible for the design and installation of power plant equipment and automatic sprinkler and fire protection work, has recently resigned to accept a position as assistant to the Southern manager of the Griscom-Russell Company with offices in the Candler building, Atlanta. This company acts as manufacturer and engineers for engines, condensers and other power plant equipment. Mr. Scott's training and experience ably fits him for his new position. He was born at Marshall, Texas, Dec. 31, 1874, remaining there until 1897, during which time he served an apprenticeship in patternmaking and drafting in railway shops. He left Marshall to enter Vanderbilt University at Nashville, Tenn., graduating in mechanical engineering in 1903. After graduation he traveled in the north for various steel companies, later becoming connected with Kilpatrick and Johnson, consulting engineers of Jackson, Miss., doing drafting and construction work in connection with sewer systems and water works. After 18 months with this firm, he went with A. M. Locket and Company of New Orleans, as mechanical engineer and during the four years with this firm designed and had charge of the construction work of a number of southern power plants, irrigation systems and water works. He resigned this position to become mechanical engineer for the Black & Laird Construction Company of New Orleans and take charge of the work on the New Orleans Purification Plant. After finishing this work he came to Atlanta as mechanical engineer in charge of the engineering department of the General Fire Extinguisher Company as above mentioned.

MR. L. S. MONTGOMERY who for the past four years has represented the National Metal Molding Company in the South as district manager, with headquarters in Atlanta, has been transferred to the home office at Pittsburgh, and given charge of the sales work in Pittsburgh territory, including the states of Ohio, West Virginia and Eastern Pennsylvania. This promotion has come to Mr. Montgomery as a reward for his earnest and aggressive sales work in the South where, as the first representative of the company in the territory, he has built up the business from practically nothing to one of the largest among competing companies. Mr. Montgomery is a Southerner by birth and an ardent booster. He has identified himself with every Southern interest that tends to promote the electrical industry, and through his success as a promoter, has gained a wide acquaintance.

Mr. Montgomery is reigning Apollo of the present Jovian Congress, and probably the best known young member of the order in the South. Every one who knows of his activity and success in placing Jovianism in the South on the highest plane will regret his transfer. Due to his connection, however, and the present Jovian organization for which he has been largely responsible in the South, it is certain that his influence will remain with us, even though his headquarters are now outside our territory. He will, it is understood, for some time, have general supervision over the Southern sales district, which will call for his attention from time to time and an occasional trip, so that his hold on the Order in the South and his other friendly connections in this territory will not be completely severed at once.

Mr. Montgomery will be succeeded as Southern manager of the National Metal Molding Company at Atlanta by his brother, who has acted as his assistant for the past year. The assistant of the Atlanta office associated with Mr. F. S. Montgomery will be G. M. Stout, who for the past six years has been connected with the Atlanta office of the Westinghouse Electric and Mfg. Co.

MR. H. G. SCOTT, who for some time was district manager of the Shelby Lamp Works of the General Electric Co., with headquarters at Atlanta, Ga., later commercial engineer for the Central Georgia Transmission Company, and all the time golf champion of the South, has become a benedict. The luck lady was (Miss) Jane Barnette, of Atlanta. The many friends of Mr. Scott in the South, we are sure, wish he and his bride the richest of blessings over many long and happy years. Mr. Scott is at present manager of the Virginian Power Company, at Charleston, West Virginia.

OBITUARY.

MR. PHILIP DIEHL, after whom the Diehl Manufacturing Company of Elizabeth, N. J., was named, passed away at 9:30 April 7th. Mr. Deal's life has a marked influence upon electrical industry, his first connection with electrical matters being in the year 1879. His initial developments in the electrical field were worked out by him in a little laboratory which he had rigged in the cellar of his house, where he was seriously handicapped by his inability to obtain such supplies as were needed, and obliged to obtain them in such form as they could be had and working them himself into the forms necessary for his experiments. In 1884, at the Franklin Institute Exhibition, Mr Diehl exhibited a dynamo with movable air gap features which awakened a great deal of interest at that time and in the same year was awarded the bronze metal by the American Institute for special merit of his electrical apparatus then developed. Mr. Diehl was vice-president of the Diehl Manufacturing Company although in the later days of his life did not take an active interest in the company's affairs.

INDUSTRIAL ITEMS.

THE MULLERGREN ENGINEERING COMPANY announce the enlargement of its engineering staff to such an extent that it is better prepared than ever to engineer extensions and improvements, design and construct electric light and power plants, hydro-electric plants, street railways, gas plants and water works. Special investigations can also be made as to operation of any of the above plants.

THE H. W. JOHNS-MANVILLE CO. announce the removal of their Newark office to 239 Halsey street. Their new office and salesroom is located on the ground floor of a modern building, right in the heart of the city's business center. With a floor area of 4,000 square feet, ample space is afforded for the display of a varied line of asbestos roofings, packings and pipe coverings, brake lining and auto accessories, fuses and protective devices, Frink lighting fixtures, etc.

THE H. W. JOHNS-MANVILLE Co., following a long-established custom, has assembled its 600 or more salesmen, as well as the department managers, in annual conventions on various dates from January 2 to February 8, at Milwaukee, Boston, New York, Philadelphia, Pittsburgh, Cleveland, Chicago, St. Louis, New Orleans, San Francisco and Toronto. The object is to learn more about the products which they sell. One by one about three hundred products of this concern were taken up and their advantages over competitive products pointed out to the salesmen by specialists in each line. A week's time was devoted to each of these conventions, with a banquet at the close as a fitting ending.

THE ATLANTIC INSULATED WIRE & CABLE CO. has recently issued a booklet giving new list prices, from fourteen cent to twenty-four cent base, inclusive, and freight additions on the Dolphin brand new code wires and cables for 600-volt service. his list is known as the new universal code list adopted by a large number of manufacturers in the interest of uniformity at the request of the general consumers, contractors and supply houses, many of whom have already incorporated it in their catalogues.

With the copper market as variable as it has been recently this booklet, covering the various basis, enables buyers to have constantly before them a complete range of prices without awaiting receipt from the manufacturers of a new list each time the copper base changes. The booklet is ready for distribution and will be sent upon request.

THE HEMMING MANUFACTURING CO. announce that owing to the increasing demand for their heat-resisting molded insulation in the West, and to meet the needs of their numerous friends and customers, Mr. B. A. Appleton has been appointed Western sales engineer, with headquarters in Suite 1654 Monadnock Block, Chicago.

THE THOMPSON ELECTRIC CO., of 337 Superior avenue, N. W., Cleveland, Ohio, has increased its capitalization from $10,000 to $50,000 to provide for the increased business which this company is doing. Mr. A. J. Thompson is president of the company, and already well-known to this trade. Mr. Charles E. Pope, secretary and treasurer, was formerly mechanical engineer with the National Malleable Castings Company, of Cleveland, and he will add strength to the organization. The company will manufacture the Thompson automatic safety cut-out hangers for arc lamps and large Tungsten units and clusters, and will put upon the market very shortly a high voltage series cut-out hanger for street lighting.

UNDERWIRTERS' LABORATORIES, INC., has secured ten thousand square feet of additional land adjoining its holdings on East Ohio street, Chicago, and plans to extend its present buildings to provide additional space for hydraulic and chemical laboratories and offices. This follows the recent completion of a special building for tests of structural methods and materials and will give the institution a total ground area of 26,600 square feet, a total floor area in buildings of 45,000 square feet and a yard space of 9,000 square feet. The year 1912 showed an increase of 50 per cent over 1911 in the volume of business handled. When the present extension is completed the plant will represent an expenditure of $175,000, this amount having been contributed by the stock fire insurance companies.

P. & S. SOCKETS. Bulletin No. 766 issued January 2, 1913, by Pass & Seymour, Inc., shows now it is possible to make 24 P. & S. sockets from 15 parts.

THE ENGINEERING DEPARTMENT of the NATIONAL ELECTRIC LAMP ASSOCIATION, Cleveland, Ohio, have issued in four-page form a chart designed to facilitate the solution of problems in general illumination. Given the intensity of illumination required, the color of the walls and the dimensions of the space to be lighted, by referring to the chart one is able to select the most desirable size of Mazda lamp, and the spacing of units to give satisfactory results.

This chart will be found a convenience by lamp people who have occasion to do specification work in illumination. Copies can be obtained from the engineering department mentioned above.

Electrical Devices
Recently Passed by Underwriters

These devices and materials have been examined under the specifications given in the National Electrical Code and working in practice, and are approved by the Underwriters Laboratories, Incorporated.

CABINETS.

ERIE ART METAL CO., Erie, Pa., Standard cabinets. Approved Feb. 25, 1913.

HAMILTON SHEET METAL WORKS, Hamilton, Ohio. Standard cabinets. Approved Feb. 26, 1913.

TROY ELECTRICAL CO., 193 Rive rSt., Troy, N. Y. "Teco" sheet metal cabinets "built-up" and "formed" types. Cast iron cabinets with porcelain base. Cut-outs or combined cut-outs and switches. Approved Feb. 28, 1913.

CONDUIT BOXES.

PRATT CHUCK CO., Frankfort, N. Y. "Pratt" pressed steel outlet boxes with galvanized or enameled finish. Approved Feb. 11, 1913.

STEEL CITY ELECTRIC CO., Pittsburg, Pa. Pressed steel boxes. Approved Feb. 4, 1913.

FLEXIBLE CORD.

IMPERIAL WIRE & CABLE CO., Montreal, Canada. Marking. Two-yellow threads cabled with copper strands. Approved Feb. 12, 1913.

SIMPLEX WIRE & CABLE CO., 201 Devonshire street, Boston, Mass. Marking: One red thread parallel with conductor between rubber insulation ond braid. N E Code 1911. Approved Feb. 6, 1913.

PANEL BOARDS.

TRIO MANUFACTURING COMPANY, 2424 Third avenue, Rock Island, Ill. Standard panel boards. Approved Feb. 4, 1913.

RHEOSTATS.

ALLIS CHALMERS CO., Norwood, Ohio. Grid type rheostats for use with A. C. apparatus. Motor-starting rheostats for induction motors and speed regulators for same. Approved Jan. 27, 1913.

SIGNS, ELECTRIC.

A. & W. ELECTRIC SIGN CO., Prospect and West Third streets, Cleveland, Ohio. Signs of standard requirements. Approved Feb. 20, 1913.

FEDERAL ELECTRIC CO., Lake and Desplaines streets. Chicago, Ill. Signs of standard requirements. Approved Feb 19, 1913.

GREENWOOD ADVERTISING CO., (Western) Los Angeles, Cal. Signs of standard requirements. Approved Feb. 4, 1913.

SOCKETS, STANDARD.

BENJAMIN ELECTRIC MFG. CO. 128 S. Sangamon street. Chicago, Ill. Benjamin brass shell sockets, keyless and twin. Also porcelain shell sockets for mogul-base lamps, keyless. Approved Feb. 21, 1913.

ELECTRICAL ENGINEERING

PUBLISHED MONTHLY

Vol. 45. JUNE, 1913 No. 6

PUBLICATION OFFICE
DALTON, GA.

EDITORIAL and ADVERTISING DEPARTMENTS
GRANT BUILDING ATLANTA, GA.

D. H. BRAYMER, Editor.
A. G. RAKESTRAW
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SUBSCRIPTION RATES

Domestic ---------- $1.00 For Two Years
Canada ---------- $1.00 Per Year
Foreign ---------- $1.50 Per Year

Complaints of failure to receive ELECTRICAL ENGINEERING regularly or of any errors of any nature, should be promptly made to the Atlanta office.

Advertising copy or change orders for standing advertisements must reach the Atlanta office by the 5th of the month preceding the month of publication.

Entered at Dalton, Ga., Postoffice as Second-class Matter.

CONTENTS.

Public Service Commissions—Investors and the Public.

No one who has carefully traced the various twists and turns of public service commissions now in existence can refrain from placing to their credit one thing and one important thing, which does now and will later on in an increasing degree, benefit the corporations with which they deal. We refer to the investigations of operations and revenues and forcing the placing of security issues in none but a proper manner. This not only safeguards the public against any but the legitimate enterprise, but it gives to those companies deserving it, the degree of confidence they are entitled to. The public service commission was once considered by the public service companies as an unnecessary evil forced on them, yet where the former has been properly made up, its activity included a goodly amount of common sense and the latter given the proper co-operation, such a commission has proved itself to be a benefactor to the industry and to the individual corporation under the cover of apparent antagonism. The place for this type of regulating commission in the affairs of the central station as related to the consumer, is therefore now established and it is against all others not included in this class to which objections are directed.

Another important result of commission agitation has been the presentation of much data of great value. This data is made available to the investor and has been largely secured through hearings on franchise, security issues, and rate regulation matters. The printed opinions of commissions in rate and security issue cases usually contains full details in relation to accounts, finances, and property values, and on this account lend themselves to valuable comparisons. The reports of decisions together with monthly, quarterly, and annual franchise statements and reports tend to place security values on a foundation of facts. They tend also to eliminate the possibility for financial manipulation and speculation of the nature that has reflected unfavorably in the past on some few corporations. Further reliable data is always available for public inspection in such form as corporation papers, franchises, mortgages, deeds, leases, maps and other documents referring either to railroad, street railroad, gas and electric properties. In short, the commission of the sort we have mentioned has formed an unbiased source of information on public utility operation and financing, the nature and accessibility of which lends it to certain studies that tend to set aright in the minds of those interested, any objectionable points which coming from the corporations themselves might not be received with as much confidence.

Probably the next important step in commission regulations of benefit to all concerned, is the bringing about of more uniform and scientific accounting systems. This has solved many a problem for not only every type of public service company, but any other private or municipal company whose operations may in any way be similar. It has enabled organization heads to find certain leaks that have previously existed unnoticed. Further, it has enabled one company to compare its operations and finances with other successful and non-successful companies and has enabled them to derive valuable deductions tending toward improvement. While these conditions have been secured by the corporation, the whole matter has reverted again to the public and the investor and has given reliable information as to the financial basis of any corporation and a means for judging as to whether or not it is rendering a fair service at a fair price.

There is yet, however, a further work for these commissions in co-operation with the government. There are no complete and detailed statistics on the earnings, capitalization, and so forth, of all public utility corporations that can be relied upon as up-to-date. The United States Census Bureau has gathered excellent data in connection with street railway and interurban railway, electric light and power companies for the period between 1902 and 1907, but this material was in the process of publication until 1910, during which time it had become obsolete. Only approximate comparisons can now, therefore, be secured from the information available, other than that from commissions, for public service corporations are growing and expanding beyond all prophesied extent year by year and thus destroying any dependence on averages taken from any data more than one year old. What we need is more just public service commissions and a further co-operation of the census bureau with them in a presentation of general data representing the conditions of the country at large and along those lines now found advisable through public service commission activity.

The Chicago Convention.

The thirty-sixth convention of the National Electric Light Association is, at the time these lines are being read, in session at Chicago, its birthplace and a city that may well be proud of the honor and event, now a prominent part of its history referring to electrical affairs, made possible by 87 men who selected it as the first meeting place for conceiving of and bringing into being what is now the largest engineering and commercial organization in the world. Whether for this reason or because of it and other natural advantages combined, Chicago seems to be a favorite meeting place for N. E. L. A. conventions, the coming meeting making the seventh held there, with New York in next place, with five conventions to her credit. The order of Chicago conventions are as follows: First, 1885; ninth, 1889; twenty-first, 1898; twenty-third, 1900; twenty-sixth, 1903; thirty-first, 1908, and thirty-sixth, 1913.

With the association gathering in its members in increasing numbers year after year, and the convention attendance increasing in proportion, now well passed the 5,000 mark, the great problem of accommodation of these members and guests at a convention is being faced, and there is some gossip of selecting a suitable place to regularly hold the annual meeting. In this connection, however, there has been some suggestion by Southern central station men, which we heartily endorse, that the South should have the honor of a convention in the near future, this suggestion referring first to 1914 and second to 1916, since the 1915 convention will be held on the Pacific coast. The possibilities for a permanent meeting place seemed to be in favor of Atlantic City, N. J., where it is possible that the next convention will be held if the requests of Southern members cannot be considered at this time.

As usual, Monday, June 2, the first day of the convention, is to be given over to registration, arrangement of exhibits and a reception to the president in the evening. During the following four days, there will be in all nineteen sessions, on an average of five each day with the exception of Tuesday, when there will be four. At these sessions, 93 subjects will come up for presentation and discussion, making the program one full of hard earnest work for four solid days. It is presented on page 276.

All the committees are hard at work on final arrangements at this writing, and all seem to be of the same opinion that the convention is one to compare most favorably with the best of those that have passed and besides add something to the already interesting pages of the association history. With Mr. Samuel Insull, of Chicago, chairman of the local entertainment committee, John F. Gilchrist, L. A. Ferguson, G. H. Atkins, H. L. Monroe, H. E. Niesz, G. B. Foster and E. A. Edkins working on other arrangements, those essential features that go with strenuous convention work are assured of completeness.

Referring to accomplished association work, two important things among others have been a decided success, namely, the remarkable strides in membership and formulation of plans for the fostering of the industry, and placing it in its proper position in public opinion. The first makes possible the universal benefit of public utility organization, and the second a means of building for the future. In regard to association growth and its future, we quote Holton H. Scott, chairman of Committee on Organization ofthe industry, from a letter to *Electrical Engineering*, as follows:

"The National Electric Light Association now comprises practically every central station company in the United States and Canada of all cities of 25,000 and over. In addition to this, it has a very creditable representation in foreign countries, such as Mexico, South America and Japan. This membership also includes many of the larger manufacturers of electrical apparatus and appliances, and the electrical trade journals. The membership was originally composed of central stations only, but after a time it was deemed wise to take into membership the manufacturing companies and technical publishing companies. The next step was the creation of the individual membership, which membership comprises the employes of central stations or manufacturing companies, and following this came the company and geographical section movement.

"The growth, as far as numbers are concerned, has resulted largely from the creation of the company sections. It is almost necessary that any central station company have some sort of an association to which all employes of the company are eligible, and the company section of the National Electric Light Association fulfills this need. All subjects presented to these various sections are sent to the central office and as a result of the company and geographical section work, the various committeemen of the association are in close touch with the industrious and thinking men of the industry who contribute to these sections.

"The National Electric Light Association is now one of the largest co-operative technical associations in the world, and the results of its work have probably more to do with the development of the electrical industry than any other one factor. Its work does not conflict with that of any other association for it aims to cover the general field in connection with the problems of the central station

Frank M. Tait, President National Electric Light Association.

and the legitimate encouragement of the manufacture of apparatus and appliances to extend the service of the central station.

"The growth of the association in the last few years has been quite remarkable. The saturation point has certainly not been reached. It is a peculiar fact that many of the smaller stations, which would be most benefited by membership, are not as yet members of the Association. My reason for saying that the smaller stations derive the most benefit is that through membership these companies could obtain the advice and experience of the larger companies who naturally have in their employ men who are experienced in every branch of the industry, and who are

J. B. McCall, First Vice-President N. E. L. A.

now and always have been, most liberal in contributing to the work of the Association.

"It is expected that the Chicago convention this year will be the greatest convention in the history of the Association. The program covers a very wide field embracing general, hydro-electric, accounting and commercial subjects. The officers of the Association have reason to believe that the attendance this year will be not less than six thousand."

In regard to relations with the public and other matters of importance to come before the Chicago convention, we present herewith an interview by one who through his various and successful experiences as a central station man, is authorized to speak and clothe his remarks with authority. Mr. George Williams, general inspector of the New York Edison Company, president of the Association of Edison Illuminating Companies, past president of the N. E. L. A., and present chairman of the Public Policy Committee, says:

Holton H. Scott, Second Vice-President N. E. L. A. and Chairman Committee on Organization of Industry.

"The Chicago convention will probably be the largest association meeting we have ever had, for Chicago is a very popular convention city, and in addition there is the enormous Company Section in the city. Further, a splendid feeling of co-operation exists, and the life and activity of the Commonwealth Edison Company and the other interests conducted by Mr. Samuel Insull will all lend to the attractiveness and importance of this convention.

"The matters to be chiefly considered at this time, in my judgment, are those which will aid in throwing our central station industry into the most complete state of harmony with enlightened public opinion. As an industry we should see to it that our employes are treated in the most liberal and fair manner; that in their work they are safeguarded against industrial dangers, and that sanitation in various forms should be adequately provided.

"Another very important question for the industry is that it should keep acquainted with the more important decisions of the Public Service Commissions and secure the fairest interpretation of those decisions, that we may find ourselves in accurate alignment with public opinion and desire and the law, as expressed through these regulating organizations. On the other hand, we should endeavor in every proper way to confine regulation to the field of regulation, and not permit it to extend into the domain of management. There is a distinction in this, and probably the rights of our member companies in this direction will be recognized by the public, just as the public wishes to have its rights recognized and adequately safeguarded by the corporations.

ARTHUR WILLIAMS, CHAIRMAN PUBLIC POLICY COMMITTEE.

"Probably the Chicago convention will give more attention than ever before to the economic importance to all concerned of combining lighting and power plants with street railway plants. The pioneer work in this direction was done in Chicago, under the direction of Mr. Insull. It has developed there to a larger extent than anywhere else, and in all probability the significance and value of this combined service will be impressed upon our industry at this meeting, and, we hope, upon the electric railway industry, more than has been possible in the past.

"Another matter of the utmost importance at this time is the question of accounting regulation through the Public Service Commissions. Many mistaken views exist for instance on the question of depreciation. The Accounting Section will undoubtedly give to it the attention that this question deserves.

"Another matter of importance is the fair allotment of value to a public utility corporation's intangible as well as tangible assets. There seems to be a tendency to inventory these properties, the matter having gone perhaps further in the steam railway field than any other at the moment. Effort should be concentrated upon securing adequate provision for intangible as well as tangible property. The former may cost a very large percentage of the latter. In various phases it is of definite value to the public and any inventory of a utility corporation's property should make fair allowance either for good will, or for organization or for the corporation as a going concern, thus placing a premium on good and efficient management.

"Of great importance also is the question of franchises. How rights of this kind about to expire within comparatively limited periods are to be protected is of great importance. Many favor the substitution of the indeterminate franchise, to be operated so long as good service at fair price is rendered and, if withdrawn by the municipality, to be done so only with the purchase of the property at a fair appraisal.

CHICAGO N. E. L. A. HEADQUARTERS—EL MEDINAH TEMPLE.

"The best thought of the industry, it would seem, should be concentrated upon these various questions and doubtless material progress will be made at the convention in these directions."

E. C. DEAL, PRESIDENT AND ORGANIZER OF SOUTHEASTERN SECTION OF NATIONAL ELECTRIC LIGHT ASSOCIATION.

As outlined in a recent issue of *Electrical Engineering*, the newly formed Southeastern Section of the Association has made special arrangements to attend the convention in larger numbers than ever before, representatives planning to be present from all the states which the section covers, namely, Georgia, Florida, Alabama, North and South Carolina. President Deal advises that the special train to be known as the Magnolia Special, starting from Atlanta, will carry a large majority of the delegates to the convention and that in case some arrive after it and desire to use it for the return trip, such arrangements can be secured. The Southeastern section has every prospect ofa rapid growth with such boosters and able supporters as the present president, E. C. Deal, vice-president and general manager of the Augusta-Aiken Railway & Electric Corporation, and past presidents, J. S. Bleecker, manager of Columbus Power Company, and Wm. Rawson Collier, contract agent of the Georgia Railway & Power Company, of Atlanta, together with many others who have the work of the section seriously at heart.

Power House and Dam of Goat Rock Hydroelectric Development of Columbus Power Co.

The Generating System of the Columbus Power Co., Columbus, Ga.

Written Exclusively for Electrical Engineering.
BY D. H. BRAYMER.

A Description of the Goat Rock Hydroelectric Development and Transmission System.

THE city of Columbus when classified according to the application and diversified use of electrical energy stands second among cities in the state of Georgia, while in population it ranks fifth. The circumstances which have attended the growth of this city have caused it to become an industrial center and the location of an interesting electrical generating and distribution system. In the city and its vicinity, there are in operation at the present time, five generating stations with an ultimate capacity of 40,350 kilowatts of which 17,850 is installed. This system is operated by The Columbus Power Co., organized in 1906; the Columbus Railroad Co., as one of its customers, operates a street railway system and distributes energy for light, power and heating in the city of Columbus. Of the five separate plants owned and controlled under lease by the company, four are located in Columbus proper, and include three water power stations of a combined capacity of 8,600 kilowatts and a reserve steam plant of 1,750 kilowatts. The capacity represented by these stations has been added gradually as the demand for light and power has required, this demand increasing very rapidly during the past few years on account of the large number of textile mills and other manufacturing establishments that have been connected to the lines. An idea of the arrangement of the generating and distribution system and the transmission lines is given in Figs. 1 and 2.

GENERATING STATIONS AT COLUMBUS.

The important generating station of the company located in Columbus is known as the North Highlands Plant or Station No. 1, and contains five 1,080 Kw. Stanley generators, operating at 5,500 volts, and one Westinghouse 1,500 Kw.—11,000-volt generator. This is a water power station constructed in 1901 under the direct charge of W. S. Lee, now chief engineer of the Southern Power Company. This was the first large dam built in the South and constructed under most favorable conditions due to floods. Adjoining this station is another water power station from which 900 Kw. is secured. A view of Station No. 1 is shown in Fig. 3. Station No. 3 is known as the City Mills station, from which 800 Kw. is secured by lease. Station No. 4 is a steam plant containing a 1,500-Kw. Curtis turbine, held in reserve, as well as a 500-Kw. motor generator and a 250-Kw. steam driven G. E. generator, supplying the street railway system. A view of this steam station is shown in Fig. 5. The Goat Rock hydroelectric station to be de-

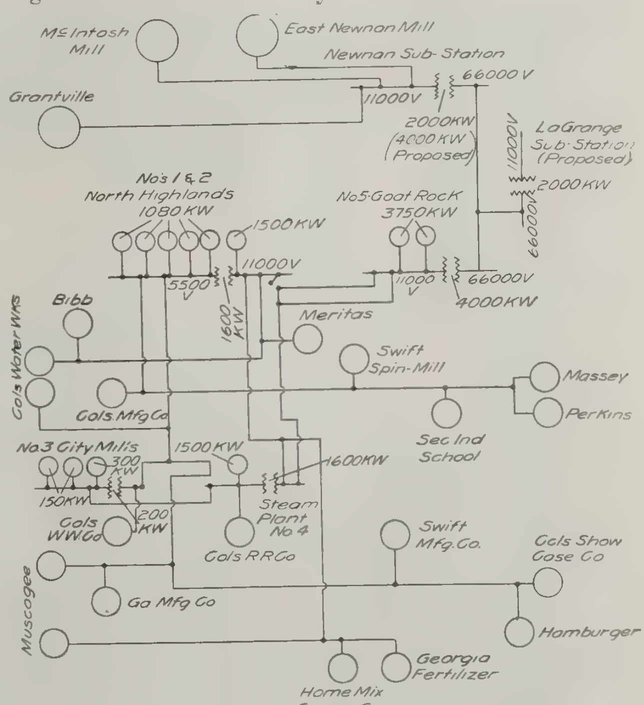


Fig. 1. Layout of Generating Stations and Distribution Lines.

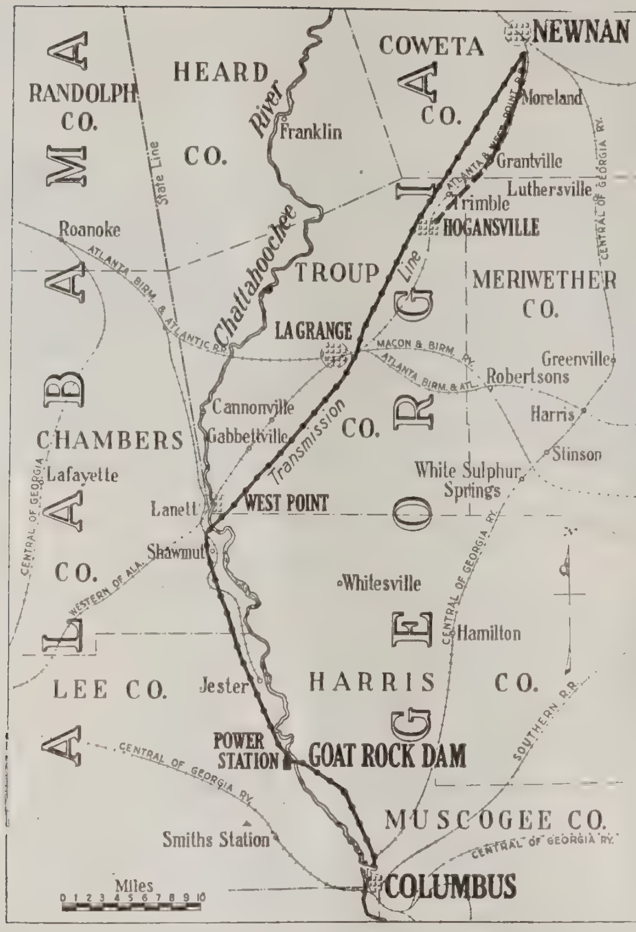


FIG. 2. MAP SHOWING 66,000-VOLT TRANSMISSION LINE FROM GOAT ROCK TO NEWNAN, GA., AND 11,000-VOLT LINES FROM NEWNAN TO HOGANSVILLE AND FROM GOAT ROCK TO COLUMBUS.

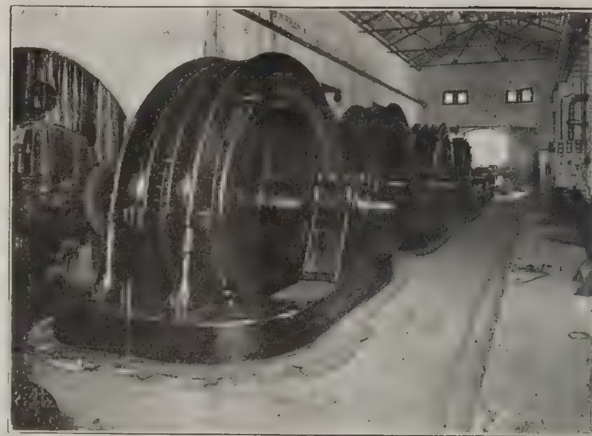


FIG. 3. GENERATING FLOOR NORTH HIGHLANDS STATION—No. 1.

scribed herein is known as Station No. 5, and at present has a generating capacity of 7,500-Kw., thus making the total capacity mentioned above of 17,850 Kw.

A particularly interesting power load is carried by The Columbus Power Company on account of its diversified character, consisting of twelve cotton mills in Columbus, two in Newnan, Ga., one in LaGrange, Ga., one in West Point, Ga., each using from 400 horsepower to 3,000 horsepower. Besides these plants there are operated in Columbus, fertilizer factories, brick and terra cotta pipe plants, cotton oil mills, show case factories, sash, door and lumber mills, and a waterworks system. This load is in addition to the street railway service and the retail lighting service and small power service in the city of Columbus. An additional load is also carried, made up of lighting service and numerous small industries in towns and cities through which their transmission lines run, the principal of these being Newnan, West Point, Grantville and LaGrange.

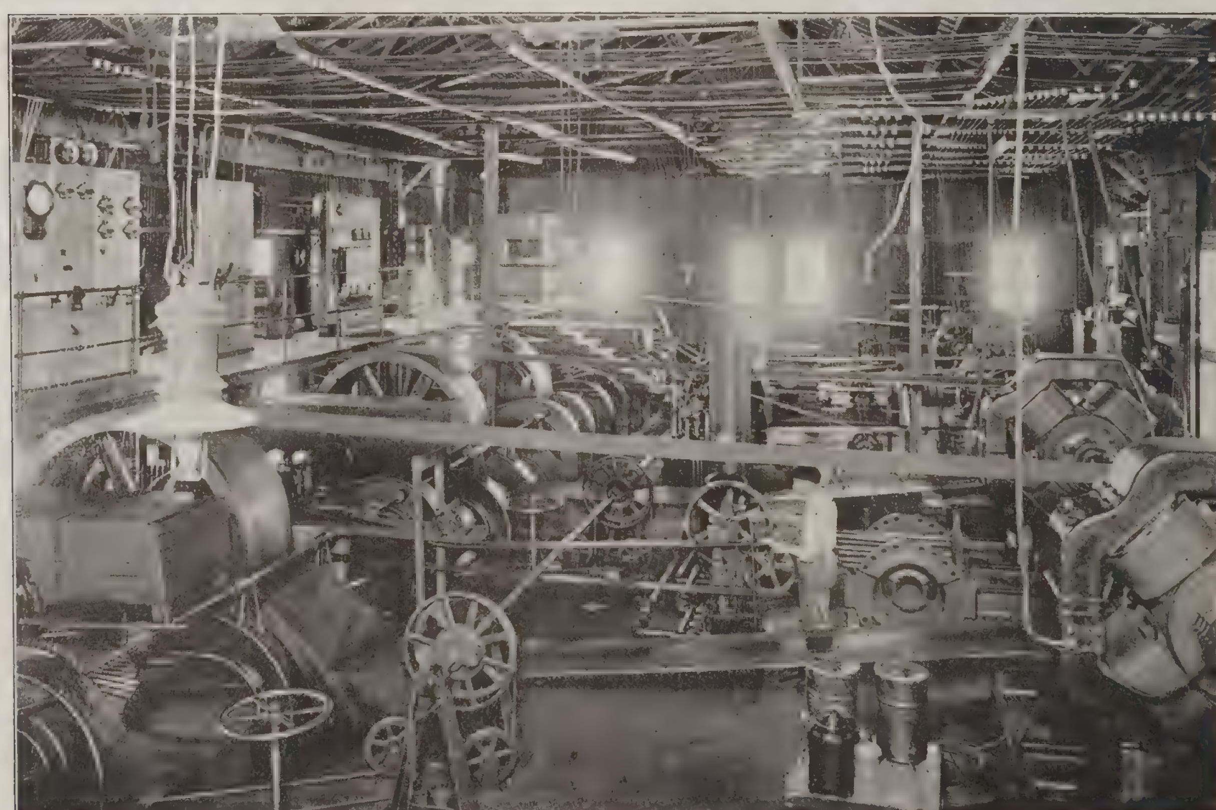


FIG. 4. VIEW OF CITY MILLS STATION SHOWING EARLY TYPE OF HYDROELECTRIC DESIGN STILL IN USE.

On account of the early types of equipment in the City Mills station mentioned above, its design as a water power development is interesting. There are in this station six water wheels of 200 hp capacity each, working under an effective head of 10 feet. The wheels are of the vertical single runner type made by James Leffel and Company, of Springfield, Ohio. Two of them are connected through a rope drive to a 300 kw. 2-phase 60-cycle, 2300 volt General Electric generator, this unit being installed in 1911.

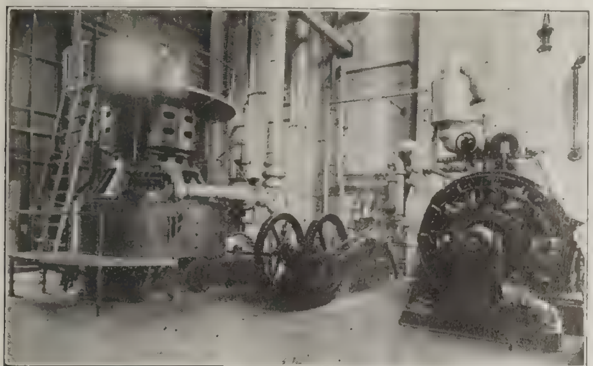


FIG. 5. GENERATOR FLOOR OF COLUMBUS STEAM STATION—No. 5.

The remaining four whee's are geared direct to a line shaft and belted to this shaft are two 150-kw., 2-phase, 60-cycle, 2200-volt, 600-rpm. Westinghouse constant potential generators of the revolving armature type and two General Electric 200 kw., 550-volt, D. C. multipolar railway generators. The violent fluctuations in load on these railway units is partially taken care of by a Barber automatic regulator which automatically grounds the bus through a resistance when the load drops off suddenly, which together with the governor on the water wheels gives a very good regulation. The wheels on the shaft are governed by a Lombard type N. S. oil pressure governor, the shaft having a number of coup'ings which enable it to be run in sections.

The most recent and important development of the generating system on account of its size is a hydro-electric plant recently placed in operation and providing for an ultimate capacity of 30,000 Kw. It is concerning the electrical features of this plant and the transmission system to which it is connected that this article will treat.

THE GOAT ROCK DEVELOPMENT.

During the early part of 1910 work was begun on an impounding dam on the Chattahoochee river thirteen miles

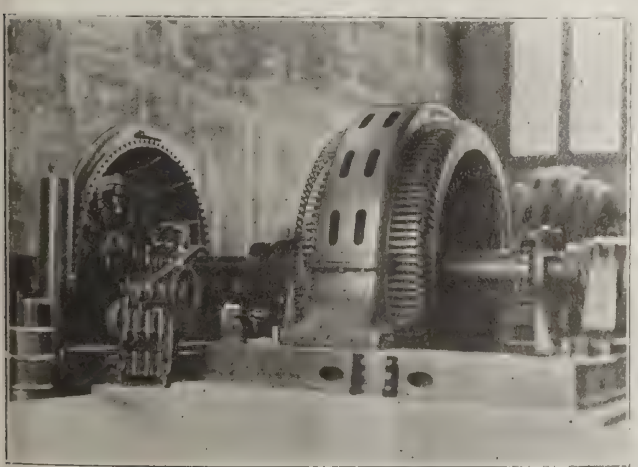


FIG. 7. VIEW OF TURBINES AND GENERATORS IN GOAT ROCK STATION.

FIG. 6. VIEW OF STEAM STATION SHOWING SWITCHBOARD GALLERY.

by air line North of Columbus at a point known as Goat Rock. Here on account of the river flowing between steep hills, an excellent site was provided for such a dam and later to construct a power dam and a generating station. The construction of the impounding dam was to provide a storage for the lower water power developments located in Columbus and allow an increase in their capacity to accommodate the rapidly increasing power business already mentioned, the connection of which was inevitable before a complete power development could be made at Goat Rock. The impounding dam was carried to a height of 21 feet, constructed with full foundations and in such a way that it could be raised to 70 feet, its final height, without requiring the use of coffer dams.

The completed power dam is of cyclopean concrete with gravity section, with a total length of 1,212 feet, of which the spillway takes up 910 feet. The base is 70 feet and the effective head with three feet of flash boards 73 feet. As shown in the plan of the station and section of the dam, a tunnel passes from one end of the dam to the other, through the spillway section, allowing easy inspection through good lighting and easy access to the rear of the wheel bearings at the power house or Alabama end. At the east end of the power house section are located four motor-operated waste gates to control the flow of water to the lower developments and capable of passing 10,000 sec-feet. Inasmuch as the flow of the river at the location of the dam varies from 1,000 to 100,000 sec-feet, the construction of the dam with a storage of 1,000 acres, makes possible the partial control of fluctuations in flow and protects lower developments on the river in times of low water.

In reference to the location of the dam, it is interesting to note that it extends across the river in practically an east and west direction, the head walls and exactly one-half of the ultimate station being in Lee county, Alabama, and

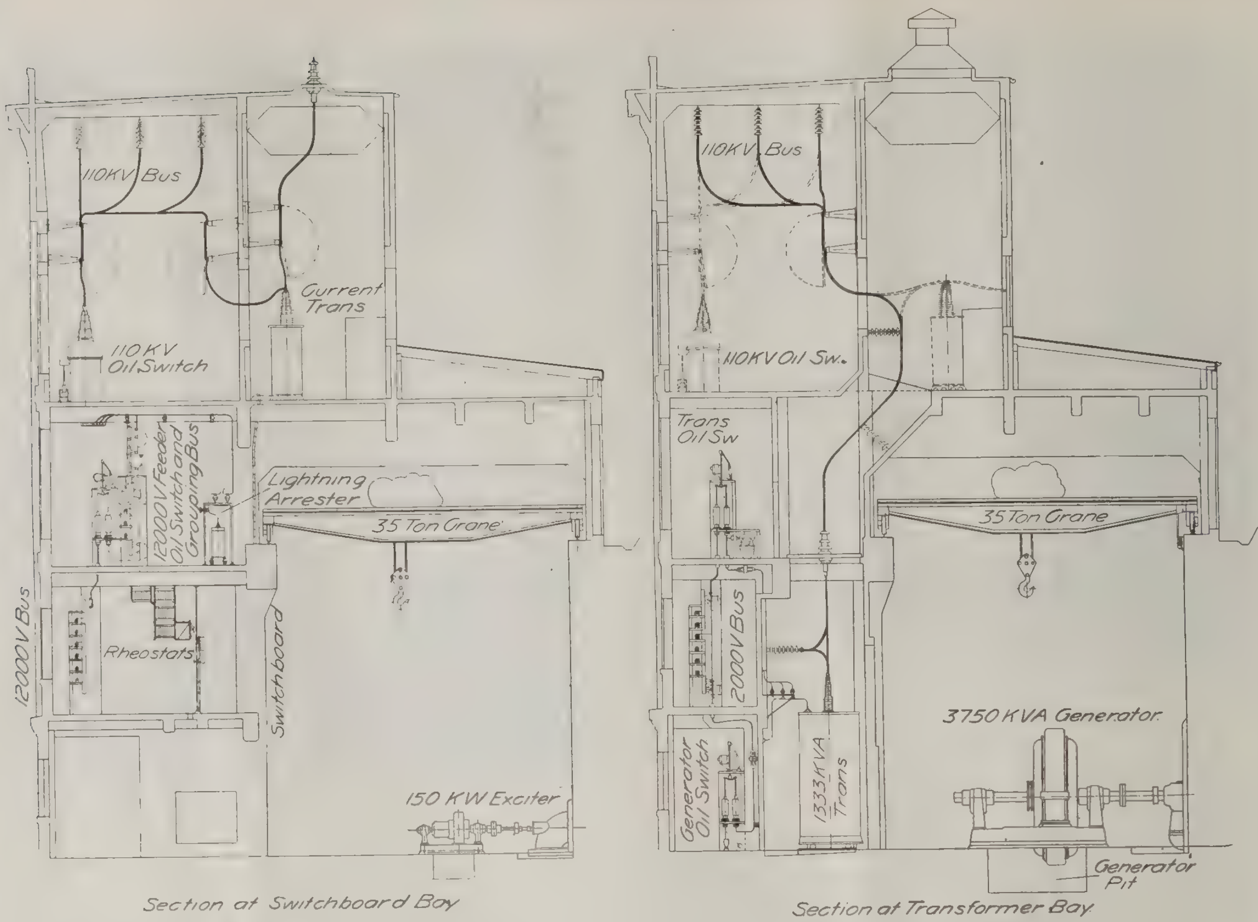


FIG. 8. SECTIONS THROUGH SWITCHING EQUIPMENT IN GOAT ROCK STATION.

the remainder of the station and dam in Harris county, Georgia.

TURBINES AND GENERATORS.

The turbines installed in the Goat Rock station are of the S. Morgan Smith type, each containing two 53-inch wheels of 4,800 horsepower, direct connected to Westinghouse 3,750 Kva. 11,000-volt generators. As already mentioned, a feature of the turbine installation is the provision through the tunnel in the dam for accessibility to the rear wheel bearings. The crown plates, gate links, and all gate control apparatus is also accessibly arranged, being located outside the wheel ceilings on the generator floor side. This construction is shown in Fig. 7. The exciter turbines are single runner 18-inch wheels direct connected to 150 Kw., 125-volt generators.

The main wheels are controlled by type NS and the exciter wheels by Type F Lombard governors. All the head gate rigging is motor driven, the motors being located in a special concrete house on the head wall, as shown in Fig. 16. The flash board arrangement which provides three additional feet head, consists of pins made up of one and three-quarter inch rods inserted in sockets on the top of the dam on 18-inch centers. The boards secured to these pins are 1 x 12 x 16 feet.

Provision is made in that part of the station now completed for three 3-phase, 11,000-volt generators of 5,000 Kva. capacity. The ultimate station arrangement provides for the installation of six 5,000 Kva. units giving a total capacity of 30,000 Kva. The present station contains two 3,750 Kva. units, which will be later replaced by generators of larger capacity. It also contains two 150 Kw. 125-volt interpole turbine driven exciters, which will be the total exciter capacity until the total number of units is installed, when a motor driven exciter set will be added.

CIRCUIT LAYOUTS.

The leads from the generators consist of 2/0 single stranded lead covered cables and run through conduit imbedded in the floor. As shown in section Fig. 8, the step-up transformers and generator 11,000-volt oil switches are located on the generator floor level in suitable compartments made of concrete, and a part of the building structure. The transformer compartments are located directly in front of

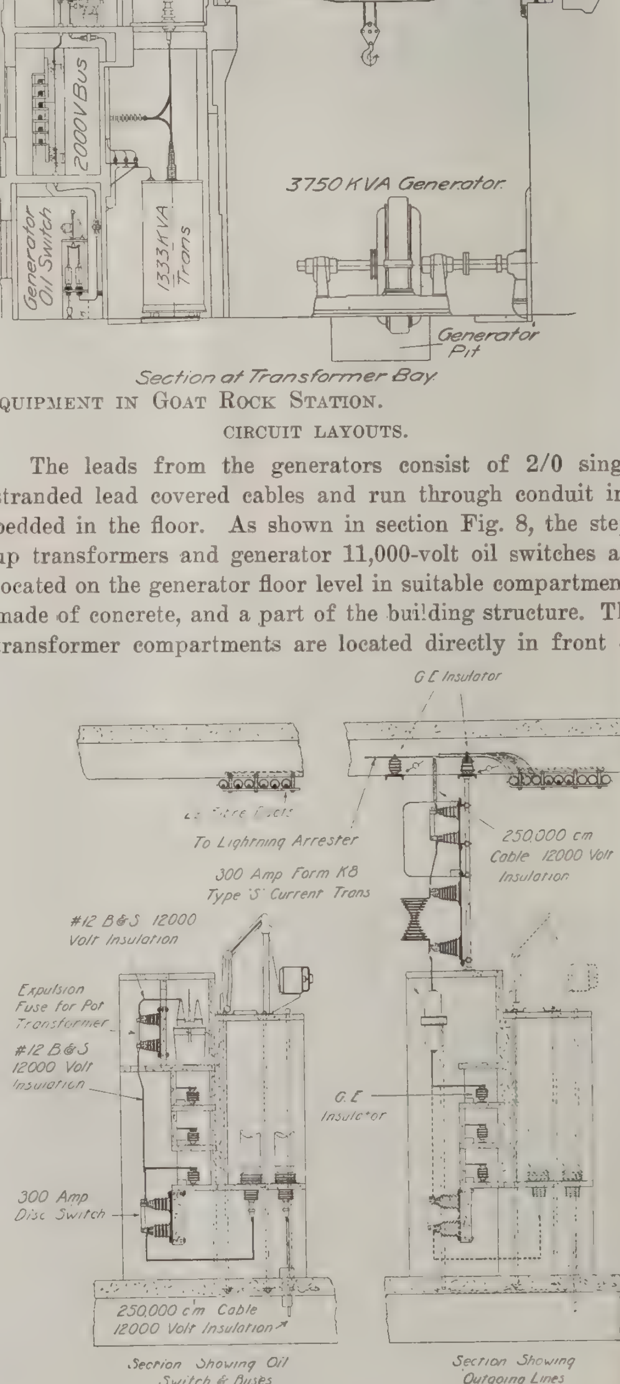


FIG. 9. FEEDER OIL SWITCH ARRANGEMENT.

the generator oil switches and 11,000-volt bus compartments and between these and the generators, provision is made for six 1,333 Kw. 66,000-volt single phase transformers, three being already installed.

The leads from the generators pass through the oil switches on the first floor, then through the floor and disconnecting switches to the main 11,000-volt bus, as shown in Fig. 8, where arrangements are made for a duplicate bus layout. All buses and disconnecting switches are set in concrete barriers reaching from the floor to the ceiling. The present section being about 70 feet long or about one-half the total installation.

FEEDER ARRANGEMENTS—11,000-VOLT LINE.

From the 11,000-volt buses, the leads for the 11,000-volt transmission lines pass through disconnecting switches, up through the second gallery floor, through motor operated oil switches and disconnecting switches, to the circuit bus located in barriers as shown in the sketch of feeder and switch connections, Fig. 8. From the circuit bus, the leads pass through current transformers, through choke coils and disconnecting switches to fiber conduit leading to the east end of the building where by a special wire arbor bolted to the side of the building, the circuits leave the station for transmission at 11,000-volts to Columbus. These circuits leave the station and cross the river by one 1,200 foot span of 3/0 copper cables to a steel anchor tower on the east bank.

FEEDER ARRANGEMENTS—66,000-VOLT LINE.

The leads to the 11,000-volt side of the transformers leave the buses through disconnecting switches and pass up through the second gallery floor through motor driven oil switches, then back through current transformers directly into the transformer bays. The high tension leads from the

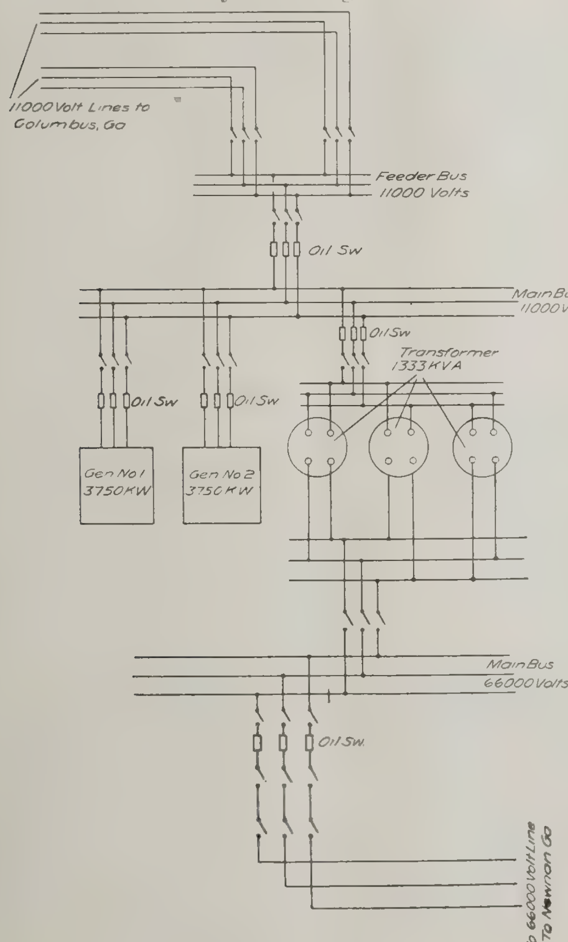


FIG. 10. BUS AND CIRCUIT LAYOUT OF GOAT ROCK STATION.

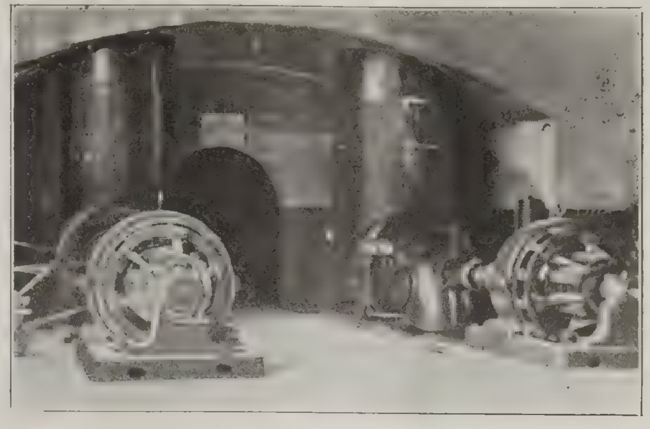


FIG. 11. TURBINE DRIVEN EXCITERS AT GOAT ROCK.

transformers are supported on post type insulators and run in separate compartments to the level of the top floor or high tension switching room. A special floor bushing is used where the high tension lead passes through the floor of the second gallery. From this point, the leads supported on post insulators pass through special compartment construction as shown in Fig. 12 to the top floor through disconnecting switches mounted on the wall of the high tension switching room, then to 66,000-volt busses, through disconnecting switches back through oil switches and current transformers and disconnecting switches out through roof bushings to a special wire arbor on the roof of the station. From this point, a single circuit leads to a special tower about 150 feet west of the station, shown in Fig. 18, where it passes through outdoor type choke coils, with connections to lightning arresters, and leads to single circuit steel towers for transmission to Newnan, Ga.

TRANSMISSION LINES.

As already mentioned, two transmission lines leave the Goat Rock station. One a single circuit on steel towers to Newnan, Ga., above mentioned, and the other a double circuit line on wood poles to Columbus, Ga. The single circuit line is run on standard Milliken steel towers, using Ohio Brass insulators of the unit type. With the present transmission voltage of 66,000, three insulator units are used, it being arranged so that at any time it is desired to raise the voltage to 110,000 volts, three more units can be added, giving the proper insulation. It is to be noted here that the transformers, oil switches and all high tension insulation has been designed for 110,000 volts, so that at some later time when the capacity of the station demands, it can be increased, and the transmission features of insula-

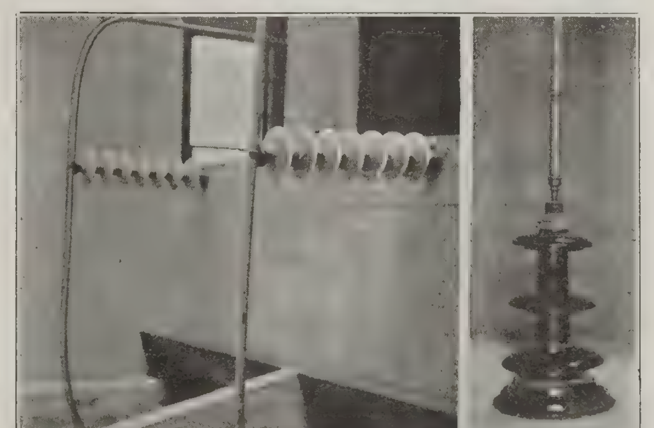


FIG. 12. POST INSULATORS AND FLOOR BUSHING USED ON HIGH TENSION LEADS.

tion require no charge further than the proper transformer and other conditions.

The towers are spaced on an average of ten to the mile, and carry stranded 2/0 copper wire from Goat Rock to West Point, Ga., a distance of 18 miles, 1/0 from West Point to LaGrange, Ga., and No. 2 from LaGrange to Newnan, Ga., a total distance of 65 miles. Lightning protection is provided by means of an overhead ground wire of 3/8-inch messenger cable, permanently grounded at each tower. The spacing of the wires is that of a tilted isosceles triangle, the base being 13 feet and each leg 15 feet. The arrangement is shown in Fig. 19. At a distance of 10½ feet below the lowest wire, a telephone line of No. 10 copper is run, transposed counter-clockwise at every tower, giving very good transmission.

The transmission line from Goat Rock to Columbus, a distance of 15 miles, is operated at 11,000 volts with wires carried on standard 40-foot wood poles, arranged in horizontal spacing on seven foot, four pin cross arms, the pin spacing on the same arm and between arms being 24 inches. Each circuit occupies one four-pin arm, the top being of 3/0 copper and the lower of No. 4. The line is protected against lightning by an overhead wire, placed on a galvanized iron support, this ground wire being 3/8-inch messenger cable. A telephone circuit is run on the same poles, transposed every fifth pole, the poles being spaced 40 to the mile.

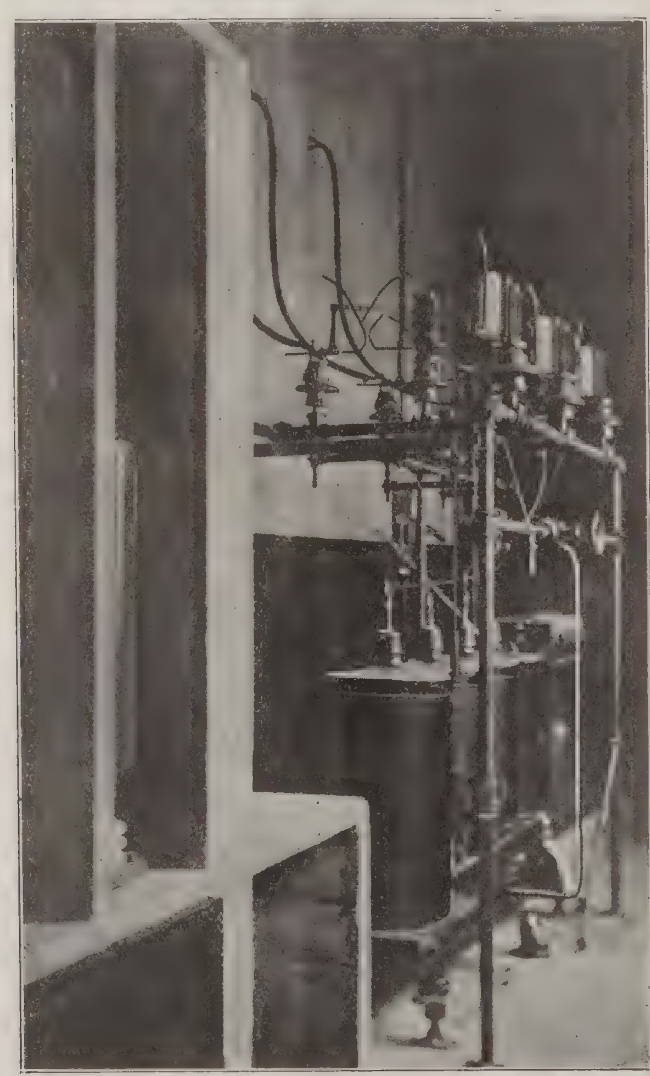


FIG. 13. LIGHTNING ARRESTER LAYOUT.

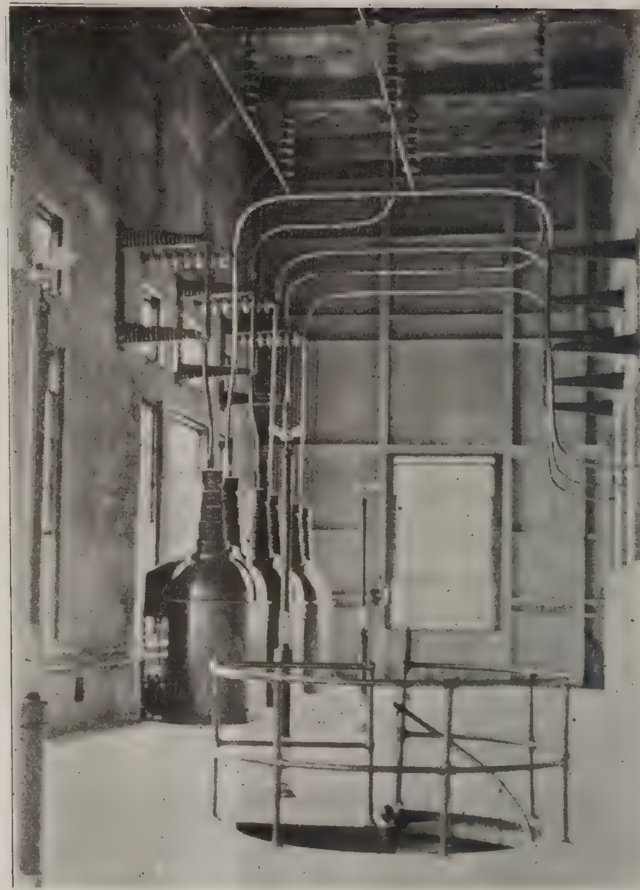


FIG. 14. VIEW OF END OF HIGH TENSION ROOM.

SWITCHBOARD ARRANGEMENT.

The main switchboard is located on a gallery overlooking the generating floor and consists of 14 panels as follows: One station power panel, controlling cranes, air compressor, and machine shop motor drives which are operated at 220 volts. Three 5 Kw. transformers are used to step the voltage down from 11,000 volts. One panel for station lighting at 110 volts. One high tension control panel. One low tension control panel with one spare panel for another bank of transformers. Two circuit panels for the 11,000-volt lines to Columbus, with one spare panel for an additional circuit. Two generator panels, with a blank panel for the additional unit provided for in the present station, two exciter panels and a Tirrill regulator panel. The instruments used are of the General Electric type and consist of standard designs of indicating and recording instruments.

MACHINE SHOP.

As shown in Fig. 19, provision is made for a complete and well arranged machine shop on the first floor adjoining

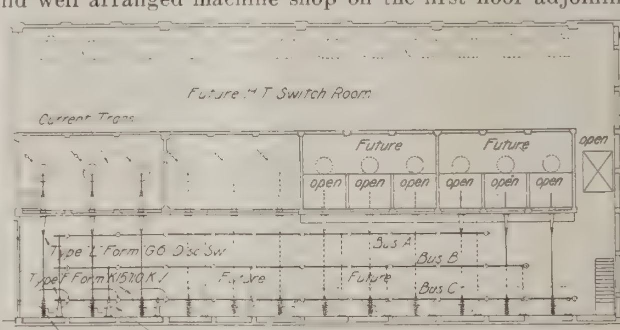


FIG 15. PLAN OF HIGH TENSION ROOM.

FIG. 16. VIEW OF UP-STREAM SIDE OF POWER STATION.

the generator floor. The importance of being able to make necessary repairs in a thorough and workmanlike manner has caused this feature of the plant to be given deserving importance. The equipment consists of a drill press, shaper, lathe, hack-saw, emery grinder, all motor driven through shafting and belts.

STATION LIGHTING.

The lighting for the station is at 110 volts taken from local lighting transformers for normal use, but can also be supplied from the exciters through a double throw switch located on the switchboard and for emergency use. The lights are all controlled from a central cabinet. The wiring is all run in conduit and all lights are tungsten used with holophane reflectors and mazdalier fixtures. Tungsten lamps are also used for lighting the tunnel, the wiring in the tunnel also being in conduit with weatherproof sockets and weatherproof glass covers. The exterior lighting around the station and dam is furnished by goose

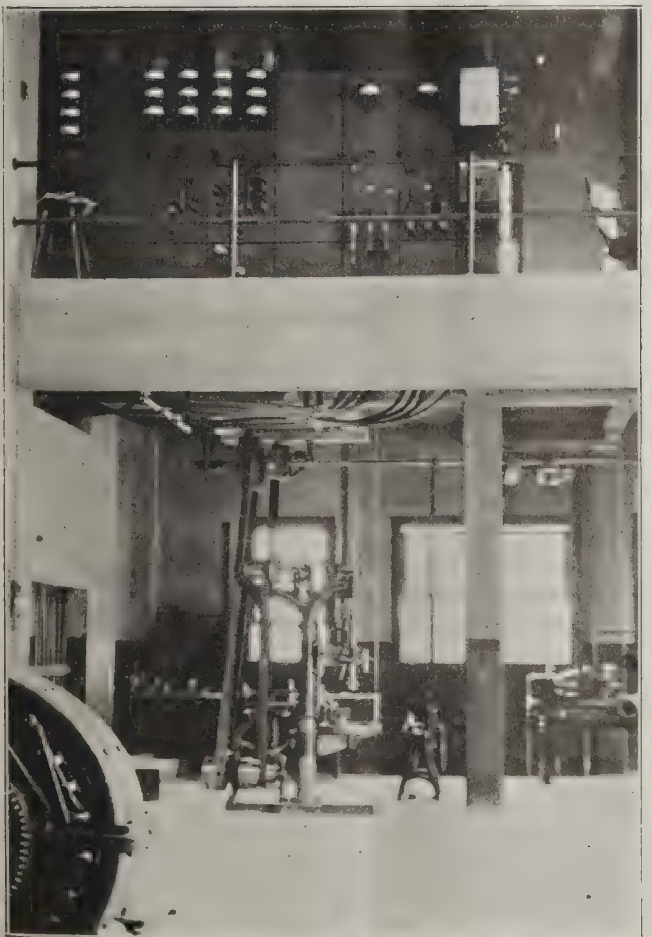


FIG. 17. VIEW FROM GENERATOR FLOOR SHOWING SWITCHBOARD GALLERY AND MACHINE SHOP.

FIG. 18. SPECIAL TOWER NEAR STATION SHOWING CHOKE COILS AND LIGHTNING ARRESTER ARRANGEMENT.

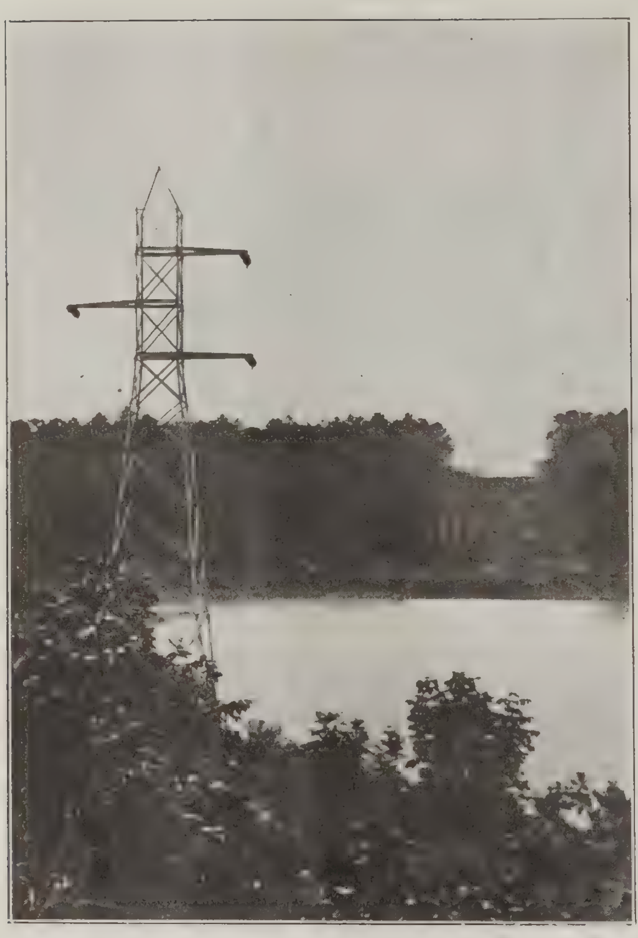


Fig. 19. Tower Line to Newnan, Ga.—66,000 Volts.

neck standards and pressed steel reflectors. These lights can all be controlled individually by snap switches if desired. In the high tension bus room, lighting is furnished by four light posts, as shown in Fig. 14, each individually controlled as desired.

SUB-STATIONS.

A standard construction for sub-stations has been adopted by the company, one being located at Newnan, now in operation, another at LaGrange, which will be completed and in operation in July of this year, and a third at West

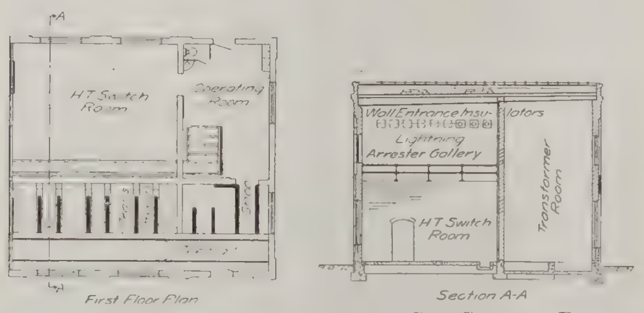


Fig. 20. Arrangement of Standard Sub-Station Design.

Point, which will be in operation in August. The substations are approximately 33 feet by 49 feet of concrete construction, two stories high, the main floor being divided into a high tension switch room and transformer bays, with a lightning arrester gallery located over the operating room. The arrangement of the sub-station is shown in Fig. 20, and the wiring layout in Fig. 21.

QUARTERS FOR OPERATING ENGINEERS.

Several large and modern houses of the bungalow type

Fig. 22. Type of Residence for Station Operators.

are being built for the station operators, one of which is shown in Fig. 22. This house is finished with all modern fixtures and furnished complete at the expense of the company. The house shown is above the forebay and occupies a most pleasant location, overlooking the river for miles in two directions. A water system is furnished the plant and the operators' houses, comprising a 10,000 gallon tank on a 50-foot tower. An electrically driven pump in the tunnel back of the turbine wheels in the station feeds this tank, the water being forced through a filter, using sulphate of aluminum.

ENGINEERING AND OPERATING ORGANIZATIONS.

The engineering in connection with the Goat Rock development was done by the Stone & Webster Engineering Corporation, of Boston, the masonry and excavation being sublet to B. H. Hardaway Contracting Company, of Columbus, Ga. The general supervision of the work was under the charge of J. L. Brown and G. F. Harley, resident engineers, of the former company.

The organization of the Columbus Power Company is one that deserves special comment in this connection, on account of its nature and the co-operative spirit that exists, as a result of each department head being entirely re-

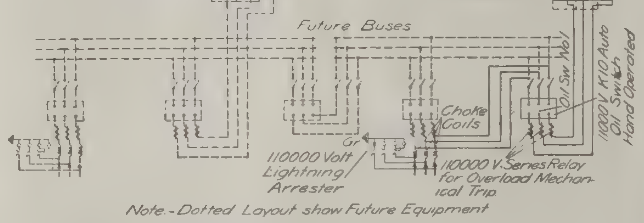


Fig. 21. Wiring Layout for Sub-Stations.

sponsible for the work it controls, reporting directly to the general manager. The company is under the management of the Stone & Webster Management Association, of Boston, with John S. Bleecker, manager at Columbus. The departmeint heads reporting to Mr. Bleecker are as follows: R. M. Harding, general superintendent; H. G. Porter, purchasing agent; A. A. Wilbur, assistant treasurer in charge of accounting department, and G. K. Hutchins, commercial agent in charge of power sales.

The Calculation of Transmission Line Losses

(*Contributed Exclusively to* ELECTRICAL ENGINEERING.)

BY N. E. FUNK, E. E.

MOST methods of calculating transmission line problems require the solution of intricate formulæ, and when simplified methods are used there is generally a considerable error. For this reason the author has devised the following method of calculation which is simple, rapid, accurate, and may be done on a slide rule. There are twenty-six tables, all of which may be interpolated or exterpolated in the same manner as logarithm tables. The resistance tables give the resistance of the size wire per mile of single-phase transmission line, that is two miles of wire. This table includes the resistance of both copper and aluminum solid wires.

The reactance factor table includes the ratio of reactance to resistance for copper wire at 60 and 25 cycles. Both of these tables are calculated for 20°C. To find the correct resistance for aluminum or copper, multiply the values found in the resistance table by the factor found in the column marked (r constant) of the temperature correction table. To find the correct (x/r) ratio, multiply values from the reactance factor table by values of (x/r) constant for copper or (x/r) constant for aluminum from the temperature correction table.

TABLE 1. RESISTANCE PER MILE OF LINE (2 MILES OF WIRE) AT 20 DEGREES C.

Size Wire	Copper	Aluminum
0000	.512	.83
000	.646	1.048
00	.815	1.32
0	1.03	1.665
1	1.293	2.095
2	1.632	2.643
3	2.06	3.34
4	2.6	4.21
5	3.275	5.31
6	4.13	6.69

TABLE 2. TEMPERATURE CORRECTION.

Degrees C.	r Constant	x/r Constant Cu.	x/r Constant Al.	Degrees C.	r Constant	x/r Constant Cu.	x/r Constant Al.
—30	.806	1.24	.77	35	1.058	.94	.58
—25	.826	1.21	.75	40	1.078	.93	.57
—20	.845	1.18	.73	45	1.097	.91	.56
—15	.864	1.16	.72	50	1.116	.90	.55
—10	.884	1.13	.70	55	1.136	.88	.54
—5	.903	1.11	.69	60	1.155	.87	.54
0	.923	1.08	.67	65	1.174	.85	.53
5	.942	1.06	.66	70	1.194	.84	.52
10	.961	1.04	.64	75	1.213	.82	.51
15	.981	1.02	.63	80	1.233	.81	.50
20	1.000	1.00	.62	85	1.252	.80	.49
25	1.019	.98	.61	90	1.271	.79	.49
30	1.039	.96	.59				

TABLE 3. CHARGING CURRENT—60 CYCLES—PER 100 MILES—PER 1,000 VOLTS BETWEEN WIRES. DISTANCE BETWEEN WIRES IN FEET.

B.& S. Gauge	1	1.5	2	2.5	3	3.5	4	5	6	7	8	9	10
0000	.426	.386	.362	.347	.334	.325	.315	.304	.292	.286	.279	.274	.27
000	.414	.373	.355	.338	.326	.317	.309	.294	.287	.281	.274	.270	.264
00	.403	.368	.345	.330	.319	.309	.302	.291	.279	.274	.270	.264	.260
0	.392	.357	.336	.322	.313	.304	.296	.285	.276	.270	.264	.260	.255
1	.382	.351	.33	.317	.302	.298	.291	.276	.268	.264	.260	.255	.251
2	.372	.340	.323	.309	.300	.291	.285	.272	.266	.260	.255	.251	.247
3	.362	.332	.317	.304	.294	.285	.275	.270	.260	.255	.251	.247	.243
4	.353	.326	.306	.296	.287	.279	.274	.264	.257	.251	.247	.243	.240
5	.345	.319	.302	.251	.279	.274	.270	.259	.253	.247	.242	.238	.234
6	.337	.311	.294	.285	.277	.270	.264	.255	.245	.244	.238	.234	.230

The capacity current is given per 100 miles of line, that is, 200 miles of wire for 1,000 volts between wires. This has been done as it is only in long distances that the capacity current is large enough to effect the voltage, and a glance at the table will show whether or not it is necessary to include this effect in the calculation.

THE SYSTEM TABLE, FOR BALANCED CONDITIONS.

Single-phase, two-wire................I′ = Kw/Kv.
Single-phase, three-wire...............I′ = Kw/Kv.
Two-phase, four-wire................I′ = Kw/2Kv.
Two-phase, three-wire*..............I′ = Kw/2Kv.
Two-phase, five-wire.................I′ = Kw/2Kv.
Three-phase, three-wire.............I′ = Kw/2Kv.
Three-phase, four-wire..............I′ = Kw/2Kv.

Kw.—The total power transmitted.

Kv.—The voltage between outside wires in single and two-phase systems and the delta voltage in three phase systems in Kilovolts.

I′—Amperes used in calculating the D. C. voltage loss.

*The power loss calculation is correct for this system but the voltage loss is in error due to the dephasing action of the (b) wire. The voltage loss as calculated will be the average of the voltage loss in each phase.

TABLE 4. CHARGING CURRENT—25 CYCLES—PER 100 MILES OF LINE—PER 1,000 VOLTS BETWEEN WIRES. DISTANCE BETWEEN WIRES IN FEET.

B.&S. Ga'ge	1	1.5	2	2.5	3	3.5	4	5	6	7	8	9	10
0000	.178	.161	.151	.145	.139	.135	.131	.127	.122	.120	.116	.114	.112
000	.173	.156	.148	.141	.136	.132	.129	.123	.120	.117	.114	.112	.110
00	.168	.153	.144	.138	.133	.129	.126	.121	.116	.114	.112	.110	.109
0	.163	.149	.140	.134	.131	.127	.123	.119	.115	.113	.110	.109	.106
1	.159	.146	.138	.132	.126	.124	.121	.115	.112	.110	.109	.106	.105
2	.155	.142	.134	.129	.125	.121	.119	.113	.111	.109	.106	.105	.103
3	.151	.139	.132	.127	.123	.119	.115	.113	.109	.106	.105	.103	.102
4	.147	.136	.128	.124	.120	.117	.114	.110	.107	.105	.103	.102	.100
5	.144	.133	.126	.121	.117	.114	.113	.108	.106	.103	.101	.098	.097
6	.141	.130	.123	.119	.116	.113	.110	.106	.102	.101	.099	.098	.096

For any other frequency multiply values of current found in above table by (.04 multiplied by f).

TABLE 5. X/R AT 20 DEGREES C FOR 60 CYCLES. DISTANCE BETWEEN WIRES IN FEET.

B.&S. Ga'ge	.5	1	1.5	2	2.5	3	3.5	4	5	6	7	8	9	10
0000	1.65	1.98	2.16	2.30	2.40	2.49	2.56	2.62	2.72	2.81	2.89	2.95	3.01	3.06
000	1.35	1.61	1.76	1.87	1.95	2.01	2.08	2.12	2.20	2.27	2.33	2.38	2.42	2.46
00	1.11	1.31	1.43	1.52	1.58	1.64	1.68	1.72	1.78	1.84	1.88	1.92	1.96	1.99
0	.91	1.07	1.16	1.23	1.28	1.32	1.36	1.39	1.44	1.48	1.52	1.55	1.58	1.61
1	.74	.86	.94	1.00	1.04	1.07	1.10	1.12	1.16	1.20	1.22	1.25	1.27	1.29
2	.60	.70	.76	.81	.84	.87	.89	.91	.94	.97	.99	1.01	1.03	1.04
3	.49	.57	.62	.65	.68	.70	.71	.73	.76	.78	.80	.82	.83	.84
4	.40	.46	.50	.53	.55	.56	.58	.59	.61	.63	.64	.65	.67	.68
5	.33	.38	.41	.43	.44	.46	.47	.48	.49	.51	.56	.53	.54	.55
6	.27	.31	.33	.35	.36	.37	.38	.39	.40	.41	.42	.43	.43	.44

TABLE 6. X/R AT 20 DEGREES C FOR 25 CYCLES. DISTANCE BETWEEN WIRES IN FEET.

B.&S G'ge	.5	1	1.5	2	2.5	3	3.5	4	5	6	7	8	9	10
0000	.69	.83	.90	.96	1.00	1.04	1.07	1.09	1.13	1.17	1.20	1.23	1.25	1.27
000	.56	.67	.73	.78	.81	.84	.87	.88	.92	.95	.97	.99	1.01	1.02
00	.46	.55	.60	.63	.66	.68	.70	.72	.74	.77	.78	.80	.82	.83
0	.38	.45	.48	.51	.53	.55	.57	.58	.60	.62	.63	.65	.66	.67
1	.31	.36	.39	.42	.43	.45	.46	.47	.48	.50	.51	.52	.53	.54
2	.25	.29	.32	.34	.35	.36	.37	.38	.39	.40	.41	.42	.43	.43
3	.20	.24	.26	.27	.28	.29	.30	.31	.32	.33	.33	.34	.35	.35
4	.17	.19	.21	.22	.23	.23	.24	.25	.25	.26	.27	.27	.28	.28
5	.14	.16	.17	.18	.18	.19	.20	.20	.20	.21	.22	.22	.23	.23
6	.11	.13	.14	.15	.15	.15	.16	.16	.17	.17	.18	.18	.18	.18

For reactance factors at any other frequency multiply the values found in this table by (.04 x f).

TABLE 7. POWER LOSS.

	Ratio of Charging Current to Direct Current.										
P.F	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
.40	6.25	6.02	5.80	5.59	5.37	5.17	4.97	4.77	4.58	4.39	4.21
.45	4.94	4.74	4.55	4.37	4.19	4.01	3.84	3.67	3.51	3.36	3.20
.50	4.00	3.83	3.66	3.50	3.35	3.20	3.05	2.91	2.77	2.64	2.52
.55	3.31	3.16	3.01	2.87	2.74	2.61	2.49	2.37	2.25	2.14	2.04
.60	2.78	2.65	2.52	2.40	2.28	2.17	2.07	1.97	1.87	1.78	1.69
.65	2.37	2.25	2.14	2.04	1.94	1.85	1.76	1.67	1.59	1.52	1.45
.70	2.04	1.94	1.85	1.76	1.67	1.59	1.52	1.45	1.39	1.33	1.27
.75	1.78	1.69	1.61	1.54	1.47	1.40	1.34	1.28	1.23	1.19	1.15
.80	1.56	1.49	1.42	1.36	1.30	1.25	1.20	1.16	1.12	1.09	1.06
.85	1.38	1.33	1.27	1.22	1.18	1.14	1.10	1.07	1.05	1.03	1.01
.90	1.23	1.19	1.15	1.11	1.08	1.06	1.03	1.02	1.01	1.00	1.00
.95	1.11	1.08	1.05	1.03	1.02	1.01	1.00	1.00	1.00	1.01	1.03
.98	1.04	1.02	1.01	1.00	1.00	1.00	1.01	1.02	1.04	1.06	1.09
.99	1.02	1.01	1.00	1.00	1.00	1.01	1.03	1.04	1.07	1.10	1.13
1.00	1.00	1.00	1.01	1.02	1.04	1.06	1.09	1.12	1.16	1.20	1.25
.99	1.02	1.04	1.06	1.09	1.12	1.15	1.20	1.24	1.29	1.35	1.41
.98	1.04	1.06	1.09	1.13	1.16	1.21	1.25	1.31	1.36	1.43	1.49
.95	1.11	1.14	1.18	1.23	1.28	1.33	1.39	1.46	1.53	1.61	1.69
.90	1.23	1.29	1.34	1.40	1.47	1.54	1.62	1.70	1.78	1.87	1.97
.85	1.38	1.45	1.52	1.59	1.67	1.76	1.85	1.94	2.04	2.14	2.25
.80	1.56	1.64	1.72	1.81	1.90	2.00	2.10	2.21	2.32	2.44	2.56
.75	1.78	1.87	1.96	2.07	2.17	2.28	2.40	2.52	2.64	2.77	2.91
.70	2.04	2.15	2.26	2.37	2.49	2.61	2.74	2.88	3.02	3.16	3.41

NOTE: Values below heavy line are for Leading Power Factor.

TABLE 8. CONVERSION TABLE.

To Find Power Factor from Power Loss Table.							
P.F.	b	P.F.	b	P.F.	b	P.F.	b
1.00	1.000	0.80	1.562	0.60	2.780	0.40	6.250
0.99	1.020	0.79	1.602	0.59	2.872		
0.98	1.041	0.78	1.643	0.58	2.972		
0.97	1.063	0.77	1.686	0.57	3.077		
0.96	1.085	0.76	1.731	0.56	3.187		
0.95	1.108	0.75	1.777	0.55	3.305		
0.94	1.131	0.74	1.826	0.54	3.429		
0.93	1.156	0.73	1.876	0.53	3.567		
0.92	1.181	0.72	1.930	0.52	3.698		
0.91	1.207	0.71	1.977	0.51	3.844		
0.90	1.234	0.70	2.041	0.50	4.000		
0.89	1.262	0.69	2.100	0.49	4.164		
0.88	1.291	0.68	2.162	0.48	4.340		
0.87	1.321	0.67	2.227	0.47	4.526		
0.86	1.352	0.66	2.295	0.46	4.725		
0.85	1.384	0.65	2.367	0.45	4.939		
0.84	1.417	0.64	2.441	0.44	5.165		
0.83	1.450	0.63	2.512	0.43	5.408		
0.82	1.487	0.62	2.601	0.42	5.668		
0.81	1.524	0.61	2.687	0.41	5.948		

NOTE: Values in Column "b" are the ratio of A.C. to D.C. power loss found in the Power Loss Table.
Values in column "P.F." are the power factors corresponding to that power loss ratio.

TABLE 9. LAGGING CURRENT. POWER FACTOR 20 PER CENT.

	D. C. Volts Loss In Per Cent.								
x/r	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
0.0	0.2	0.3	0.4	0.5	0.6	0.8	0.9	1.0	1.1
0.2	0.4	0.6	0.8	1.0	1.2	1.5	1.7	1.9	2.1
0.4	0.6	0.9	1.2	1.5	1.8	2.2	2.5	2.8	3.1
0.6	0.8	1.2	1.6	2.0	2.4	2.8	3.2	3.6	4.1
0.8	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
1.0	1.2	1.8	2.4	3.0	3.6	4.2	4.8	5.4	6.0
1.2	1.4	2.1	2.8	3.5	4.2	4.8	5.6	6.3	6.9
1.4	1.6	2.4	3.2	4.0	4.8	5.5	6.4	7.1	7.9
1.6	1.8	2.7	3.6	4.4	5.3	6.1	7.1	8.0	8.8
1.8	2.0	2.9	4.0	4.9	5.9	6.7	7.9	8.8	9.8
2.0	2.2	3.2	4.3	5.4	6.5	7.4	8.7	9.7	10.8
2.2	2.4	3.5	4.7	5.9	7.1	8.1	9.5	10.6	11.8
2.4	2.6	3.8	5.1	6.3	7.7	8.8	10.3	11.5	12.7
2.6	2.8	4.1	5.5	6.8	8.2	9.5	11.0	12.4	13.7
2.8	3.0	4.4	5.9	7.3	8.8	10.3	11.8	13.2	14.7
3.0	3.2	4.7	6.3	7.8	9.4	11.0	12.6	14.1	15.7
3.2	3.4	5.0	6.6	8.3	10.0	11.7	13.2	15.0	16.6
3.4	3.6	5.3	7.0	8.8	10.6	12.3	14.0	15.9	17.6
3.6	3.8	5.6	7.4	9.3	11.2	13.0	14.8	16.8	18.6
3.8	3.9	5.9	7.8	9.8	11.8	13.7	15.6	17.6	19.6
4.0	4.1	6.2	8.2	10.3	12.4	14.4	16.5	18.5	20.6
4.2	4.3	6.5	8.6	10.8	13.0	15.1	17.2	19.4	21.6
4.4	4.5	6.8	9.0	11.3	13.6	15.8	18.0	20.2	22.6
4.6	4.7	7.0	9.4	11.8	14.0	16.5	18.8	21.1	23.6
4.8	4.9	7.3	9.8	12.2	14.6	17.1	19.6	22.0	24.4
5.0	5.1	7.6	10.2	12.7	15.3	17.8	20.4	22.9	25.5

TABLE 10. LAGGING CURRENT, POWER FACTOR 40 PER CENT.

	D. C. Volts Loss In Per Cent.										
x/r	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0
0.0	1.0	1.2	1.4	1.7	1.9	2.1	2.3	2.5	2.8	3.0	3.3
0.2	1.5	1.8	2.1	2.4	2.7	3.0	3.3	3.6	4.0	4.2	4.6
0.4	1.9	2.4	2.7	3.1	3.5	3.9	4.3	4.7	5.1	5.5	6.0
0.6	2.4	2.9	3.3	3.8	4.3	4.8	5.3	5.8	6.3	6.8	7.3
0.8	2.8	3.4	4.0	4.6	5.1	5.7	6.3	6.9	7.4	8.0	8.6
1.0	3.3	4.0	4.6	5.3	5.9	6.6	7.3	8.0	8.6	9.3	10.0
1.2	3.7	4.5	5.3	6.0	6.7	7.5	8.3	9.1	9.8	10.6	11.3
1.4	4.2	5.1	5.9	6.8	7.5	8.4	9.3	10.2	11.0	11.8	12.7
1.6	4.7	5.6	6.5	7.5	8.3	9.3	10.3	11.3	12.2	13.1	14.0
1.8	5.1	6.2	7.1	8.2	9.1	10.3	11.3	12.4	13.4	14.4	15.4
2.0	5.6	6.7	7.8	9.0	10.1	11.2	12.3	13.5	14.6	15.7	16.8
2.2	6.0	7.2	8.4	9.7	10.8	12.1	13.4	14.6	15.8	17.0	18.1
2.4	6.5	7.8	9.1	10.4	11.7	13.0	14.4	15.7	17.0	18.2	19.5
2.6	7.0	8.3	9.8	11.2	12.5	14.0	15.4	16.8	18.2	19.5	20.9
2.8	7.4	8.9	10.4	11.9	13.4	14.9	16.4	17.9	19.3	20.8	22.3
3.0	7.9	9.5	11.1	12.6	14.2	15.8	17.4	19.0	20.5	22.1	23.7
3.2	8.4	10.0	11.7	13.3	15.0	16.7	18.4	20.1	21.7	23.4	25.1
3.4	8.8	10.6	12.3	14.1	15.9	17.6	19.4	21.2	22.9	24.7	26.5
3.6	9.3	11.1	13.0	14.8	16.7	18.6	20.4	22.3	24.1	26.0	27.9
3.8	9.8	11.7	13.7	15.6	17.6	19.5	21.4	23.4	25.3	27.3	29.3
4.0	10.2	12.2	14.3	16.3	18.4	20.4	22.4	24.5	26.5	28.6	30.7
4.2	10.7	12.8	15.0	17.0	19.2	21.3	23.5	25.6	27.7	29.9	32.1
4.4	11.1	13.3	15.6	17.8	20.0	22.2	24.5	26.7	28.9	31.2	33.4
4.6	11.6	13.9	16.2	18.5	20.9	23.1	25.5	27.9	30.1	32.5	34.8
4.8	12.0	14.4	16.8	19.2	21.7	24.0	26.6	29.0	31.4	33.8	36.3
5.0	12.5	15.0	17.5	20.0	22.5	25.0	27.6	30.1	32.6	35.1	37.7

TABLE 11. LAGGING CURRENT, POWER FACTOR 60 PER CENT.

	D. C. Volts Loss In Per Cent.								
x/r	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
0.0	2.0	2.6	3.1	3.6	4.1	4.7	5.2	5.8	6.3
0.2	2.5	3.2	3.9	4.5	5.1	5.8	6.5	7.2	7.8
0.4	3.1	3.9	4.7	5.5	6.2	7.0	7.8	8.6	9.4
0.6	3.6	4.5	5.4	6.4	7.2	8.1	9.1	10.1	10.9
0.8	4.1	5.1	6.2	7.3	8.3	9.3	10.4	11.5	12.5
1.0	4.7	5.8	7.0	8.2	9.3	10.5	11.7	12.9	14.0
1.2	5.2	6.5	7.8	9.2	10.4	11.7	13.0	14.4	15.6
1.4	5.8	7.2	8.6	10.1	11.4	12.9	14.4	15.8	17.2
1.6	6.3	7.8	9.4	11.1	12.5	14.1	15.7	17.3	18.9
1.8	6.8	8.5	10.2	12.0	13.6	15.3	17.1	18.7	20.5
2.0	7.3	9.2	11.0	12.9	14.7	16.5	18.4	20.2	22.1
2.2	7.9	9.9	11.8	13.9	15.7	17.7	19.8	21.7	23.8
2.4	8.4	10.6	12.6	14.8	16.8	18.9	21.2	23.2	25.4
2.6	9.0	11.2	13.4	15.7	18.0	20.2	22.5	24.8	27.1
2.8	9.5	11.9	14.2	16.7	19.1	21.4	23.9	26.3	28.7
3.0	10.0	12.6	15.1	17.6	20.2	22.7	25.3	27.8	30.4
3.2	10.6	13.2	15.9	18.5	21.3	24.0	26.7	29.4	32.1
3.4	11.1	13.9	16.7	19.5	22.4	25.3	28.1	30.9	33.8
3.6	11.7	14.6	17.5	20.5	23.5	26.6	29.6	32.5	35.5
3.8	12.2	15.3	18.4	21.5	24.7	27.8	31.0	34.0	37.2
4.0	12.7	16.0	19.2	22.5	25.8	29.1	32.4	35.6	38.9
4.2	13.3	16.7	20.1	23.5	26.9	30.4	33.8	37.2	40.6
4.4	13.8	17.4	20.9	24.5	28.0	31.6	35.2	38.8	
4.6	14.4	18.1	21.7	25.5	29.2	33.0	36.6		
4.8	14.9	18.8	22.6	26.5	30.3	34.2	38.1		
5.0	15.5	19.5	23.5	27.5	31.5	35.5	39.5		

TABLE 12. LAGGING CURRENT, POWER FACTOR 70 PER CENT.

	D. C. Volts Loss In Per Cent.						
x/r	2	3	4	5	6	7	8
0.0	2.0	3.0	4.1	5.1	6.2	7.2	8.3
0.2	2.4	3.6	4.9	6.1	7.4	8.6	9.9
0.4	2.8	4.2	5.7	7.1	8.6	10.0	11.4
0.6	3.2	4.9	6.5	8.1	9.7	11.3	13.0
0.8	3.6	5.5	7.3	9.1	10.9	12.7	14.5
1.0	4.0	6.1	8.1	10.1	12.1	14.1	16.1
1.2	4.4	6.7	8.9	11.1	13.4	15.6	17.8
1.4	4.8	7.3	9.7	12.2	14.6	17.0	19.5
1.6	5.3	7.9	10.6	13.2	15.9	18.5	21.1
1.8	5.7	8.5	11.4	14.3	17.1	19.9	22.8
2.0	6.1	9.1	12.2	15.3	18.4	21.4	24.5
2.2	6.5	9.7	13.1	16.4	19.7	23.0	26.3
2.4	6.9	10.4	13.9	17.5	21.0	24.5	28.1
2.6	7.4	11.0	14.8	18.5	22.3	26.1	29.8
2.8	7.8	11.7	15.6	19.6	23.6	27.6	31.6
3.0	8.2	12.3	16.5	20.7	24.9	29.2	33.4
3.2	8.6	13.0	17.4	21.8	26.3	30.8	35.3
3.4	9.0	13.6	18.3	22.9	27.6	32.4	37.1
3.6	9.5	14.3	19.1	24.1	29.0	33.9	39.0
3.8	9.9	14.9	20.0	25.2	30.3	35.5	40.8
4.0	10.3	15.6	20.9	26.3	31.7	37.1	
4.2	10.7	16.2	21.8	27.4	33.1	38.8	
4.4	11.2	16.9	22.7	28.6	34.5	40.4	
4.6	11.6	17.6	23.6	29.7	35.8		
4.8	12.1	18.2	24.5	30.9	37.2		
5.0	12.5	18.9	25.4	32.0	38.6		

TABLE 13. LAGGING CURRENT, POWER FACTOR 80 PER CENT.

D. C. Volts Loss In Per Cent.

x/r	3	4	5	6	7	8	9	10	11
0.0	3.0	4.0	5.1	6.1	7.1	8.2	9.2	10.3	11.3
0.2	3.4	4.6	5.8	7.0	8.1	9.4	10.5	11.7	12.9
0.4	3.9	5.2	6.6	7.9	9.2	10.5	11.8	13.2	14.5
0.6	4.3	5.8	7.3	8.7	10.2	11.7	13.2	14.6	16.1
0.8	4.8	6.4	8.0	9.6	11.3	12.8	14.5	16.1	17.7
1.0	5.2	7.0	8.8	10.5	12.3	14.0	15.8	17.5	19.3
1.2	5.7	7.6	9.6	11.4	13.4	15.3	17.2	19.1	21.1
1.4	6.2	8.2	10.4	12.4	14.5	16.6	18.7	20.7	22.9
1.6	6.6	8.9	11.1	13.3	15.6	17.8	20.1	22.4	24.6
1.8	7.1	9.5	11.9	14.3	16.7	19.1	21.6	24.0	26.4
2.0	7.6	10.1	12.7	15.2	17.8	20.4	23.0	25.6	28.2
2.2	8.1	10.8	13.5	16.2	19.0	21.8	24.5	27.3	30.2
2.4	8.5	11.4	14.3	17.2	20.2	23.2	26.1	29.1	32.1
2.6	9.0	12.1	15.2	18.3	21.4	24.5	27.6	30.8	34.1
2.8	9.4	12.7	16.0	19.3	22.6	25.9	29.2	32.6	36.0
3.0	9.9	13.4	16.8	20.3	23.8	27.3	30.7	34.3	38.0
3.2	10.4	14.1	17.7	21.3	25.0	28.7	32.4	36.1	40.0
3.4	10.9	14.7	18.5	22.4	26.3	30.2	34.0	38.0	
3.6	11.4	15.4	19.4	23.4	27.5	31.6	35.7	39.8	
3.8	11.9	16.1	20.2	24.5	28.8	33.1	37.3		
4.0	12.4	16.7	21.1	25.5	30.0	34.5	39.0		
4.2	12.9	17.4	22.0	26.6	31.3	36.0			
4.4	13.5	18.1	22.9	27.7	32.6	37.5			
4.6	14.0	18.9	23.8	28.8	34.0	39.1			
4.8	14.6	19.6	24.7	29.9	35.3	40.6			
5.0	15.1	20.3	25.6	31.0	36.6				

TABLE 14. LAGGING CURRENT, POWER FACTOR 85 PER CENT.

D. C. Volts Loss In Per Cent.

x/r	3	4	5	6	7	8	9	10	11
0.0	3.0	4.0	5.0	6.1	7.1	8.1	9.1	10.2	11.2
0.2	3.4	4.5	5.6	6.8	7.9	9.1	10.2	11.4	12.5
0.4	3.7	4.9	6.2	7.5	8.8	10.0	11.3	12.6	13.8
0.6	4.1	5.4	6.8	8.3	9.6	11.0	12.3	13.8	15.2
0.8	4.4	5.9	7.4	9.0	10.5	11.9	13.4	15.0	16.5
1.0	4.8	6.4	8.0	9.7	11.3	12.9	14.5	16.2	17.8
1.2	5.2	6.9	8.7	10.5	12.3	14.0	15.8	17.6	19.4
1.4	5.6	7.5	9.4	11.3	13.2	15.1	17.0	19.0	20.9
1.6	6.0	8.0	10.0	12.1	14.2	16.2	18.3	20.4	22.5
1.8	6.4	8.6	10.7	12.9	15.0	17.3	19.5	21.8	24.0
2.0	6.8	9.1	11.4	13.7	16.1	18.4	20.8	23.2	25.6
2.2	7.2	9.6	12.1	14.6	17.1	19.6	22.1	24.7	27.3
2.4	7.6	10.2	12.8	15.4	18.1	20.8	23.5	26.2	28.9
2.6	8.0	10.7	13.5	16.3	19.2	21.9	24.8	27.7	30.6
2.8	8.4	11.3	14.2	17.1	20.2	23.1	26.2	29.2	32.2
3.0	8.8	11.8	14.9	18.0	21.2	24.3	27.5	30.7	33.9
3.2	9.2	12.4	15.6	18.9	22.3	25.6	28.9	32.3	35.8
3.4	9.6	13.0	16.4	19.8	23.4	26.8	30.4	34.0	37.6
3.6	10.1	13.5	17.1	20.7	24.4	28.1	31.8	35.6	39.5
3.8	10.5	14.1	17.9	21.6	25.5	29.3	33.3	37.3	
4.0	10.9	14.7	18.6	22.5	26.6	30.6	34.7	38.9	
4.2	11.3	15.3	19.4	23.5	27.7	31.9	36.2	40.6	
4.4	11.8	15.9	20.1	24.4	28.9	33.3	37.8		
4.6	12.3	16.5	20.9	25.4	30.0	34.6	39.3		
4.8	12.7	17.1	21.6	26.3	31.2	36.0	40.9		
5.0	13.1	17.7	22.4	27.3	32.3	37.3			

TABLE 15. LAGGING CURRENT, POWER FACTOR 90 PER CENT.

D. C. Volts Loss In Per Cent.

x/r	4	5	6	7	8	9	10	11	12
0.0	4.0	5.0	6.1	7.1	8.1	9.1	10.1	11.1	12.1
0.2	4.4	5.5	6.7	7.8	8.9	10.0	11.1	12.2	13.3
0.4	4.8	6.0	7.2	8.4	9.6	10.8	12.0	13.2	14.4
0.6	5.2	6.5	7.8	9.1	10.4	11.7	13.0	14.3	15.6
0.8	5.6	7.0	8.3	9.7	11.1	12.5	13.9	15.3	16.7
1.0	6.0	7.5	8.9	10.4	11.9	13.4	14.9	16.4	17.9
1.2	6.4	8.0	9.6	11.2	12.8	14.4	16.1	17.7	19.3
1.4	6.8	8.5	10.2	12.0	13.7	15.5	17.2	19.0	20.7
1.6	7.2	9.1	10.9	12.7	14.7	16.5	18.4	20.2	22.2
1.8	7.6	9.6	11.5	13.5	15.6	17.6	19.5	21.5	23.6
2.0	8.0	10.1	12.2	14.3	16.5	18.6	20.7	22.8	25.0
2.2	8.5	10.7	12.9	15.1	17.5	19.7	22.0	24.3	26.6
2.4	8.9	11.3	13.6	16.0	18.4	20.8	23.2	25.7	28.2
2.6	9.4	11.8	14.3	16.8	19.4	21.9	24.5	27.2	29.7
2.8	9.8	12.4	15.0	17.7	20.3	23.0	25.7	28.6	31.3
3.0	10.3	13.0	15.7	18.5	21.3	24.1	27.0	30.1	32.9
3.2	10.8	13.6	16.4	19.4	22.4	25.3	28.4	31.6	34.6
3.4	11.2	14.2	17.2	20.3	23.4	26.6	29.8	33.2	36.4
3.6	11.7	14.8	17.9	21.2	24.5	27.8	31.2	34.7	38.1
3.8	12.1	15.4	18.7	22.1	25.5	29.1	32.6	36.3	39.9
4.0	12.6	16.0	19.4	23.0	26.6	30.3	34.0	37.8	
4.2	13.1	16.6	20.2	24.0	27.8	31.6	35.5	39.5	
4.4	13.6	17.3	21.0	25.0	28.9	32.9	37.0		
4.6	14.1	17.9	21.9	25.9	30.1	34.3	38.5		
4.8	14.6	18.6	22.7	26.9	31.2	35.6	40.0		
5.0	15.1	19.2	23.5	27.9	32.4	36.9			

TABLE 16. LAGGING CURRENT, POWER FACTOR 95 PER CENT.

D. C. Volts Loss In Per Cent.

x/r	4	5	6	7	8	9	10	11	12	13	14
0.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0
0.2	4.3	5.3	6.4	7.5	8.6	9.6	10.7	11.8	12.8	13.9	15.0
0.4	4.6	5.7	6.8	8.0	9.1	10.3	11.4	12.6	13.7	14.8	16.0
0.6	4.8	6.0	7.3	8.4	9.7	10.9	12.1	13.3	14.5	15.8	16.9
0.8	5.1	6.4	7.7	8.9	10.2	11.6	12.8	14.1	15.4	16.7	17.9
1.0	5.4	6.7	8.1	9.4	10.8	12.2	13.5	14.9	16.2	17.6	18.9
1.2	5.7	7.1	8.6	10.0	11.5	12.9	14.4	15.8	17.2	18.8	20.2
1.4	6.0	7.5	9.0	10.5	12.1	13.7	15.2	16.8	18.2	19.9	21.5
1.6	6.2	7.8	9.5	11.1	12.8	14.4	16.1	17.7	19.3	21.1	22.7
1.8	6.5	8.2	9.9	11.6	13.4	15.2	16.9	18.7	20.3	22.2	24.0
2.0	6.8	8.6	10.4	12.2	14.1	15.9	17.8	19.6	21.3	23.4	25.3
2.2	7.1	9.0	10.9	12.8	14.8	16.8	18.8	20.7	22.6	24.8	26.8
2.4	7.4	9.4	11.4	13.5	15.6	17.7	19.8	21.8	23.9	26.2	28.4
2.6	7.8	9.9	12.0	14.1	16.3	18.5	20.7	23.0	25.2	27.6	29.9
2.8	8.1	10.3	12.5	14.8	17.1	19.4	21.7	24.1	26.5	29.0	31.5
3.0	8.4	10.7	13.0	15.4	17.8	20.3	22.7	25.2	27.8	30.4	33.0
3.2	8.8	11.2	13.6	16.1	18.7	21.3	23.9	26.5	29.2	32.0	34.8
3.4	9.1	11.7	14.2	16.8	19.5	22.3	25.0	27.8	30.7	33.6	36.6
3.6	9.5	12.1	14.8	17.6	20.4	23.3	26.2	29.1	32.1	35.2	38.3
3.8	9.8	12.6	15.4	18.3	21.2	24.3	27.3	30.4	33.6	36.8	
4.0	10.2	13.1	16.0	19.0	22.1	25.3	28.5	31.7	35.0	38.4	
4.2	10.6	13.6	16.7	19.8	23.0	26.4	29.7	33.1	36.6		
4.4	11.1	14.2	17.4	20.6	24.0	27.5	31.0	34.5	38.2		
4.6	11.5	14.7	18.0	21.4	25.0	28.6	32.2	36.0	39.8		
4.8	12.0	15.3	18.7	22.2	25.9	29.7	33.0	37.4			
5.0	12.4	15.8	19.4	23.0	26.8	30.8	34.7	38.8			

THE VOLTAGE LOSS.

All values below the solid line in the Leading Current Tables are for negative voltage loss and are subtracted from the voltage at the receiving end of the line to get the voltage at the generator end. All other values found in both Leading and Lagging Current Tables are for positive voltage loss and are added to the voltage at the receiving end of the line to get the voltage at the generator end. All values below the dotted line in the Leading Current Table indicate that the power factor has changed from leading to lagging and are used in connection with the Power Conversion Table to determine the power factor at the generator end of the line.

The system table gives the values of I' to be used in making calculations. The simplicity of the method lies in the fact that the calculations of polyphase circuits are all made as though one-half of the power were transmitted on a single, two-wire line at the same voltage as the transmission line to be solved, but using direct current as the medium of transmission. By solving the D.C. voltage loss in per cent we have at the same time the D.C. power loss in per cent.

If the capacity current of the line is divided by the direct current I' then the value I_c/I' applied to the power loss factor table in connection with the power factor of the load, the power loss factor will be obtained, which multiplied by the D.C. voltage loss in per cent, will give the A.C. power loss in per cent.

The power loss factor applied to the power factor conversion table will then give the correct power factor to use in connection with the D.C. volts loss in per cent, as applied to the voltage loss table, to obtain the A.C. voltage loss in per cent.

The power factor at the generator end of the line requires some calculation which is rather simple.

e = A.C. voltage loss in per cent.

w = A.C. power loss in per cent.

$\cos. \Theta'' = \cos \Theta' (100 + w) \div (100 + e)$.

$I'_c/I'_g = I_c/I' (100 + e)^2/(100 + w)$.

Apply the values of $\cos. \Theta''$ and I'_c/I'_g to the power loss factor table and the power factor conversion table in succession to obtain the power factor at the generator end of the line. If charging current is so small as to be neglected, then the power factor at the generator end of the line is $\cos. \Theta_g = \cos. \Theta' (100 + w) \div (100 + e)$. The following section entitled "The Method" describes the steps in detail but to assure a complete understanding the following problems have been worked out completely. The distances are considered correct for sag.

Table 17. Lagging Current, Power Factor 98 Per Cent.

D. C. Volts Loss in Per Cent.

x/r	5	6	7	8	9	10	11	12	13	14	15
0.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0
0.2	5.2	6.3	7.2	8.4	9.4	10.4	11.4	12.5	13.5	14.5	15.5
0.4	5.4	6.5	7.6	8.6	9.7	10.8	11.9	12.9	14.0	15.1	16.1
0.6	5.6	6.7	7.9	9.0	10.1	11.3	12.4	13.5	14.6	15.8	16.9
0.8	5.9	7.0	8.2	9.4	10.6	11.8	12.9	14.1	15.3	16.5	17.7
1.0	6.1	7.3	8.6	9.8	11.1	12.3	13.6	14.8	16.1	17.3	18.6
1.2	6.4	7.6	8.9	10.2	11.5	12.8	14.1	15.4	16.8	18.1	19.2
1.4	6.6	7.9	9.3	10.7	12.0	13.4	14.8	16.1	17.5	18.9	20.2
1.6	6.9	8.3	9.7	11.1	12.5	14.0	15.4	16.9	18.3	19.8	21.3
1.8	7.1	8.6	10.1	11.6	13.1	14.7	16.2	17.8	19.4	21.0	22.6
2.0	7.4	9.0	10.5	12.1	13.8	15.4	17.1	18.8	20.5	22.2	24.0
2.2	7.7	9.4	11.0	12.7	14.5	16.2	18.0	19.8	21.6	23.5	25.4
2.4	8.0	9.8	11.5	13.3	15.1	17.0	18.9	20.8	22.7	24.7	26.8
2.6	8.4	10.1	11.9	13.8	15.8	17.7	19.7	21.8	23.9	26.0	28.1
2.8	8.7	10.5	12.4	14.4	16.4	18.5	20.6	22.8	25.0	27.2	29.5
3.0	9.0	10.9	12.9	15.0	17.1	19.3	21.5	23.8	26.1	28.5	30.9
3.2	9.3	11.3	13.4	15.7	17.9	20.2	22.6	25.0	27.5	30.0	32.6
3.4	9.7	11.8	14.0	16.3	18.7	21.1	23.6	26.2	28.8	31.5	34.3
3.6	10.0	12.2	14.5	17.0	19.4	22.1	24.7	27.4	30.2	33.0	35.9
3.8	10.4	12.7	15.1	17.6	20.2	23.0	25.7	28.6	31.5	34.5	37.6
4.0	10.7	13.1	15.6	18.3	21.0	23.9	26.8	29.8	32.9	36.0	39.3
4.2	11.1	13.6	16.2	19.1	21.9	25.0	28.0	31.2	34.4	37.7	
4.4	11.5	14.1	16.9	19.8	22.8	26.0	29.2	32.5	35.9	39.4	
4.6	11.8	14.6	17.5	20.6	23.8	27.1	30.4	33.9	37.5		
4.8	12.2	15.1	18.2	21.3	24.7	28.1	31.6	35.2	39.0		
5.0	12.6	15.6	18.8	22.1	25.6	29.2	32.8	36.6			

Table 18. Lagging Current, Power Factor 99 Per Cent.

D. C. Volts Loss In Per Cent.

x/r	5	6	7	8	9	10	11	12	13	14	15
0.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0
0.2	5.2	6.2	7.2	8.3	9.3	10.4	11.4	12.4	13.5	14.5	15.6
0.4	5.3	6.4	7.5	8.5	9.6	10.7	11.8	12.8	13.9	15.0	16.1
0.6	5.5	6.6	7.7	8.8	9.9	11.1	12.2	13.3	14.4	15.5	16.6
0.8	5.7	6.8	7.9	9.1	10.2	11.4	12.6	13.7	14.9	16.0	17.2
1.0	5.8	7.0	8.2	9.4	10.6	11.8	13.0	14.2	15.4	16.6	17.9
1.2	6.0	7.2	8.4	9.7	10.9	12.2	13.5	14.8	16.1	17.4	18.7
1.4	6.2	7.4	8.7	10.0	11.4	12.7	14.0	15.4	16.8	18.2	19.6
1.6	6.4	7.7	9.0	10.4	11.8	13.2	14.6	16.1	17.5	19.0	20.5
1.8	6.6	8.0	9.4	10.8	12.3	13.8	15.3	16.8	18.3	19.9	21.5
2.0	6.8	8.3	9.7	11.2	12.7	14.3	15.9	17.5	19.1	20.8	22.5
2.2	7.1	8.6	10.1	11.7	13.3	14.9	16.6	18.3	20.0	21.8	23.6
2.4	7.3	8.9	10.5	12.1	13.8	15.5	17.3	19.1	20.9	22.8	24.8
2.6	7.6	9.2	10.9	12.6	14.4	16.2	18.1	20.1	21.9	24.0	26.1
2.8	7.8	9.5	11.3	13.1	15.0	17.0	19.0	21.1	23.1	25.2	27.4
3.0	8.1	9.9	11.8	13.7	15.7	17.8	19.9	22.1	24.3	26.6	29.0
3.2	8.4	10.3	12.3	14.3	16.4	18.6	20.8	23.2	25.5	28.0	30.4
3.4	8.7	10.7	12.7	14.9	17.1	19.4	21.8	24.3	26.7	29.4	32.0
3.6	9.0	11.0	13.2	15.5	17.8	20.3	22.7	25.3	28.0	30.7	33.6
3.8	9.3	11.4	13.6	16.0	18.5	21.1	23.7	26.4	29.2	32.1	35.4
4.0	9.6	11.8	14.1	16.6	19.2	21.9	24.6	27.5	30.4	33.5	36.6
4.2	9.9	12.2	14.7	17.3	20.0	22.9	25.7	28.7	31.8	35.1	38.4
4.4	10.2	12.7	15.2	18.0	20.8	23.8	26.8	30.0	33.2	36.6	
4.6	10.5	13.1	15.8	18.6	21.6	24.8	27.9	31.2	34.6	38.2	
4.8	10.9	13.6	16.3	19.3	22.4	25.7	29.0	32.4	36.0	39.2	
5.0	11.2	14.0	16.9	20.0	23.2	26.6	30.1	33.6	37.4		

Problem No. 1.

Transmit 500 kilowatts, 3 miles at 2400 volts at receiving end. Power factor 80%; two phase, 4-wire, 60 cycle system. No. 00 B. & S. copper wire, 12-in. centers. Temperature 30° C.

From the system table, it is found that for a two-phase, four-wire system, I′ = K. W./2 K. V.

Then I′ = 500/2 × 2.4 = 104 amps.

From temperature correction table at 30° C., r const. = 1.039 and x/r const. = .96.

The resistance per mile of No. 00 copper (Table I) = .815 and the total resistance = .815 × 3 × 1.039 = 2.54 ohms.

From voltage loss table, for x/r = 1.26, 80 % P. F. × 100 = 11%.

From reactance factor table No. 5 for No. 00 wire, 1 foot centers and 60 cycles x/r = 1.31 × .96 = 1.26. The capacity too small to be considered.

From voltage loss table, for x/r = 1.26, 80 % factor and D. C. loss in percentage = 11%. Find A. C. loss in percent to be 21.6%.

From power loss table: For I_c/I' = 0, and 80% P.F. the power loss factor = 1.56.

The A. C. power loss = 1.56 × 11 = 17.16%.

Table 19. Lagging Current, Power Factor 100 Per Cent.

D. C. Volts Loss In Per Cent.

x/r	5	6	7	8	9	10	11	12	13	14	15
0.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0
0.2	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.1	14.1	15.2
0.4	5.0	6.0	7.0	8.1	9.1	10.1	11.1	12.2	13.2	14.3	15.3
0.6	5.1	6.1	7.1	8.1	9.2	10.2	11.3	12.3	13.4	14.4	15.5
0.8	5.1	6.1	7.1	8.2	9.3	10.3	11.4	12.5	13.6	14.7	15.8
1.0	5.1	6.2	7.2	8.3	9.4	10.5	11.6	12.7	13.8	14.9	16.0
1.2	5.2	6.2	7.3	8.4	9.6	10.7	11.8	12.9	14.1	15.2	16.4
1.4	5.2	6.3	7.4	8.6	9.7	10.9	12.1	13.2	14.4	15.7	16.9
1.6	5.3	6.4	7.6	8.7	9.9	11.1	12.3	13.6	14.9	16.2	17.5
1.8	5.4	6.5	7.7	8.9	10.1	11.3	12.6	13.9	15.3	16.7	18.2
2.0	5.5	6.7	7.9	9.2	10.5	11.8	13.1	14.5	15.9	17.3	18.8
2.2	5.6	6.8	8.2	9.4	10.8	12.2	13.6	15.0	16.5	18.0	19.6
2.4	5.7	7.0	8.3	9.7	11.2	12.7	14.2	15.6	17.2	18.7	20.4
2.6	5.8	7.1	8.5	10.0	11.4	13.0	14.6	16.2	17.8	19.5	21.2
2.8	5.9	7.3	8.7	10.2	11.8	13.4	15.1	16.8	18.6	20.4	22.3
3.0	6.1	7.5	9.0	10.6	12.3	14.0	15.8	17.6	19.5	21.4	23.4
3.2	6.2	7.7	9.3	11.0	12.8	14.6	16.5	18.4	20.5	22.6	24.8
3.4	6.4	7.9	9.6	11.4	13.2	15.2	17.2	19.2	21.4	23.7	26.0
3.6	6.5	8.2	9.9	11.8	13.7	15.8	17.9	20.1	22.3	24.7	27.2
3.8	6.7	8.4	10.2	12.1	14.1	16.3	18.5	20.8	23.3	25.8	28.4
4.0	6.9	8.6	10.5	12.6	14.7	17.0	19.3	21.7	24.3	26.9	29.7
4.2	7.1	8.9	10.9	13.1	15.4	17.8	20.2	22.8	25.5	28.3	31.2
4.4	7.3	9.2	11.3	13.6	15.9	18.5	21.1	23.8	26.6	29.6	32.7
4.6	7.5	9.5	11.7	14.0	16.5	19.2	21.9	24.8	27.8	30.9	34.2
4.8	7.7	9.8	12.1	14.5	17.2	20.0	22.8	25.8	29.0	32.3	35.8
5.0	7.9	10.1	12.5	15.1	17.8	20.8	23.8	26.9	30.2	33.7	37.3

Table 20. Leading Current, Power Factor 99 Per Cent.

D. C. Volts Loss In Per Cent.

x/r	5	6	7	8	9	10	11	12	13	14	15
0.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0
0.2	4.9	5.8	6.8	7.8	8.8	9.8	10.8	11.8	12.8	13.8	14.8
0.4	4.8	5.7	6.7	7.7	8.6	9.6	10.6	11.6	12.6	13.5	14.5
0.6	4.7	5.6	6.6	7.5	8.5	9.5	10.5	11.5	12.4	13.4	14.4
0.8	4.6	5.5	6.4	7.4	8.3	9.3	10.3	11.3	12.3	13.3	14.3
1.0	4.5	5.4	6.3	7.3	8.2	9.2	10.2	11.1	12.1	13.1	14.1
1.2	4.4	5.3	6.2	7.2	8.1	9.1	10.1	11.1	12.0	13.0	14.0
1.4	4.3	5.2	6.1	7.1	8.0	9.0	10.0	10.9	11.9	12.9	14.0
1.6	4.2	5.1	6.0	7.0	8.0	9.0	10.0	11.0	12.1	13.2	14.3
1.8	4.2	5.1	6.0	7.0	8.0	9.1	10.1	11.2	12.3	13.4	14.5
2.0	4.1	5.0	6.0	7.0	8.1	9.2	10.3	11.4	12.6	13.8	15.0
2.2	4.1	5.0	6.0	7.1	8.2	9.3	10.4	11.6	12.8	14.0	15.3
2.4	4.0	5.0	6.0	7.1	8.3	9.3	10.7	11.9	13.2	14.5	15.9
2.6	4.0	5.0	6.0	7.2	8.4	9.5	10.9	12.2	13.6	15.0	16.5
2.8	4.0	5.0	6.1	7.3	8.5	9.7	11.2	12.6	14.1	15.7	17.4
3.0	4.1	5.1	6.2	7.4	8.7	10.0	11.5	13.1	14.7	16.5	18.3
3.2	4.1	5.1	6.3	7.5	8.9	10.3	11.9	13.6	15.3	17.2	19.2
3.4	4.1	5.2	6.4	7.8	9.2	10.7	12.4	14.2	16.1	18.1	20.3
3.6	4.2	5.3	6.6	8.0	9.6	11.2	13.0	14.8	16.8	19.0	21.2
3.8	4.2	5.4	6.8	8.3	9.9	11.7	13.5	15.5	17.6	19.9	22.2
4.0	4.3	5.5	7.0	8.6	10.3	12.2	14.1	16.2	18.4	20.8	23.3
4.2	4.3	5.7	7.2	8.9	10.8	12.8	14.9	17.0	19.4	21.8	24.5
4.4	4.4	5.8	7.4	9.2	11.1	13.3	15.5	17.8	20.3	23.0	25.8
4.6	4.5	5.9	7.6	9.5	11.5	13.8	16.1	18.6	21.2	24.0	27.0
4.8	4.6	6.1	7.9	9.8	12.0	14.4	16.8	19.4	22.2	25.2	28.4
5.0	4.7	6.3	8.1	10.1	12.4	14.9	17.5	20.2	23.2	26.3	29.7

A. C. volts loss = 2400 × .216 = 518.4..

K. W. loss = 500 × .1716 = 85.8.

Voltage at generator = 2918.4.

Power at generator = 585.8 Kw.

Problem No. 2.

Transmit 750 K. W., 5 miles at 5500 volts, power factor 80%. Three phase, three wire, 60 cycle system. No. 0000 B & S wire of copper, 18″ centers, temperature 25°C.

From the system table, for a three phase, three wire system, I′ = K. W./2 K. V. = 750/(2 × 5.5) = 68.2.

From temperature correction table, r const. = 1.019; and x/r const. = .98.

From resistance table, resistance per mile = .512 and total resistance = .512 × 5 × 1.019 = 2.6.

The D. C. volts loss in percent = (2.6 × 68.2)/5500 × 100 = 3.2%.

From reactance factor table, for No. 0000 wire, 18″ centers and 60 cycles, x/r = 2.16 × .98 = 2.12.

The capacity is too small to consider.

From voltage loss table, for x/r = 2.12, 80% power

TABLE 21. LEADING CURRENT, POWER FACTOR 98 PER CENT.

D. C. Volts Loss In Per Cent.

x/r	5	6	7	8	9	10	11	12	13	14	15
0.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0
0.2	4.8	5.8	6.7	7.7	8.7	9.7	10.7	11.7	12.7	13.7	14.7
0.4	4.7	5.6	6.5	7.5	8.4	9.4	10.4	11.3	12.3	13.3	14.3
0.6	4.5	5.4	6.3	7.2	8.2	9.1	10.1	11.0	12.0	13.0	14.0
0.8	4.3	5.2	6.1	7.0	7.9	8.9	9.8	10.8	11.7	12.7	13.6
1.0	4.2	5.0	5.9	6.8	7.7	8.6	9.5	10.5	11.4	12.4	13.4
1.2	4.0	4.8	5.7	6.6	7.3	8.4	9.3	10.3	11.2	12.2	13.2
1.4	3.9	4.7	5.5	6.4	7.3	8.3	9.2	10.2	11.2	12.2	13.2
1.6	3.8	4.6	5.4	6.3	7.2	8.2	9.1	10.1	11.1	12.2	13.2
1.8	3.7	4.5	5.4	6.3	7.2	8.2	9.2	10.2	11.3	12.4	13.5
2.0	3.6	4.4	5.3	6.2	7.2	8.2	9.2	10.3	11.4	12.6	13.8
2.2	3.5	4.3	5.2	6.1	7.1	8.2	9.3	10.4	11.6	12.8	14.1
2.4	3.4	4.2	5.1	6.1	7.2	8.3	9.4	10.6	11.9	13.2	14.6
2.6	3.3	4.2	5.1	6.1	7.2	8.4	9.6	10.8	12.2	13.5	15.0
2.8	3.3	4.2	5.1	6.2	7.3	8.5	9.8	11.1	12.5	14.0	15.6
3.0	3.2	4.1	5.1	6.2	7.4	8.7	10.0	11.4	12.9	14.5	16.2
3.2	3.2	4.1	5.1	6.3	7.5	8.9	10.3	11.9	13.5	15.3	17.1
3.4	3.1	4.1	5.2	6.4	7.7	9.2	10.7	12.4	14.1	16.0	18.0
3.6	3.1	4.1	5.3	6.5	8.0	9.5	11.1	12.8	14.7	16.7	18.8
3.8	3.1	4.2	5.4	6.7	8.2	9.9	11.6	13.4	15.4	17.5	19.7
4.0	3.1	4.2	5.5	7.0	8.5	10.2	12.0	13.9	16.0	18.2	20.6
4.2	3.1	4.2	5.6	7.1	8.8	10.6	12.5	14.6	16.8	19.2	21.8
4.4	3.1	4.3	5.7	7.3	9.0	11.0	13.0	15.3	17.6	20.2	23.0
4.6	3.2	4.4	5.9	7.5	9.4	11.5	13.7	16.0	18.5	21.2	24.2
4.8	3.2	4.5	6.0	7.8	9.8	12.0	14.3	16.8	19.4	22.3	25.4
5.0	3.3	4.6	6.2	8.1	10.2	12.5	14.9	17.5	20.3	23.4	26.6

TABLE 22. LEADING CURRENT, POWER FACTOR 95 PER CENT.

D. C. Volts Loss In Per Cent.

x/r	4	5	6	7	8	9	10	11	12	13	14
0.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0
0.2	3.7	4.7	5.6	6.6	7.6	8.6	9.5	10.4	11.4	12.3	13.3
0.4	3.5	4.4	5.3	6.2	7.1	8.0	8.9	9.9	10.8	11.8	12.7
0.6	3.3	4.1	5.0	5.8	6.7	7.6	8.5	9.4	10.3	11.2	12.2
0.8	3.0	3.8	4.6	5.4	6.2	7.0	7.9	8.8	9.7	10.6	11.6
1.0	2.8	3.5	4.3	5.0	5.8	6.6	7.4	8.3	9.1	10.0	10.9
1.2	2.6	3.3	4.0	4.7	5.4	6.2	7.0	7.9	8.7	9.6	10.5
1.4	2.4	3.0	3.7	4.4	5.1	5.9	6.6	7.5	8.3	9.2	10.1
1.6	2.2	2.8	3.4	4.1	4.8	5.5	6.3	7.1	8.0	8.9	9.8
1.8	2.0	2.5	3.2	3.8	4.5	5.2	6.0	6.9	7.8	8.7	9.7
2.0	1.8	2.3	2.9	3.6	4.3	5.0	5.9	6 7	7.7	8.6	9.7
2.2	1.6	2.1	2.7	3.4	4.1	4.9	5.7	6.6	7.6	8.6	9.7
2.4	1.4	1.9	2.5	3.2	3.9	4.7	5.6	6.5	7.6	8.6	9.8
2.6	1.2	1.7	2.3	3.0	3.7	4.6	5.5	6.5	7.6	8.7	9.9
2.8	1.0	1.5	2.1	2.8	3.6	4.5	5.5	6.5	7.7	8.9	10.2
3.0	0.9	1.4	2.0	2.7	3.5	4.4	5.4	6.5	7.8	9.1	10.5
3.2	0.7	1.2	1.8	2.5	3.4	4.3	5.4	6.6	7.9	9.3	10.8
3.4	0.6	1.1	1.7	2.4	3.3	4.3	5.4	6.7	8.1	9.6	11.2
3.6	0.4	0.9	1.6	2.4	3.3	4.4	5.6	6.9	8.4	10.0	11.8
3.8	0.3	0.8	1.5	2.3	3.3	4.5	5.8	7.2	8.8	10.5	12.5
4.0	0.2	0.7	1.4	2.3	3.3	4.6	6.0	7.5	9.2	11.1	13.2
4.2	0.1	0.6	1.3	2.3	3.4	4.8	6.2	7.9	9.7	11.8	14.0
4.4	0.0	0.5	1.3	2.3	3.5	5.0	6.5	8.3	10.3	12.6	15.0
4.6	0.1	0.5	1.3	2.3	3.6	5.1	6.8	8.7	10.9	13.2	15.8
4.8	0.2	0.4	1.2	2.4	3.7	5.4	7.2	9.2	11.4	13.9	16.7
5.0	0.4	0.3	1.2	2.4	3.9	5.7	7.6	9.7	12.1	14.7	17.6

factor and D. C. volts loss in percent = 3.2; the A. C. volts loss in percent = 8.42%.

From power loss table, $I_c/I' = O$ and 80% power factor, the power loss factor = 1.56 and the A. C. power loss percent = 1.56 × 3.2 = 5.0%.

PROBLEM NO. 3.

Transmit 2000 K. W., 10 miles at 13000 volts, power factor 90%, two phase, three wire, 25 cycles, No. 0000 B. & S. Aluminum wire, two feet centers, temperature 35°C.

From the system table for a two phase, three wire system, I' = K. W./2 K. V. = 2000/(2 × 13) = 77 amps.

From temperature correction table at 35°C., r const. = 1.058 and x/r const. = .58.

The resistance per mile (Table I) = .83 and total resistance = .83 × 10 × 1.058 = 8.78 ohms.

TABLE 23. LEADING CURRENT, POWER FACTOR 90 PER CENT.

D. C. Volts Loss In Per Cent.

x/r	4	5	6	7	8	9	11	11	12
0.0	4.0	5.0	6.0	7.0	8.0	9.0	10.1	11.1	12.1
0.2	3.7	4.6	5.6	6.5	7.4	8.4	9.3	10.2	11.2
0.4	3.3	4.2	5.0	5.9	6.8	7.7	8.6	9.5	10.4
0.6	3.0	3.7	4.5	5.3	6.2	7.0	7.8	8.6	9.5
0.8	2.6	3.3	4.0	4.7	5.4	6.2	7.0	7.8	8.6
1.0	2.2	2.9	3.5	4.1	4.8	5.5	6.2	6.9	7.7
1.2	1.9	2.5	3.1	3.7	4.3	5.0	5.6	6.3	7.0
1.4	1.6	2.1	2.6	3.2	3.8	4.4	5.1	5.7	6.4
1.6	1.2	1.7	2.2	2.7	3.3	3.9	4.5	5.1	5.8
1.8	0.9	1.3	1.7	2.2	2.7	3.3	3.9	4.5	5.2
2.0	0.6	0.9	1.3	1.7	2.2	2.7	3.3	4.0	4.7
2.2	0.3	0.6	0.9	1.3	1.8	2.3	2.9	3.6	4.3
2.4	0.0	0.3	0.6	0.9	1.4	2.0	2.6	3.2	4.0
2.6	0.3	0.1	0.2	0.6	1.0	1.6	2.2	2.9	3.7
2.8	0.6	0.4	0.2	0.2	0.7	1.3	1.9	2.6	3.5
3.0	0.8	0.7	0.5	0.2	0.3	0.9	1.6	2.4	3.4
3.2	1.1	1.0	0.8	0.5	0.0	0.6	1.4	2.2	3.2
3.4	1.3	1.3	1.1	0.7	0.2	0.4	1.2	2.1	3.2
3.6	1.6	1.5	1.3	1.0	0.5	0.2	1.1	2.1	3.4
3.8	1.8	1.8	1.6	1.2	0.6	0.1	1.1	2.3	3.6
4.0	2.1	2.1	1.9	1.4	0.8	0.0	1.1	2.4	3.8
4.2	2.3	2.3	2.1	1.6	0.9	0.0	1.2	2.6	4.2
4.4	2.6	2.6	2.3	1.8	1.0	0.0	1.3	2.8	4.6
4.6	2.8	2.8	2.5	1.9	1.0	0.1	1.5	3.1	5.0
4.8	3.0	3.0	2.6	1.9	0.9	0.3	1.7	3.4	5.4
5.0	3.3	3.2	2.8	2.0	0.8	0.4	2.0	3.8	5.9

TABLE 24. LEADING CURRENT, POWER FACTOR 85 PER CENT.

D. C. Volts Loss In Per Cent.

x/r	3	4	5	6	7	8	9	10	11
0.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.1	11.1
0.2	2.6	3.5	4.4	5.0	6.2	7.2	8.1	9.1	10.0
0.4	2.3	3.1	3.9	4.7	5.5	6.4	7.2	8.1	8.9
0.6	1.9	2.6	3.3	4.1	4.8	5.6	6.3	7.1	7.8
0.8	1.6	2.2	2.8	3.4	4.1	4.7	5.4	6.0	6.7
1.0	1.2	1.7	2.2	2.7	3.3	3.8	4.4	5.0	5.6
1.2	0.9	1.3	1.7	2.2	2.7	3.1	3.6	4.2	4.7
1.4	0.5	0.8	1.2	1.6	2.0	2.5	2.9	3.4	4.0
1.6	0.2	0.4	0.7	1.0	1.3	1.7	2.2	2.7	3.2
1.8	0.2	0.0	0.1	0.4	0.7	1.0	1.4	1.8	2.3
2.0	0.5	0.5	0.4	0.2	0.0	0.3	0.6	1.1	1.5
2.2	0.8	0.9	0.8	0.7	0.5	0.3	0.0	0.4	0.9
2.4	1.1	1.2	1.3	1.2	1.1	0.9	0.6	0.2	0.2
2.6	1.4	1.6	1.7	1.7	1.5	1.4	1.1	0.7	0.2
2.8	1.7	2.0	2.2	2.2	2.1	1.9	1.7	1.3	0.8
3.0	2.0	2.4	2.6	2.7	2.7	2.5	2.2	1.7	1.1
3.2	2.3	2.7	3.0	3.1	3.1	2.9	2.6	2.1	1.4
3.4	2.6	3.1	3.4	3.6	3.6	3.4	3.0	2.5	1.8
3.6	2.9	3.5	3.8	4.0	4.0	3.8	3.3	2.7	1.9
3.8	3.1	3.8	4.2	4.4	4.3	4.1	3.6	2.9	2.0
4.0	3.4	4.1	4.5	4.7	4.7	4.4	3.9	3.1	2.1
4.2	3.7	4.4	4.8	5.0	5.0	4.6	4.0	3.2	2.1
4.4	4.0	4.7	5.2	5.4	5.3	4.9	4.2	3.3	2.0
4.6	4.2	5.0	5.5	5.7	5.6	5.1	4.4	3.3	1.9
4.8	4.5	5.4	5.9	6.0	5.8	5.3	4.4	3.2	1.7
5.0	4.8	5.7	6.2	6.3	6.1	5.5	4.5	3.2	1.4

The D. C. voltage loss in percent = (8.78 × 77/13000 × 100 = 5.2%.

From reactance factor table for No. 0000 wire and 2 feet centers at 25 cycles, x/r = .96 × .58 = .556.

The capacity is too small to consider.

From voltage loss table, for 90% power factor, 5.2% D. C. loss and x/r = .556, the A. C. voltage loss in percent = 6.55%.

From power loss table, for $I_c/I' = O$ and power factor = 90%, the power loss factor = 1.23. The A. C. power loss then = 5.2 × 1.23 = 6.4%.

The power factor at generator = 90 × (1 + .064)/(1 + .0655) = 90%.

PROBLEM NO. 4.

Transmit 1000 K. W., 25 miles at 25,000 volts, power

Table 25. Leading Current, Power Factor 80 Per Cent.

D. C. Volts Loss In Per Cent.

x/r	3	4	5	6	7	8	9	10	11
0.0	3.0	4.0	5.0	6.0	7.1	8.1	9.2	10.3	11.3
0.2	2.6	3.5	4.4	5.3	6.2	7.1	8.0	8.9	9.8
0.4	2.1	2.9	3.7	4.4	5.3	6.1	6.9	7.8	8.7
0.6	1.7	2.4	3.0	3.7	4.3	5.0	5.8	6.5	7.3
0.8	1.3	1.8	2.3	2.8	3.4	4.0	4.6	5.3	6.0
1.0	0.9	1.2	1.6	2.0	2.5	2.8	3.4	3.6	4.5
1.2	0.5	0.7	1.0	1.3	1.7	2.0	2.5	2.9	3.4
1.4	0.0	0.2	0.3	0.6	0.8	1.1	1.5	1.9	2.3
1.6	0.4	0.4	0.3	0.1	0.1	0.3	0.6	0.9	1.3
1.8	0.8	0.9	0.9	0.9	0.8	0.9	0.8	0.5	0.2
2.0	1.2	1.4	1.6	1.6	1.6	1.5	1.3	1.1	0.8
2.2	1.6	1.9	2.1	2.2	2.2	2.2	2.1	1.9	1.7
2.4	2.0	2.4	2.7	2.9	2.9	3.0	2.9	2.7	2.4
2.6	2.3	2.9	3.1	3.5	3.6	3.7	3.6	3.4	3.1
2.8	2.7	3.3	3.8	4.2	4.3	4.4	4.3	4.1	3.7
3.0	3.1	3.8	4.4	4.8	5.0	5.1	5.0	4.8	4.4
3.2	3.5	4.3	4.9	5.3	5.6	5.7	5.6	5.4	5.0
3.4	3.8	4.7	5.4	5.8	6.1	6.2	6.1	5.8	5.3
3.6	4.2	5.2	5.9	6.4	6.7	6.8	6.7	6.3	5.7
3.8	4.5	5.7	6.4	7.0	7.4	7.4	7.2	6.7	6.0
4.0	5.0	6.1	6.9	7.5	7.8	7.8	7.6	7.0	6.2
4.2	5.3	6.5	7.3	7.9	8.2	8.2	7.8	7.2	6.3
4.4	5.6	6.8	7.8	8.3	8.6	8.5	8.1	7.4	6.3
4.6	6.0	7.3	8.2	8.8	9.0	8.9	8.3	7.4	6.2
4.8	6.3	7.7	8.6	9.2	9.5	9.2	8.5	7.5	6.1
5.0	6.6	8.0	9.1	9.7	9.9	9.5	8.7	7.5	5.8

factor 70%, three phase, four wire 25 cycle system. No. 4 B & S Aluminum wire, 3 feet centers temperature 30° C.

From the system table for a three phase four-wire system, $I' = K. W./2\ K. V. = 1000/(2 \times 25) = 20$ amps.

From temperature correction table, for 30° C., r const. = 1.039; and x/r const. = .59.

From resistance table, resistance per mile = 4.21 and the total resistance = $4.21 \times 25 \times 1.039 = 109.2$ ohms.

The D. C. volts loss percent = $[(109.2 \times 20)/25000)] \times 100 = 8.74\%$.

From reactance factor table, for No. 4 aluminum wire, 3 feet centers and 25 cycles, $x/r = .23 \times .59 = .135$.

The capacity too small to consider.

From voltage loss table, for x/r = .135, D. C. volts loss = 8.74 % and power factor = 70% the A. C. voltage loss = 10.25%.

From power loss table, $I_c/I' = 0$, power factor = 70 %; the power loss factor = 2.04 and the A. C. power loss in percentage = $2.04 \times 8.74 = 17.8\%$.

The power factor at generator = $(.70 \times 1.178) / 1.1025 = 74.7\%$.

Problem No. 5.

Transmit 15000 K. W., 50 miles at 60,000 volts, power factor 85%, three phase, three wire, 60 cycle system, No. 0000 B & S copper wire, 4 feet centers, temperature 20° C.

From the system table for a three phase, three wire system, $I' = K. W./2\ K. V. = 15000/(2 \times 60) = 125$.

From temperature correction table, for 20° C., r const. = 1 and x/r const. = 1.

From resistance table, the resistance per mile = .512 and the total resistance = $.512 \times 50 = 25.6$ ohms.

The D. C. volts loss percent = $[(25.6 \times 125)/60000] \times 100 = 5.34\%$.

From reactance factor table, for No. 0000 B & S copper wire, 4 feet centers, and 60 cycles, $x/r = 2.6 \times 1 = 2.6$.

From charging current table, $I_c/I' = (.315 \times 5 \times 60)/125 = .0754$.

From power loss table, for $I_c/I' = .0754$ and power factor of 85 %; the power loss factor = 1.34 and power loss per cent = $1.34 \times 5.34 = 7.16\%$.

From Power Factor Conversion Table, 1.34 = 86% power factor.

Table 26. Leading Current, Power Factor 70 Per Cent.

D. C. Volts Loss In Per Cent.

x/r	2	3	4	5	6	7	8
0.0	2.0	3.0	4.0	5.1	6.1	7.2	8.3
0.2	1.5	2.4	3.2	4.1	5.0	6.0	7.0
0.4	1.1	1.8	2.4	3.2	3.9	4.7	5.5
0.6	0.7	1.2	1.7	2.2	2.8	3.4	4.0
0.8	0.3	0.6	0.9	1.3	1.6	2.1	2.6
1.0	0.0	0.0	0.2	0.4	0.6	0.8	1.1
1.2	0.5	0.6	0.6	0.6	0.5	0.3	0.1
1.4	0.8	1.1	1.3	1.5	1.5	1.5	1.4
1.6	1.2	1.7	2.0	2.3	2.5	2.6	2.6
1.8	1.6	2.2	2.8	3.2	3.6	3.8	4.0
2.0	1.9	2.7	3.5	4.1	4.5	4.9	5.2
2.2	2.3	3.3	4.1	4.8	5.4	5.9	6.3
2.4	2.7	3.8	4.8	5.6	6.3	6.9	7.4
2.6	3.1	4.4	5.5	6.4	7.2	7.9	8.4
2.8	3.5	4.9	6.1	7.2	8.1	8.9	9.4
3.0	3.8	5.4	6.8	8.0	9.0	9.8	10.5
3.2	4.2	5.9	7.4	8.7	9.8	10.6	11.3
3.4	4.5	6.4	8.1	9.5	10.6	11.5	12.1
3.6	4.9	7.0	8.8	10.3	11.4	12.3	12.9
3.8	5.4	7.6	9.5	11.0	12.2	13.1	13.7
4.0	5.6	8.0	10.1	11.8	13.1	14.0	14.6
4.2	6.0	8.5	10.6	12.5	13.8	14.7	15.2
4.4	6.4	9.0	11.2	13.1	14.4	15.2	15.7
4.6	6.7	9.5	11.8	13.7	15.0	15.9	16.2
4.8	7.1	10.0	12.4	14.4	15.7	16.5	16.8
5.0	7.5	10.4	13.0	15.0	16.4	17.1	17.4

From voltage loss tables, for 85% power factor, x/r = 2.6, D. C. volts loss = 5.34%. by interpolation, A. C. voltage loss = 14.8%, the volts loss = $60000 \times .148 = 8880$

The K. W. loss = $15000 \times 7.16 = 1074$.

Volts at generator = 68,880.

K. W. at generator = 16,074.

The power factor at generator:

$\cos \Theta'' = 86 \times 1.0716/1.148 = 81.7\%$.

$I'_c/I'_g\ [.0754 \times (1.148)^2]/1.0716 = .0927$.

The power loss factor for 81.7% and $I'_c/I'_g = .0927$, is 1.44. From power factor conversion table, P. F.=83%.

Methods to Use in Calculations.

(1) Charging Current. Find the charging current for a single phase line of the same size wire, spacing and length of line as the line to be calculated, using the voltage as given in the System table. (2) Find I′, (amperes for calculating D. C. voltage loss) as given in the System table.

(3) D.C. Voltage Loss. Find D.C. volts loss by multiplying I′ by the ohmic resistance of the above single phase line. (The resistance of the outgoing and the returning wire are included in the resistance calculation.) Divide this result by the line voltage to get the per cent D. C. voltage loss.

(4) A.C. Power Loss Factor. Divide the charging current as found in item (1) by I′. Apply this ratio to the power loss table where, for the power factor of the load, will be found the power loss factor which will give the A.C. power loss in per cent when multiplied by the D.C. volts loss in per cent.

(5) Power Factor. To find the correct power factor at the receiving end of the line, apply power loss factor to the power factor conversion table. This power factor is used in calculating the A. C. voltage loss.

(6) Reactance Factor. Find ratio of inductive reactance to ohmic resistance for the size wire, spacing and material from reactance table.

(7) A. C. Voltage Loss.. Apply values found in items (3), (5) and (6) to voltage loss tables to get A. C. voltage loss in per cent.

(8) Power Factor at Generator. Multiply the power

factor is found it the item (5) by the ration of $(I + w)$ to $(1 + e)$. Multiply the ratio of charging current to I′ by $(1 + e)^2 \div (1 + w)$. Apply these new values of power factor and ratio of charging current to I′, to the power loss and power factor conversion tables as in items (4) and (5) to get the power factor at the generator. The power factor will be leading or lagging as indicated in the comments on voltage loss table.

w = A. C. power loss in percent as a fraction.

e = A. C. voltage loss in percent as a fraction.

Testing High Tension Transformers

Contributed Exclusively to Electrical Engineering.

BY H. G. DAVIS.

Section 3. Heat Runs and Potential Tests. Continued from May Issue.

After the iron and copper losses were determined the machines were connected for the temperature tests on heat runs. There were four machines and could have been tested by the opposition method of two in multiple. However, as there were two secondary windings in each transformer guaranteed to give full transformer output at the minimum voltage, it was necessary to give two sets of temperature tests on the transformers to determine heating for the two conditions. From the iron loss tests and the copper loss tests we found that the losses when using one independent secondary winding did not differ materially from the losses found when the other secondary was used. Taking this into consideration two sets of tests were taken. No. 1, No. 2 and No. 3 transformers were tested by the three phase delta method shown in Fig. 3, using the 6000 volt secondary winding in this test for normal load and overload tests. After this test, No. 1 and No. 4 were to be run on normal load by the opposition method using the 12,600 volt winding as the low tension winding. In all tests the high tension 34,600 volt winding was used.

In taking the temperature tests, the transformers were first connected up as shown in Fig. 3. Thermometers were hung so as to read room temperature temperature of ingoing and outgoing water from the cooling coils and oil temperature. Cold resistance readings of the minimum windings were available from the resistance measurements while the measuring instruments were ready to take the resistances of the windings when hot.

In supplying the load to the three thransformers by the method of Fig. 3, the iron loss is supplied on the low tension side. A bank of small transformers were connected in temporarily to raise the alternator voltage to 6000 volts. As a check on the Kva. capacity necessery from the generator, we have from the iron loss test that each machine took 18.5 amperes at 6000 volts or 11.8 Kw. in actual power capacity. The Kva. capacity for excitation required for this bank of 3 transformers is 3×18.5×6000 = 335 Kva. but the power actually taken to supply the iron loss is only 36 Kw. The generator used was a 350 Kva-60 cycle, 2300 volt, 3 phase machine, and the voltage stepped up to 6000 volts by 3—100 Kva. single phase transformers, ratio 2300/6600. Thus the generator was operating at 2090 volts which was very close to normal density.

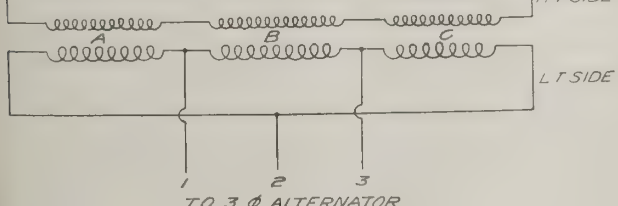


Fig. 3. Connections for Heat Run.

Note: In these connections the iron loss is supplied by the 3-phase alternator on the secondary side and the current supply taken from an auxiliary transformer in the high tension delta.

The copper loss supply of current was impressed on the primary winding through an auxiliary single phase transformer. An inspection of Fig. 3 shows that the voltage required from the auxiliary transformer is 3 times the impedance volts of one transformer or the sum of the impedance volts of three transformers. The current at normal load was 39.3 and volts, 1550+1580+4580. At 125% load, amps = 49.1; volts = 5720. At a normal load, the Kva required from the alternator was 39.3×4580 = 180 Kva. Power required = 9.1+9.08+9 = 27.18 Kw. At 125% load, Kva = 49.1×5720 = 281. The power required = 48 approx.

The generator used was a 60 cycle, 2300 volt, 500 Kva, 3 phase. The auxiliary transformer was 300 Kva—6000/2300 volts 60 cycles. Thus at 125% load the auxiliary transformer was delivering 49.1 amperes at 5720 volts. The generator was then delivering to the transformer 140.5 amps at 1995 volts from one phase.

It will be noted that to test the 4500 Kva of transformers only one three phase, 350 Kva generator and one 500 Kva, 3 phase generator was necessary, while the actual instantaneous power required was only about 65 Kw. This shows the ease and cheapness of this method of test. It will be noted that the auxiliary transformer in the primary winding is subjected to the strain of the high voltage of the transformer under test. Thus an auxiliary transformer should always be used and if the generator is used, this delta point should be grounded.

The above calculations show the method of arriving at size of machines to supply the losses for the heat tests. The calculations given above for the alternator to supply copper loss, is from the impedance test which was made on the maximum winding. The minimum winding for the same output would require a slightly greater current so that the impedance volts would not differ materially. When the heat run connection is made, the checking of magnetizing current and voltage on the auxiliary current supply can be used as a check against the tests of impedance and core loss to see if heat run connections are made properly.

Thus from the iron loss alternator the current should be about 97 amperes or about 32 amperes in a delta lead from the 3 auxiliary transformers supplying the iron loss.

To save time of testing, hot oil was placed in the transformer and the current and voltage impressed for a half hour before the water was passed through the cooling coils. The readings of all thermometers were made each hour and as soon as oil temperature and temperature rise of water from cooling coils indicated that the transformer was reading a constant temperature, the resistance of the high tension windings were taken at hour intervals. In doing this, the loss supply alternators were disconnected—cooling water shut off and high tension windings opened at the delta points. These readings must be taken quickly and provision was made in connecting up so that the resistance measurements could be taken rapidly. When the thermometer and resistance measurements on the primary indicated a constant temperature, readings were taken for all thermometers and resistance measurements made for each winding under test. During the normal load test the cooling water through the coils was held constant at 4 gallons per minute.

After final temperatures were taken the transformer had cooled slightly. They were run under normal conditions again until the constant temperatures were reached after which the overload test was taken for a period of two hours with temperature measurements taken at the end as for the previous full load test. For this overload run, iron conditions or voltage remained the same but the current was increased to 125% of normal value. The cooling water was also increased to 5 gals. This increase in cooling water is sometimes specified and sometimes the specifications call for no increase of cooling water.

After the tests of the three transformers operating in delta were made, No. 1 and No. 4 were tested at normal load by the opposition method using the 12600 volt seconday winding in place of the 6000 volt winding. The current was impressed by the auxiliary transformer in the primary circuit as before but the voltage required from this transformer under this connection is the sum of the impedance volts of the two transformers instead of three. The impressed voltage on the two transformers is now 12600 volts single phase which required new auxiliary step up transformers. The final temperature for this test using the 12600 volt winding checking with the previous test under normal load using the 6000 volt winding. No further temperature tests were then necessary.

DATA FOR TRANSFORMERS UNDER HEAT RUN.

	No. 1	No. 2	No. 3	No. 4	No. 1
Res. 34600 V. @ 25°....	1.98	1.98	1.98	1.995	1.98
Res. after normal run.....	2.20	2.24	2.15	2.16	2.2
Temperature	54	59.5	49	47	54
Ingoing Water Temp.	25	25	15	15.0	25
Rise above water..........	29	34.5	34	32	29
Res. after overload run...	2.27	2.32	2.25	2.25	2.28
Temperature	64	69	61	58	64.5
Rise	39	44	46	43	39 5
Res. 6000 V. @ 25°........	.0737	.0737	.0737	.0743	.0737
Res. after normal run.....	.082	.082	.0806		
Temperature	54.5	54 5	50		
Rise	29.5	29.5	35		
Res. after overload	.0848	.0848	.084		
Temperature	65°	65°	62°		
Rise	40	40	47		
Res. 12600 V. @ 25°.......	.342	.3405	.342	.344	.342
Res. after normal				.368	.38
Temperature				45°	54°
Rise				30°	29°
Oil temperature, normal...	43 5	45 5	36.7	36 7	44
Rise	18 5	20 5	21.7	21.7	19
Oil Temp. overload	50.0	51.0	46.0		
Rise	25.0	26	31.0		
Outgoing water normal....	42	42	30	30	43
Amount	4 gal.	4	4	4 gal.	4
Rise	17	17	15	15	18
Outgoing water overload...	40	40	32		
Rise	15	15	17		
Amount	5 gal.	5 gal.	5 gal.		

The following table shows the temperatures reached for each load test with the hot resistance measurements of each coil with the calculated temperature rise above room and above ingoing water:

The first columns under No. 1, No. 2 and No. 3, show readings taken on the first test of three machines connected in delta. The next two columns show results obtained on No. 1 and No. 4 when run in opposition. It will be noted that the temperatures reached on the normal run in the second test, check closely with the values obtained in the first test. All temperature rises are given above the temperature of the ingoing water which is the cooling medium. The hot resistance measurements connected to a temperature of ingoing water, which is to be the operating condition, should be used for efficiency calculations and the rise above the water at this temperature should be so specified. It is to be noted that increasing the water in proportion to the load allows the water to have about the same temperature rise as under flow for normal load.

The rises as found by test are well within the specified rise. If a higher rise is permitted as an operating conditon these transformers can be used with a smaller amount of water which would be a saving if water is costly. Again, at overload the water need not be increased above that used at normal as the rise is very low.

LOAD DIVISION.

In the specifications on these two transformers, the two secondary windings were to carry the full rating independently or together. This meant that the two windings should not have reactions that would effect load or voltage. To test this, two machines were put in parallel on the 34,600 volt winding, on the 12,600 volt winding and on the 6,000 volt winding. Normal current was forced through the primaries and normal voltage impressed on the 6,000 volt winding. The current in the two secondary windings was then read and it was found that the current divided inversely as their voltage or that their Kva ratings were equal.

POTENTIAL TESTS.

Specifications for these transformers call for operation in a three phase connection to give 66,000 volts on the primary side. This means that the primary side should have a potential test to ground of twice this voltage. Polarity test also showed that the windings were of opposite polarity which means that if two adjacent leads—one primary and one secondary—should come together the resultant voltage across the other two terminals would be the sum of the primary and secondary voltages. In this case the resultant Y voltage would be $(1.73 \times 38100) + 13800 =$ 79,000 volts. Double this voltage would be 159,000 volts. Each primary winding was tested at 159,000 volts for one minute. Each of the two secondary windings was tested at 27,000 volts which is approximately double the voltage on the 13,800 volt winding. Also the insulation between the two secondary windings was tested at 27,000 volts for one minute. When testing each winding to ground, each of the other windings was grounded. The voltages were read by using a gap between needle points. When making insulation tests to ground the terminals and bushings should always be connected as most often this is the point at which failure occurs.

After the high potential test, the insulation between turns should be tested. This is done by exciting the windings to double voltage for one minute and 1½ times voltage for five minutes. Each of these transformers had 12,000 volts impressed on the 6000 volt winding while the other windings were open circuited. It is evident that to excite the windings to double voltage we could not double the flux in the core because of the rapid increase in magnetizing current. (See saturation curve). Since volts = Kx frequency x flux density, it is evident that we must increase the frequency. A 200 cycle alternator was used in taking this test. After double potential was impressed for one minute, 1½ times potential was impressed for 5 minutes.

If there is a break-down in the insulation between turns it will be shown by the transformer smoking. Also by reading the exciting current we can check against the saturation curve. In this case the frequency used was 200 cycles or 3 1/3 times normal. Voltage = 12000 or twice normal. Density in core then = 2/3.33 = .6. Referring to the saturation curve on 6,000 volt winding, we find that for .6 density at normal frequency, voltage = 3600 and exciting current should be approximately 3 amps. The actual current read on No. 1 transformer was 3.1 amps.

This completed the tests and showed that ratio of voltage change was satisfactory and that insulation was satisfactory. The ability to deliver guaranteed load without excessive temperature rise was also shown by the heat runs as well as the proportional distribution of load between the two secondary windings. What remains is the calculation of efficiency and regulation from the values obtained from the core loss and impedance tests.

EFFICIENCY.

From the results obtained in tests for losses we have all the data necessary to calculate efficiency at the various loads to see if the guarantees are met. In making these calculations, the iron loss is constant inasmuch as the voltage is constant. The iron loss was determined for No. 1 transformer for the minimum 6000 volt winding. It was checked on the 12,600 volt winding and also on both of the windings for the remaining three transformers. The losses checked very closely as the tests show, so that we can use the core loss as found on No. 1 transformer at normal voltage on the 6,000 volt winding.

In using values of copper loss for efficiency calculations, the temperature of the windings have to be considered. Some manufacturers use the values of copper loss at 25°C while others specify the temperature which should be used. It is evident that the constant temperature reached after a continuous full load run corrected to a room temperature of 25°C should be used for efficiency at full load point. This value of resistance for the windings will give a lower calculated value for efficiency at fractional loads and a higher value at loads greater than normal. However, since at fractional loads the copper loss is a smaller part of the total losses, this error in calculated efficiency will be more than counterbalanced by the error at 125% load. Since it is very difficult to hold the temperature of the windings constant at load temperature in order to determine load losses, the load losses for different values of current are taken from the impedance test. This curve of load loss is shown on the curve sheet. Since total resistances checked closely whether one or the other low tension windings was used, the copper loss is taken using the 6,000 volt secondary winding.

The following table of losses at different load shows the calculated efficiency as made from the test values obtained above:

LOSSES AND EFFICIENCY ON 1500 K. V. A. TRANSFORMER.

Output Load	Voltage	Total R Pri Terms	Pri* Cur.	I^2R	**Load Loss	Iron Loss	Total Loss	Total Input	Efficiency
375 kva	6000	4.74	10.9	562	170	11800	12532	387532	.959
750	6000		21.7	2240	320	11800	14360	764360	.979
1125	6000		32.5	5010	430	11800	17240	1142240	.985
1500	6000		43.3	8900	1150	11800	21850	1521850	.986
1875	6000		54.1	13900	1700	11800	27400	1902400	.984

Total R is measured for 34600 volt and 6000 volt windings at 30° C rise above ingoing water at 15° C, that is at 45° C.

*Primary current for full output at 34600 volts. **Load less taken from impedance test as found on 38100 volt winding. It will be noted that the eddy current loss increases very rapidly. This excessive increase above the I^2R loss is probably due to the heating of the windings during test above that shown by thermometer.

ACTUAL EFFICIENCY AND GUARANTEED VALUES.

Load	Guar. Efficiency	Test Efficiency
375 KVA	.957	.959
750	.976	.979
1125	.981	.985
1500	.983	.986
1875	.983	.984

For the calculation of regulation many formulas are used which vary slightly in their results. There is or has been a discussion among engineers as to the effect of magnetizing current on regulation. However, the equation given here for regulation will hold and will be used in determining regulation for the machines under test.

$$E = \sqrt{[(E_o \text{ cosine } \Theta + R\,I)^2 + (E_o \sin \Theta + X\,I)^2]}.$$

Using primary terms and maximum windings with temperature rise as found at end of normal heat run, R = 5.45; and I = 39.3. From impedance test, Z = 39 = E/I. Apparent resistance = 5.9.

Then $Z^2 = R^2 + X^2$

$(39)^2 = (5.9)^2 + X^2$

$X = 38.7.$

In per cent calculation, $E_o = 1$.

$RI/E_o = (5.45 \times 39.3)/38100 = 225/38100$
$= .00563.$

$XI/E_o = (38.7 \times 39.3)/38100 = .04.$

For inductive load, cos $\Theta = 1$; sin $\Theta = 0$.

For 80% P. F., load, cos $\Theta = .8$; sin $\Theta = .6$.

$E_1 = \sqrt{[(1 + .00563)^2 + (.04)^2]} = 1.00642.$

Regulation = .00642.

At 80% P. F., $E_1 = \sqrt{[(1 \times .8 + .00563)^2 + (1 \times .6 + .04)^2]} = 1.029.$

Regulation = .029.

The calculations for regulation show that guarantees are met. These calculations show that the non-inductive regulation is practically the resistance loss of the transformer. At inductive loads the reactance begins to appear materially. The calculations made above are for resistance at 45° of the maximum windings as measured after the heat runs. In specifying regulation, the temperature of the windings and the winding—maximum or minimum—should be specified.

Telephone Equipment for Private Cars.

The Erie Railroad Company is equipping its private cars with intercommunicating telephone systems, which are similar in effect to those used in business offices and factories. President Underwood's car, No. 999, was the first one to be equipped. It has a system of six stations interconnecting the staterooms, observation room, stenographer's desk, and the kitchen. The telephones are hand sets, each equipped with a cord and plug. Jack plates are mounted on the car wall, each having a push button and jack into which the plug of the hand telephone is inserted. When not in use the plugs are withdrawn and the hand sets are stored away. The different stations are called by means of a buzzer system.

Reconstruction of Public Utility Property at Vicksburg, Mississippi

(*Contributed Exclusively to* Electrical Engineering).

BY A. J. BEMIS, CONSULTING ENGINEER IN CHARGE OF OPERATION, ELSTON, CLIFFORD AND CO., CHICAGO, ILL.

FROM the time an engineering report is submitted and the necessary funds provided for rebuilding a property, until its completion, is a period of mental anxiety and great physical activity. As usual when a property changes ownership the power plant is the first thing to receive attention, followed by reconstruction of the tracks, roadways, distribution system and the organization of a new business department, and such has been the case of the Vicksburg Light & Traction Co., of Vicksburg, Miss.

Fig. 1. General View Present Power Plant Vicksburg Light and Traction Company.

On July 1st, 1912 the power plant, car barn and condensing pool appeared as shown in the accompanying illustration, Fig. 2, with belted equipments, countershafts, old type machinery, leaky steam lines, and delapidated buildings. Thisnecessitated high cost of operation, and extremely high maintenance, with very unsatisfactory service. The new power plant was started August 10th, 1912, and completed about March 10th, 1913, and appears as shown in Fig. 1, taken from approximately the same point as photograph of Fig. 2. To accomplish this work it was necessary to erect the new building over the old plant, and continue operation, which required numerous temporary changes in location of equipments, steam and water lines, but was finally completed without serious interruption to the service.

The power plant was constructed of brick with a steel frame and concrete foundation, supported on piling. The turbine and generating section is 36 x 75 feet, with a gable roof of reinforced concrete slabs made by the Federal Cement Tile Company of Chicago. The boiler room roof is of reinforced concrete constructed with expanded metal poured in place. Steel window sash and wire glass were used to secure first-class fire protection, the only wood in the building being the doors. The turbine room is located on the street level, and has a thirteen foot basement, where all of the condensing equipment is installed directly under each turbine, thereby securing high efficiency. The boiler room has the same elevation as the turbine section basement of the plant, and the coal tracks are on the same level, permitting coal to be unloaded at the end of the boiler room.

The generating equipment is 60 cycles, 3 phase, 2300 volts and consists of the following apparatus: One 500 K. W. vertical Curtis turbine with 44 inch Helander barometric condenser, 2 oWrthington pumps, Wood accumulator, circulating and vacuum pumps. One 600 K. W. horizontal Curtis turbine with Wheeler Condenser & Engineering Company surface condenser, having the necessary steam driven air pump and direct connected turbine driven centrifugal circulating pump. One 300 K. W. Crocker-Wheeler motor generator set, used for furnishing 500 volt railway current, and a small amount of direct current power. One, 200 K. W. railway motor generator set, General Electric design, for emergency use. For exitation a 12½ K. W. engine driven turbine type machine is used in connection with a 15 K. W. motor driven set. Sufficient space is provided in the turbine room for an additional 1,000 K. W. capacity in turbines, the foundation for which is completed with piling and concreted to the basement elevation. Provision has also been made in the boiler room for an additional 1,000 horse power capacity in boilers. Shower baths and wash room are supplied for the employes and every provision possible has been made for their comfort. Especial care has been taken to secure proper ventilation in all parts of the plant, making it cool, thereby securing better attention and operation.

The switch board is of slate enamel, with the necessary number of panels and instruments for modern operation. There are four 250 horse power Stirling water tube boilers equipped with Murphy stokers, and a steel stack 125 feet high, 6 feet in diameter. A fifteen ton crane, hand oper-

Fig. 2. General View of Property Before Reconstruction.

ated, is installed in the turbine room with a runway the entire length of the building.

The company was unable to make satisfactory arrangements with the local water company for its water supply and was obliged to resort to wells and the erection of reservoirs for storage and condensing purposes. The water supply from the wells has proved excellent for boiler use, and far better than the treated water supplied by the water company. The main well is 375 feet deep, with nine inch casing, and furnishes by four hours pumping, with air compression, all the water necessary for twenty-four hours use. The monthly cost of water prior to the company installing its own plant was approximately $600.00, while the cost per month under the present arrangement does not exceed $35.00. The cooling tower is essential, whether the city water is used or not, and this is operated with a 35 horse power motor driving two 10-ft. fans, with the usual economy for such equipments.

Ash conveying devices were also installed, operated by a 7.5 horse power motor, which conveys the ashes from the boiler room level into an ash car, situated on the street level. The ashes are then removed to any point on the system and used for ballast, enabling the company to eliminate gravel ballast, formerly used, which cost $1.50 per cubic yard.

The general appearance of the property is improved as may be noted in the photographs, and in place of the unsightly approach to the plant, it now appears finished, surrounded with grass plats. This feature has received favorable comments from the public, as the plant is located in the center of the city and the best residential section.

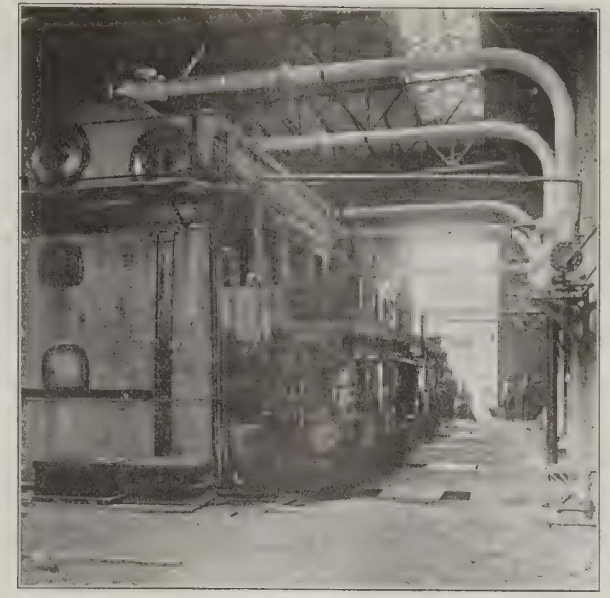


FIG. 4. BOILER ROOM IN NEW STATION.

It is evident that to make this notable change the cost has been considerable, but not without the desired results. For comparison, the pounds of coal per K. W. H. with the old plant was 11.2, while the pounds of coal per K. W. H. at present is averaging 5.6, and it is estimated that even a lower consumption will be possible. It is estimated that a saving of at least $15,000.00 per year will be made in the operation of the plant, aside from the excellent service which the company is able to render.

FIG. 3. VIEW OF GENERATOR ROOM IN VICKSBURG POWER STATION.

Fig. 5. View Showing Power Plant and Car Barn.

The company is furnishing all of the electric light and power for commercial and residential purposes, together with the street lighting. For street lighting 7.5 amp. enclosed type arcs, with some series incandescent lamps are used with 3-75 light tub transformers, a standard marble panel board being provided for each transformer. The distributing system is of standard construction, most of the power business being 3-phase, 220 volts secondary, the company having eliminated nearly all of the direct current power consumers. The overhead lines at present are undergoing a general re-arrangement, so that there will be a separate 3-phase power circuit, which will enable better regulation and permit of a large increase in power business recently acquired.

The greater part of the railway system is within the paved section of the city, and it is contemplated that about another mile of track will be paved this year. 70 and 85 lb. rails are used in the paved section; 45 and 60 being used in the outlaying districts. All of the 45 lb. rail will be replaced probably within the next two years.

The rolling stock has been entirely overhauled, and a number of the 10-bench open cars, with side running boards, have been changed to end entrance, with side aisles, in order to permit pay-as-you-enter operation and lessen accidents. The Johnson cash fare box is used on all of the cars, and is operated in connection with the registers, which has proven very satisfactory.

The recently organized new business department with

Fig. 6. General Office and Display Room, Vicksburg Light and Traction Co.

modern methods of solicitation and publicity, has accomplished good results, and increased the gross receipts of the light and power department at least fifteen per cent each month. The office is now located at the corner of the principal business streets of the city. The main floor being used for general offices, and display room, a large area being set aside for a rest room for the comfort and convenience of the public.

In cities of the size of Vicksburg, in order to secure all possible business, it is necessary for the company to retail fixtures, electrical appliances of all descriptions, and do wiring. During the past six months the new business and commercial department has shown excellent results along these lines, necessitating the employment of a force of inside wiremen, consisting of a foreman and eight men, also, on account of the additional business secured, the company has had to increase its outside line forces. Improvements made by public utility corporations in any city stimulates the community. This has been noticeable in Vicksburg, especially in the business section, and the management is highly pleased with its results.

Tests to Determine Economy of Combustion

(*Contributed Exclusively to* Electrical Engineering).

BY E. H. TENNEY, M. E.

THE problem of testing to determine the conditions of economical combustion of fuel in a boiler plant is not altogether a simple one because of the many points at which the investigation must be made and the close interrelation of the functions of heat production in the furnace and of heat absorption in the boilers. Regarding the function of the furnace to be that of producing heat from fuel, high furnace economy may be considered to consist in the production of the greatest amount of heat per pound of fuel and the delivery o fthat heat under conditions most favorable for its transmission to the water in the boiler. Regarding the function of the boiler to be that of absorbing heat generated in the furnace, high boiler economy may be considered to consist in the absorption of the greatest amount of heat per pound of fuel and the successful transmission of this heat to the water in the boiler.

NATURE OF THE FUEL.

In order to obtain any sort of satisfactory tests of combustion, the nature of the fuel and the chemical processes involved in its combustion must be well borne in mind.

The burning of coal consists in its chemical combination with oxygen, this combination taking place in the presence of heat and itself producing heat. The elements composing coal are as follows: Carbon, hydrogen, oxygen, nitrogen, sulphur and ash. In the process of combustion the carbon, hydrogen and sulphur combine with the free oxygen, supplied from the air and coal, and produce heat with an evolution of gas—the so-called products of combustion. The ash not only does not burn by its intimate mixture with the other elements making up the coal, tends to retard combustion by preventing the free passage of oxygen to the particles of combustible matter about it. The nitrogen is of such small quantity that for all practical purposes it may be disregarded.

The carbon, hydrogen and sulphur combine with oxygen in a fixed proportion according to their atomic weights. Thus carbon (C) combines with oxygen and forms carbon dioxide (CO_2). The atomic weight of carbon is 12, and that of a molecule of carbon dioxide 44, so that in 44 pounds of (CO_2) gas there are 12 pounds of carbon and 32 pounds of oxygen; in other words, one pound of carbon requires 32/12 or 2.66 pounds of oxygen for its combustion.

Similarly, for the amount of oxygen required for combination with the hydrogen: Two atoms of hydrogen combine with one of oxygen to form one molecule of water (H_2O). The atomic weight of hydrogen is one and that of oxygen 16, hence 18 pounds of water (molecular weight 18) contains 16 pounds of oxygen and 2 pounds of hydrogen, one pound of hydrogen requiring for its combustion 8 pounds of oxygen. In like manner the sulphur burns to sulphur dioxide gas (SO_2), sulphur having an atomic weight of 32 and (SO_2) a molecular weight of 64. Sixty-four pounds of (SO_2) thus contains 32 pounds sulphur and 32 pounds oxygen, or each pound of sulphur requires one pound of oxygen for its combustion.

The ratio of air to the oxygen contained in air is about 4.348 to 1, by weight, hence,

One pound of carbon requires for its combustion $2.667 \times 4.348 = 11.596$ pounds of air.

One pound hydrogen requires for its combustion $8 \times 4.348 = 34.784$ pounds of air.

One pound sulphur requires for its combustion $1 \times 4.348 = 4.348$ pounds of air.

A coal which contains 88.89 per cent carbon; 2.58 per cent oxygen; 4.15 per cent hydrogen, and 2.78 per cent sulphur in a pound of its combustible matter would require the following pounds of air for its combustion:

Carbon, $11.596 \times .889 = 10.309$.

Hydrogen, $34.784 \times .038 = 1.322$, where $[4.15 - (2.58/8)] = 3.83$.

Sulphur, $4.348 \times .028 = 0.122$. Total, 11.753.

The approximate amount of air required for the theoretical combustion of a pound of coal is given by the formula: $A = 12C + 36\ (H - O/8 + S)$. Where A = the number of pounds of air per pound of fuel and C, H, O and S the proportionate part of carbon, hydrogen, oxygen and sulphur, respectively. The use of this formula involves a chemical analysis of the coal.

When the analysis of the flue gases is known the actual amount of air supplied per pound of fuel may be determinded from Kent's formula: $A = 3.032\ [N/(CO_2 + CO)] \times C$. Where N, CO, and CO_2 are the percentages by volume of nitrogen, carbon monoxide and carbon dioxide, respectively, in the flue gases and C the proportionate part, by weight, of carbon in the fuel.

Tests for the determination of furnace economy consist in the investigation of this supply of air to the furnace and its relation to the quality of the products of the combustion. Of the elements producing the gases found in the products of combustion, carbon is the most important and is found in by far the greatest quantity. Its complete combustion results in the formation of carbon dioxide gas and the generation of 14,500 British Thermal Units of heat per pound. Its incomplete combustion results in the formation of carbon dioxide gas and carbon monoxide gas. The part burning to carbon monoxide produces only 4,450 B.t.u. per pound—about one-third of the heat generated by the complete combustion of the carbon.

In an ideal case of combustion where just enough oxygen is furnished the fuel to completely burn it, the products of the combustion would contain carbon dioxide and nitrogen, all o fthe oxygen being combined. The percentage of (CO_2) would then be 20.91 and of nitrogen 79.09. This condition, however, cannot be obtained in a furnace. The admission and distribution of air in such a manner as to bring the oxygen into intimate contact with each particle of coal during its partial combustion and into intimate contact with the gases thus formed in order to complete the combustion can be only approximated. Hence, there is always to be found in the products of combustion a certain amount of free oxygen which has escaped combination and has gone through to the stack. There will then be found in the flue gases carbon dioxide, oxygen and nitrogen and, if combustion has been incomplete, carbon monoxide. In addition to these moisture will be present from the burning of the hydrogen and from the free water which the coal contains, and a small amount of (SO_2) from the combustion of sulphur. The combined percentages of (CO_2) and oxygen will closely approximate 20.91 per cent.

From the above it is evident that a given percentage of (CO_2) in the flue gases represents either an excess or deficiency in the amount of air supplied to the fuel. A deficient air supply is indicated by the presence of (CO) and any change whereby more air is admitted to the fire will eliminate this (CO) and increase the amount of (CO_2) thereby increasing the economy of the furnace. An excessive air supply, on the other hand, will be indicated by a high percentage of free oxygen in the gases and a correspondingly low percentage of (CO_2). Any increase in the (CO_2) and hence in the economy must then be accom-

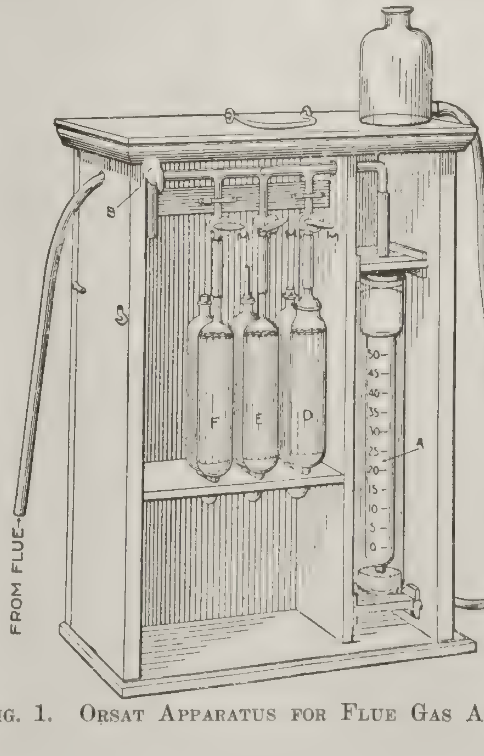


FIG. 1. ORSAT APPARATUS FOR FLUE GAS ANALYSIS.

plished by such adjustment of the furnace as to decrease the relative amount of air supplied to the fuel.

The determination of the amount of (CO_2) which the flue gases contain is an exceedingly simple operation and may be accomplished by means of several different devices. The Orsat apparatus, Fig. 1, operated by hand, indicates the percentages of (CO_2) (O), (CO) and nitrogen in the flue gases. This is the most used of any (CO_2) instrument and the one giving more satisfactory results than any other arrangement. There are a great many modifications of this apparatus on the market, all with more or less merit. Automatic instruments, of which Fig. 2 is a typical illustration, operate mechanically and record the percentage of (CO_2) upon a chart. The results obtained on these instruments are accurate and very satisfactory, and are almost indispensable in properly testing for furnace economy.

PROCESSES OF COMBUSTION ON THE CHAIN GRATE.

In the investigation of the processes of combustion of a given coal under a boiler with automatic chain grate with "Dutch Oven" type of furnace, Fig. 3, the following points are involved and may be regarded as typical to a large extent of the processes of combustion in any other type of furnace and boiler. 1—Kind of coal. 2—Side of coal. 3— Rate of firing coal. 4—Dept of fire. 5—Draft over fire. 6—Available draft in breeching. 7—Surface moisture in coal. Economy of combustion in a furnace of this sort means a combination of these conditions in such a manner as to permit of the complete combustion of the greatest amount of coal, assuming that the heating surface of he boiler is so designed in relation to the area of the grate that highest furnace temperature will give highest boiler efficiencies.

The determination of the proper sizing of coal of a given quality can only be accomplished by close observation and careful judgment of the above furnace conditions.

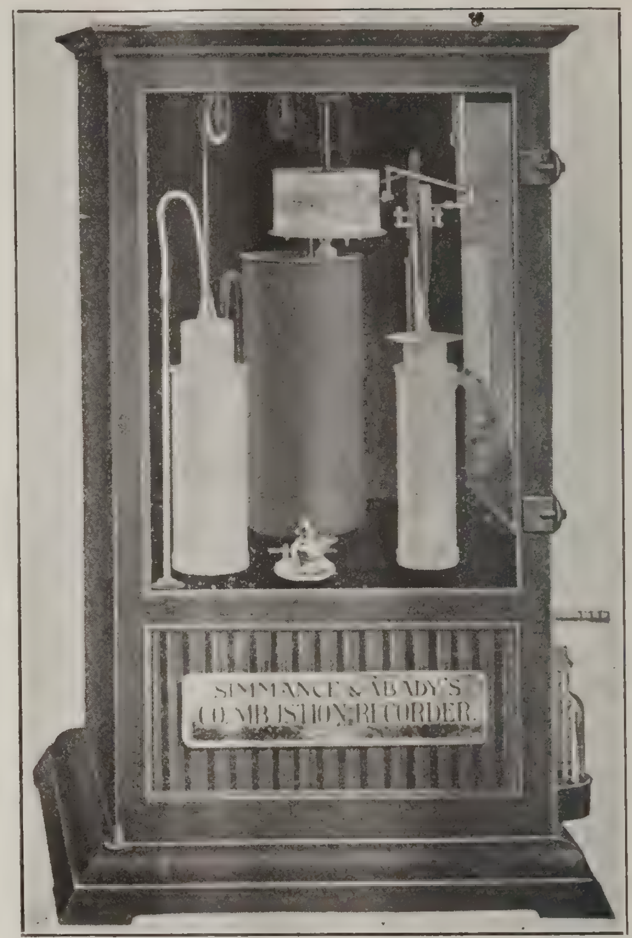


Fig. 2. A Graphic Carbon Dioxide Recorder.

First of all the coal must be of sufficiently high quality to produce a fire which will maintain a hot ignition arch.

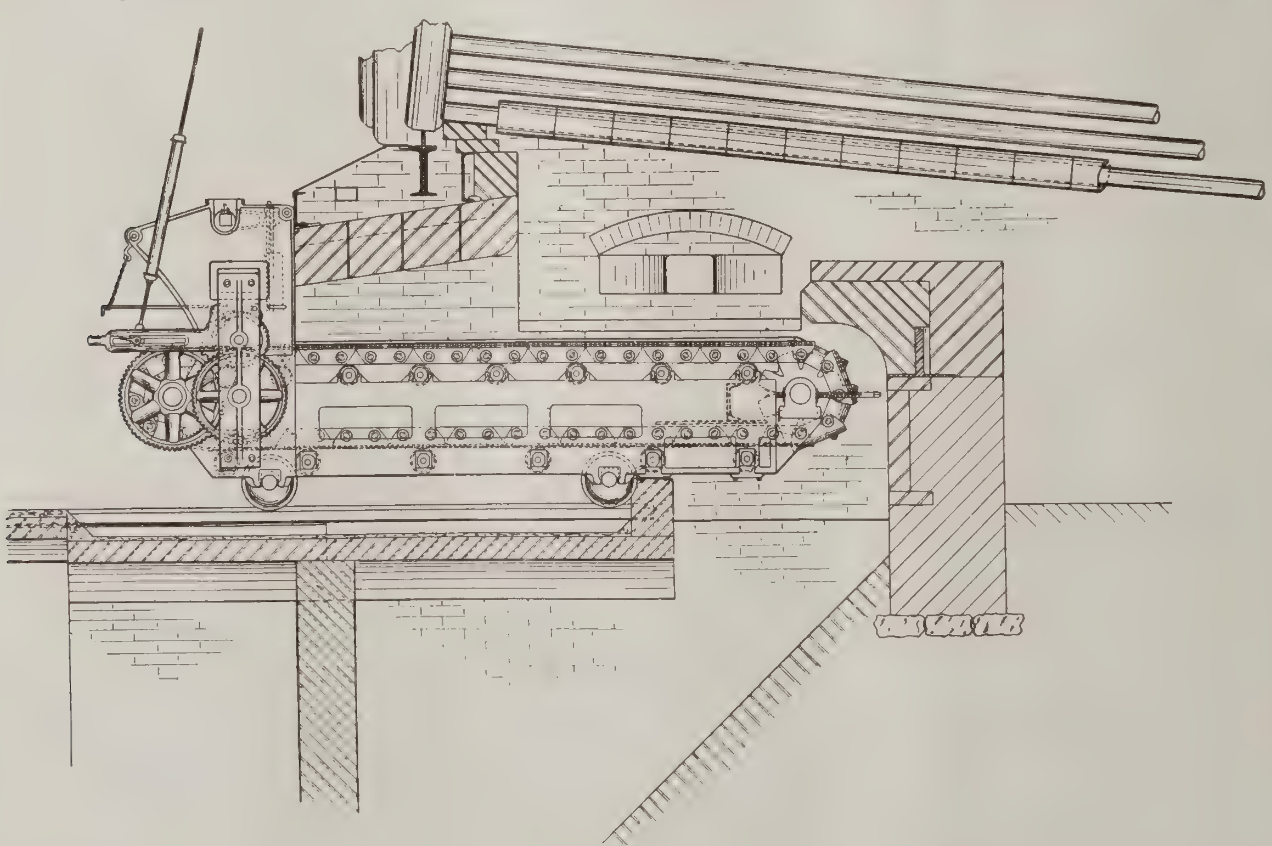


Fig. 3. Automatic Chain Grate With Dutch Oven Furnace.

Satisfactory combustion cannot occur without a hot arch.

The sequence of events as a fair grade of bituminous screenings move forward across a chain grate is as follows: As the coal emerges from beneath the gate it is closely packed (especially so in the case of slack) and permits the passage of only a small amount of the air necessary for its combustion. As it starts forward beneath the arch the surface quickly dries and ignition begins. As the coal moves farther forward, the heat gradually penetrates deeper, continually vaporizing moisture. This moisture as it passes through the bed of the fuel opens up small passageways which serve for the distribution of air which the coal now needs for its combustion. The vaporizing of the surface moisture takes heat away from the furnace, this heat being supplied from the ignition arch above. This water vapor impinging upon the hot surfaces of the arch dissociates and furnished oxygen to the hydrocarbons rising from the surface of the coal, forming the two combustible gases, carbon monoxide and hydrogen. To assist in completing the combustion of such gases is the function of the increased supply of air coming up through the bed of the coal. (The amount of surface moisture necessary for successful ignition in the formation of air passages through the bed of the fuel varies along with the other functions of combustion—more especially with the sizing of the coal. Nut coal does not require surface moisture for its successful combustion. For coal of this size the amount of air necessary for the combustion of the gases can readily pass through the openings between the particles of coal and any surface moisture serves but to absorb heat from the arch without assisting the processes in any way. On the other hand, coal which contains a large percentage of slack requires the further addition of surface moisture in amounts as high as 5 per cent, varying with the amount of slack).

The proper thickness of fire is determined in connection with the speed at which the grate must be run. These two are governed by the condition of the bed of coal at the rear of the grate, sufficient depth being maintained to avoid the burning of holes or running the fire "short." Free burning coking coals for this reason call for heavier thicknesses of fire and slower rates of feeding than coals higher in carbon. In no case, however, should the rate of feeding be so great as to allow the coal to pull away any distance from the grate before ignition. When this takes place the cool air and water vapor are drawn through the coal and pass up along the surface of the arch cooling it and eventually interrupting the service of the boiler. Too great speed of grate also results in a "long" fire which involves a loss of the fuel which is still unburned when it reaches the rear end of the grate and usually causes a "roll" beginning at the bridge wall. Section 2 of this article wi l continue this subject.

Inspection and Tests on Electrical Machinery

(*Contributed Exclusively to* Electrical Engineering).

BY HUGH T. WREAKS AND R. L. SHEARER, OF TRANSPORTATION EQUIPMENT INSPECTION BUREAU.

Section 1. Factory Tests on Direct Current Generators and Motors.

THIS series of articles will treat the testing of electrical generators and other machinery including those prime movers used in conjunction with same. It is of vital importance to the purchaser of costly machinery, such as gas engines, water wheels, steam engines and electric generators or motors to obtain proper design, construction and performance under test. The important points are efficiency and durability. The former is the relation of input to output, as measured by various direct tests, the latter a question of design and construction. In determining efficiency, the input and output must be very accurately measured. In the case of water wheels, the guarantee states the percent of energy to be delivered as compared to the energy of the water at the wheel; with steam engines, direct connected to generators and turbo-generators, the guarantee is a given number of kilowatt hours per pound of steam used and gas engine generator efficiencies are based on British Thermal Units per kilowatt hours. The efficiency of generators can then be taken as resultant kilowatt hours output compared with input from whatever type of prime mover operates them, and can also be tested by measuring and calculating the losses in the various parts of the machine, frictional and electrical, and thus obtaining the net output. Heating and regulation must also be carefully determined.

In many cases, electrical machinery and apparatus are not tested until after they have been installed. This is not a satisfactory method, as after installation any faults developed during test would be difficult to remedy. The proper place to make inspection and tests is at the works of the manufacturer, who is equipped with necessary portable instruments and standardized apparatus for checking same, so that any faults or defects developing can be remedied before the apparatus or machinery is accepted. This is especially true of electric generators and motors, and is generally recognized, so that complete tests of these are seldom called for at the power station for large units and at other location for smaller sizes. In fact, with generators, especially the larger sizes, so many are direct connected to a prime mover that complete tests to locate efficiency of generator would be extremely difficult. With electrical machinery it is desirable to know first whether it is efficient, and if not, the particular cause of such inefficiency, as indicated by various tests outlined in this article.

In the design and assembling of electrical apparatus mistakes may occur which, if not discovered and corrected, will cause considerable trouble after installation. The majority of engineers and power companies today buy apparatus and machinery under specifications and have a representative at the works of the manufacturer to see that such specifications are met in all detail. The first questions of importance are the salient points of design and construction, so that the electrical machine may operate under most satisfactory conditions for the service to be met. This naturally will be special for each case or particular group of conditions and subject to points of view based on experience of various engineers and could not be covered very well in one general article, being covered generally by specifications in each case.

The salient points of design and construction being agreed upon, it is necessary to know whether machines are satisfactory electrically and mechanically, and for this purpose specific tests are made. These will be taken up for specific classes of apparatus in the following order: Direct current generators and motors; alternating current generators and motors, and transformers. For direct current machines specific tests are as follows: Core losses, windage and friction losses, saturation, regulation, heating, dielectric insulation tests.

FACTORY TESTS ON DIRECT CURRENT GENERATORS AND MOTORS.

The tests for core loss, windage and friction are taken together by running the machine under test light, generator or motor, and noting power absorbed in these conditions. In order that satisfactory results may obtain in these tests, the brushes must be adjusted on the commutator for direct current machines to the no-load neutral point. They must be under only normal tension with commutator clean and free from grit, so that no excess commutator brush friction is obtained.

RUNNING LIGHT CORE LOSS.

The driving power should be supplied by a reliable voltage circuit that is not subject to sudden fluctuations; this so that the power input required to drive the machine running free as a motor may be obtained correctly and so that voltage and current readings may not be taken when the rotating parts are either accelerating or decelerating. Also, it is important that armature voltage must be steady and field current must have constant value to make these running light tests for loss accurate on motors or generators run as motors. Full load field flux must be obtained. On generator tests the potential applied to armature must be equal to normal rated voltage increased by the I R drop in the armature at full load. With this voltage impressed, the field current is varied until normal speed is obtained when careful readings must be made of armature current, armature volts, field current, field volts and speed. If the machine is a d. c. motor, the voltage applied to armature should be equal to normal rated voltage of the motor, less the I R drop in armature under full load. The field current is then adjusted to give normal speed and the electrical and speed readings taken as outlined above for direct current generators.

In both the generator and motor tests under conditions given, the power supplied to the machines running light will equal that absorbed in bearing friction, brush friction, windage and core losses; this after the armature I^2R losses have been subtracted. Belted core loss methods for similar tests differs from the above by separating the core losses from the bearing friction, brush friction and windage. The method of operation is as follows:

A small direct current motor is used to drive the machine under test as a generator. This motor is generally about 10 per cent of the capacity of the machine under test as this has been found quite satisfactory in practice. It is customary to use a belt drive between motor and generator and the latter must be run at its full rated speed. It is also important that the motor should operate with good commutation and fixed setting of brushes through the range of load required by the core loss test.

In addition the following conditions must be observed: The maximum load which the motor should carry with heaviest field on generator under test should not exceed 50 per cent of its normal rated capacity. The driving motor should be operated as nearly as possible at its rated speed and field strength. The brushes should be carefully set at the best position for good commutation at all loads required, and should remain in this position during the test. The motor commutator should be in first-class condition and be carefully examined before test is started, and the motor must be wired so that readings can be continually taken of amperes armature, volts armature, amperes field and speed, volts field being constant. This latter is accomplished by exciting the motor fields separately from those of the armature, and at a constant voltage which is determined experimentally as that voltage which gives the motor fields their normal value. With this method the speed of the driving motor is regulated by varying voltage applied to the armature terminals. The generator under test is also wired with its field separately excited and provisions made for reading amperes field, volts field and volts armature. Careful resistance measurements should be made on armature of driving motor previous to starting the test.

The test is carried out as follows: First readings are taken on the motor corresponding to the normal speed of machine under test. The driving motor and generator under test are then run together a sufficient length of time to allow the friction to reach a constant value. This will occur when electric input on driving motor becomes constant when driving the generator with no field excitation in the latter. Careful readings are now taken of the input to the motor with the machine under test excited, and all brushes down on commutator. Similar readings should then be made with brushes raised from commutator. Then starting from zero field on the generator, observations of input to the driving motor should be made with gradually increasing generator field strength, until these are recorded at various values of the fields from zero up to those which give 125 per cent normal load voltage. Then correcting the motor input readings at these various field strengths by subtracting the I^2R loss in armature of driving motor, and also the power input to the driving motor at zero field, we obtain the core losses corresponding to the various field strengths during entire test. It is advisable to take the readings of the motor input with zero fields at least three times as a check; once at beginning of test, once near the middle, and once at end of test. Readings should also be taken at the end of the test with normal voltage field current and with brushes raised from the commutator to compare with the similar readings in which field was the same, but with brushes resting on commutator and with the set of readings giving the brush friction. With these precautions quite accurate results will be obtained.

Theoretically, to calculate the efficiency of any piece of apparatus at a given load, we divide the output by the input. The input is equal to the output, plus the losses. The efficiency may, therefore, be defined as the ratio of the output plus the losses. In nearly every case the efficiency can be determined more accurately by measuring the losses and then computing the efficiency according to this latter definition, then by attempting to measure the total output and input and then taking their ratio.

SATURATION.

To determine the characteristics of the magnetic circuit, a test known as saturation test is made. This is made either on machines run as generators or as motors in either of the two following ways:

(1) To obtain a saturation curve on a machine run as a generator, constant speed should preferably be obtained and the brushes set at neutral point. The field current is

then increased step by step until at least 125 per cent of the normal voltage of the machine is reached, taking readings at each step of volts armature, volts field and amperes field. After reaching the maximum value of the field current, then without opening the field circuit, reduce the current gradually in four or five steps, and again take readings to determine the value of the residual magnetism at various points on curve. Special care should be taken to insure accurate readings, particularly at and above normal voltage. This "generator" method is the one preferably used.

(2) When it is not possible to drive the machine as a generator, a motor saturation may be made. In this test the machine is operated as a free running motor with power furnished from a variable voltage circuit. A certain voltage, at least fifty per cent lower than the normal voltage of the machine is impressed on the armature, and motor field weakened or increased to give normal speed and record made of the volts armature, amperes armature, amperes field, volts field and speed. The voltage at the armature should be increased by steps to 25 per cent above normal value, and the field increased correspondingly to keep speed constant, similar readings being recorded at the various steps as before. The armature voltage and field current are then reduced by steps as before and similar voltage and ampere readings taken at three or four points. A curve is then plotted out using the volts armature as abscissæ and amperes field as ordinates.

REGULATION. With a generator, when the speed is fixed the variation in voltage between no load and full load determines the regulation, while with a motor the speed variation is similarly noted.

In testing generators for regulation of the usual shunt type, readings are first taken at no load normal voltage, then without changing the rheostat, one-quarter load is thrown on and a reading taken of amperes armature, volts armature, amperes field and volts field. Holding one-quarter load, the voltage should be brought to normal and the same readings taken. The load should then be increased to one-half full load with rheostat in same position; similar readings and adjustments made as before. This is again repeated at three-quarter and full load. When the voltage has been brought to normal after full load readings, and with the rheostat left in position, the load is taken off the machine and rise in voltage noted. A curve can then be plotted showing voltage regulation and using amperes aramture as abscissae and volts as ordinates. Speed should be kept constant during test.

In testing motors for speed regulation; this is done by putting on varying loads from no load to full load and noting speed variation. The adjustment of commutator brushes will give a point where the regulation is best, and this should be done at full load after same has been applied long enough for motor to obtain its running temperature. This brush adjustment should never be made at the expense of commutator. Similar regulation tests are also made on compound wound machines, the method varying slightly according to whether the no load and full load voltage is designed to be the same or to vary.

HEAT TESTS. The determination of heating of different parts of machine is very important, and great care must be taken to obtain temperatures accurately. On the fixed parts, or rather stationary parts of machine this is comparatively simple, and consists in proper location of thermometers and protecting them from radiation. On the moving parts this is not so simple as the thermometers cannot be placed in position until after the moving parts have come to rest. Then additional thermometers must be promptly placed in such location on the rotor parts as to register typical temperatures, and these thermometers must also be protected from radiation, as after the machines come to rest there is a certain increase in temperature in all parts of the machine, the maximum temperature attained must be measured in every case. As the value of temperature tests depends upon rise in temperature, room temperatures must be carefully noted before and during tests.

DIELECTRIC AND INSULATION RESISTANCE. These two tests are very important as indicating any carelessness in workmanship or defective material, and are figured at a high enough factor of safety to insure against these two defects. Dielectric tests are made on all machines at factory, and insulation resistance tests made when called for. The general requirements for insulation resistance are that it will exceed one megohm, and this, in our opinion, is sufficient and easily met. Occasionally engineers call for two or more megohms, which entails a greater baking of the coils, and a hardening to the point of possible brittleness, which means a distinct weakening of the insulation strength from a mechanical viewpoint.

After machines have been accepted and installed and used in service for one or more years it is wise to make periodic insulation resistance tests so as to observe any indication of deterioration before it becomes serious enough to damage the machine. Tests of this kind are made more frequently in England than in this country. On the other hand, dielectric tests at any appreciable multiple of voltage normally used would be generally improper on machines in service as likely to break down points of potential weakness which might otherwise remain intact and allow machines to render good service for some time to come.

In addition to these tests at factory there are several salient points of design to be noted and checked. Armature clearance, air circulation, armature design, commutator design, brush rigging, bearings, design of frame and other details. In a later issue these, and the points discussed, will be drawn up into typical d. c. motor and generator specifications, including clauses for inspection and tests.

Kansas Section of National Electrical Contractors' Association Formed.

At a meeting of electrical contractors at Topeka, Kansas, May 3, a state section of the National Electrical Contractors' Association was formed. The following companies, members of the national organization, were present: Stanley and Fees, Wichita; Bushong Electric Co., Ottawa; Meeks Electric Co., Eldorado; American Electric Co. and N. C. Pickard Electric Co., Kansas City; Græber Bros., Lawrence; Mears Bros., Arkansas City; Woodhouse, Stein and Francis Electric Co., Atchison; O. T. Comer Electric Co., Hutchinson, and the following from Topeka, Kansas: E. L. Overton Engineering Co., Tucker Electric Co., E. P. Jordon Electric Co., H. B. Howard Electric Co., and The Machinists' Electric Co.

The following officers were elected: President, E. L. Staley, Wichita; vice-president, J. C. Bushong, Ottawa; treasurer, J. R. Woodhouse, Atchison; secretary, J. A. Mercer, Topeka. A banquet was given at the Troop Hotel attended by 40 electrical men.

Fifth Annual Convention of the Mississippi Electrical Association

The fifth annual convention of the Mississippi Electrical Association, a state section of the National Electric Light Association, was held April 21, 22 and 23, at Natchez, Miss. As recorded in the April issue of Electrical Engineering, the members and delegates to the convention assembled at Vicksburg, where a steamer was taken for Natchez.

The first session of the convention was held on board the Steamer Cordill, Monday afternoon at 2 p. m., the convention being officially opened at this time by the reading of the president's report by R. B. Claggett, of Greenville. President Claggett in his report outlined the events of the year, mentioning the successful work of the committees, and stated that the reports of the various committees appointed at annual conventions are to be looked upon as one of the important features of convention work. He also referred to the successful executive meetings which have been held, recommending that these meetings be held more often. The increased work for the secretary was outlined and a recommendation made that a paid assistant be appointed to keep in touch with association work throughout the year. President Claggett touched upon the subject of rates advising that the matter be taken up by the association in such a way as to be able to show at any time the fundamental derivation of the various rates in use. He referred further to the work the association can do in regard to forestalling adverse legislation, and mentioning some of the cases that had come up during the year. In closing his report, Pesident Claggett referred to the progress and advancement of electricity in the past 25 years, and commented briefly on future development.

Following this report, the report of the committee on electric heating and cooking was presented, by Mr. C. G. Murdock, of Hattiesburg. This report was interesting in many ways on account of the details presented from the view points of different manufacturing companies, the report being made up largely of statements from these companies. Special reference was made to better construction of heating units ,connections and the satisfactory service that the majority of current consuming devices are now giving. It was stated that largely on account of these features as well as a reduction of a former obstacle, namely, price, the devices are being widely introduced. The status of the electric range was touched upon, it being shown that considerable improvement has been made, both in the reduction of current consumption and cost of ranges so that they may be more easily installed in the average home. It was the opinion of one of the manufacturers reported by the chairman of the report, that unless the central station can see its way to making a rate of 4 or 5 cents for cooking it will have no great measure of success. The largest installation of electric ranges in the United States was referred to as located at Billings, Montana, where a rate of 3 cents per Kw hour is charged, with a minimum of $1.00 per month. 300 ranges are installed here and the average cost in 1912 per customer was $2.50 per month. The central station company increased its revenue in 1912 from electric cooking $9,000 without material increase in the investment. It was stated that a transformer capacity of only 20 per cent of the connected load is required when stoves are banked on one transformer, due to diversified hours of cooking in different homes.

An interesting discussion followed this paper in which the following members took part: A. J. Bemis, Vicksburg; J. K. Stewart, Vicksburg; C. G. Murdock, Hattiesburg; A. H. Jones, McComb City; J. E. Sims, General Electric Co; F. J. Duffy, Natchez. The discussion was mainly on the basis on which electricity for heating and cooking can compete with gas, it being agreed that the rate for heating and cooking determines largely the amount of business that can be successfully secured.

The report of the committee on meter testing and practice was next presented by Mr. Stern of Hattiesburg. This report took up in considerable detail the nature of tests of meters and the troubles that arise.

The discussion on this paper was taken part in by Messers. Hayes of Columbus, Prof. Reid of the A. & M. College; F. J. Duffy of Natchez; J. K. Stewart of Vicksburg; W. F. Gorenflo, of Gulfport, and C. Z. Stevens, of Hattiesburg. The discussion developed the reasons for testing meters and proper accuracy. Mr. Duffy suggested that in case a customer is dissatisfied and believes the meter wrong, that another meter should be connected in series and both allowed to run in circuit so as to prove to the customer that when the two readings are alike, the meter complained of was correct. Considerable discussion developed over the prepayment meter and the troubles that occur in connection with the meter becoming hung and operating without the required money to feed the meter. It was, however, developed that the prepayment meter is in most cases proving satisfactory in service. The prepayment meter is being successfully used in Gulfport, where one man looks after the meters very carefully. The theft of current was brought up and a suggestion made that a committee be appointed to draw up a bill to be presented before the next state legislature to make theft of current punishable.

Sessions on Tuesday.

The Tuesday morning session, the first in Natchez, was opened by an address of welcome by Hon. W. G. Benbrook, mayor of Natchez. The mayor extended the members a hearty greeting, stating that special arrangements had been made for their entertainment, and asking that they be willing to be entertained.

The first paper was one on steam flow meters by R. E. Wooley, and was read by Mr. Carnagy of the General Electric Co., in the absence of the author. This paper while brief took up the interesting details in connection with the use of the steam flow indicating meter explaining that the instrument is a means of knowing that each boiler of any plant is doing its proper amount of work. It was also shown that besides increasing the efficiency of boilers by operating them at economical load points, flow meters in actual service have shown objectionable and peculiar conditions that exist which were unknown before the meters were installed. When the boiler is equipped with the flow meter the fireman at once knows when the steam pressure commences to drop and can locate the trouble without loss of time. The instrument is being widely used and found of decided value

The discussion on this paper was taken part in by Messers. Duffy, Gorenflo, Cox, Stewart, Prof. Reid, and Mr. Carnagy. This discussion brought out the methods of installing the meter, its size and cost for different installations. It was shown that little intelligence on the part of the fireman is required to operate and understand the meter since its indication plainly shows what is happening and the fireman who is familiar with his work can then locate any trouble.

The next paper on domestic appliances for load building by S. G. Levings was read by Mr. Starliper, of the Westinghouse Electric and Manufacturing Company, in the absence of the author. This paper took up in detail a discussion of the different current consuming devices, the cost of operating same and the methods of purchasing and handling them by the central station. The nature of national advertising done by large manufacturing companies was commented upon as an assistance in handling these devices. Methods of securing sales for domestic and industrial current consuming devices were touched upon, window display being mentioned.

The discussion following this paper was entered into by Messers. Stewart, Murdock, Cabell and Hickox, of the Greenwood Advertising Co. Mr. Stewart took up in detail the various points mentioned in the paper, pointing out especially that the prices of devices influenced the sale decidedly. He mentioned a campaign which he carried on successfully in Vicksburg, placing an electric iron in the home at no cost to the consumer. 130 irons were placed in this manner in three days, the customer purchasing $6.00 worth of coupons accepted by the company in payment of bills. This scheme seems to have worked satisfactorily in Vicksburg and it will be tried out on a larger scale shortly. Mr. Murdock suggested the loaning of irons to the customer as long as he retains the meter, thus holding the title of the irons in the company's name.

The next paper, on Large Power Contracts, was presented by Mr. A. B. Patterson. This paper discussed the nature of large power contracts, their treatment by the central station and the profitableness of such customers. The author referred to particular cases, outlining the important features to be considered when connecting large power customers to central station lines.

The discussion was taken part in by Messers. Duffy, Patterson, Gorenflo, Stewart, Hays, Jones and Robertson. Mr. Patterson stated in the discussion that it was his opinion that the rate for large power business should be such as would justify the party in making change to electric drive. He mentioned the fact that a knitting mill in Hattiesburg received a rate of 1.26 cents per Kw hour, and that the business was profitable. Mr. Patterson further stated that in his opinion very few southern towns in the state of Mississippi have a very great peak and it is therefore not wise to limit a consumer to what is known as a peak. Since there is more power in most towns then lighting loads if the proper rates are made the station can get the customers on the lines. The reduction of customers insurance through the installation of motors was mentioned and a case pointed out where in a factory and planing mill the rate was reduced $3.00 per year by installing motors, making a saving of $150 per year in insurance. Mr. Robertson commented upon the use of high voltage motors, saying that the promiscuous installation of small units of high voltage is a mistake. He, however, favored high voltage motors when they were installed properly.

The afternoon session was opened by a paper on line construction and grounding of secondaries presented as a report of the committee covering these subjects. The report was read by the chairman, C. L. McBride of Meridian. The paper took up the discussion of the important parts of well constructed lines and choice of materials. It was recommended that cross arms should be used with a minimum distance of 30 inches between pole pins. It was further recommended that all poles be treated with a preservative at the bottom, that cross arm braces, bolts and steps should be of steel properly galvanized or sherardized. In regard to pole setting, it is recommended that not less than five feet, and in some localities six feet, should be used for 30-foot poles. The report stated that lines in Mississippi seem to be particularly in need of adequate lightning protection owing to serious storms. It was recommended to ground to water systems or use copper plates or a copper coil buried in the ground.

In regard to grounding of secondaries, it was recommended that this matter be given serious consideration, first because it affords greater protection against personal injury, and second, because it decreases the fire hazard, and third, it places the central station in a better legal position in case of trouble or serious accident when an attempt is made to shift the blame on the electric company. It was recommended that in general practice a piece of three-quarter inch galvanized iron pipe be driven well below permanent moisture level at close intervals for proper grounding. This applies in moderately low ground where the moisture is easily reached. In high dry ground it is necessary to bury a ground plate of copper in suitable material such as charcoal. All grounds should be connected by not less than No. 6 B. & S. Gauge wire. The committee stated that the using of street car rails for a ground should be strongly condemned as they do not give a proper path to the ground and are useless. It further recommended the securing of permission to attach ground wires to pipes of water works sytems as this is the best ground obtainable.

Following a short discussion of this paper, the report of the secretary and treasurer was presented, through which considerable information was presented bearing on the future welfare of the association and the relation of its members to others interested in it, especially jobbers and contractors. The discussion of commercial relationship between member companies and jobbers and contractors was thoroughly taken up, a point that brought out a decidedly interesting and earnest discussion, steps being taken to bring about the fullest cooperation.

Sessions on Wednesday.

The first paper of the Wednesday morning's session was presented by J. F. Jones, of the Wagner Electric & Mfg. Co., on "Solving the Small Power Users' Problems." This paper took up the use of single-phase alternating current motors and presented a considerable amount of information to show how the first cost of single-phase and poly-phase motors compares as far as installation is concerned and also as to how transformer losses vary with single-phase motor installations, how the meter investment is from 10 to 50 per cent less for single-phase than for polyphase motors and how single-phase distribution is cheaper than polyphase distribution from points of labor cost, cost of conductors, conduit cross arms, pins, insulatorr, etc. The paper also commented upon power factor and discussed in some detail the single-phase unity power factor motor of the Wagner design, showing how it is capable of operating at unity power factor.

The discussion of this paper was taken part in by Messrs. Stewart, Jones, Patterson, Prof. Reid, Gorenflo, Duffy, Starliper and Hays. It brought out the difference in cost of single-phase and three-phase motors, the central station members pointing out that the high cost of the single-phase motor makes it difficult to induce the customer to use same if a three-phase motor can be used.

The next paper on Lubricating Oils was presented by W. A. McWhorter, of the Galena Signal Oil Co., Atlanta. In the treatment of this subject, the author went into the subject of lubrication, thoroughly outlining the value of different lubricants in reducing friction. He gave a brief sketch of the use and practice in regard to lubrication in power plants, taking up the different features and the recently improved methods of lubrication and lubricating devices. He further took up the causes of complaint of improper lubrication, mentioning the fact that some of the most common causes of complaint are in allowing edges of the piston and bull rings to become sharp and act as scrapers removing all traces of oil from the surfaces in contact, resulting in excessive friction heating and eventually cutting if not checked in time. The author recommended the gravity feed system as the most efficient method of furnishing oil to external parts of reciprocating engines. In regard to turbine lubrication, he recommended that an absolutely pure mineral oil, free from acid, animal fats and parafine be used, that does not have the characteristic of forming an emulsion when mixed with water and violently agitated. In regard to the lubrication of railway motors, the author recommended that the former crude methods of grease lubrication should be superceded by systematic and uniform application of a proper lubricating oil, adapted to and applied as demanded by the needs of the service. The proper preparation of the packings for journals and motor bearings is very important in connection with lubrication and has not received the attention from electric railway men which its importance would justify. He recommended that before being used the waste be submerged in oil not less than 48 hours, then the surplus drained or pressed off, allowing sufficient oil to remain, approximately equal to four pints of oil per pound of dry waste.

This paper was discussed by Messrs. Patterson, Hays, Duffy, McArthur, Gorenflo, Bemis, Stevens, Jones and Cox. The discussion brought out the different methods of oiling used by member companies and the cost of same. One member stated that at one time their lubricating cost was about 45 cents per thousand miles, and that with the proper system now in use the cost had been reduced 50 per cent.

Following this discussion the committee on insurance made its report. The discussion of this report brought out the fact that the fire rates for Mississippi during the past year have been materially reduced. The subject of employers' liability and public liability insurance was taken up, the opinion being voiced that liability insurance is very important and that the association can do no better work than give this matter particular attention. It was recommended that the committee continue its work for another year. The use of the pulmotor was suggested as a means of reducing costs due to accidents.

The session on Wednesday afternoon opened with a paper on ornamental street lighting in small towns by Mr. Horton, of the National Electric Lamp Association. This paper took up in detail the essential features of a lighting system, a discussion of the units used for best efficiency and illumination and the distribution of light for different streets. The subject was divided into three main divisions, namely, street lighting for business districts, residence districts, and outlying districts. It was recommended that the lighting in the business districts should not be similar to that of the residence district, as the business center should stand out distinct from the rest of the town. A high intensity should not be sought, but a uniform intensity of such a value as to attract attention. This applies especially to ornamental lighting on business streets. With cluster lamps a spacing of posts from 60 to 80 feet was given as common in engineering practice.

For residential districts a uniform moderately low intensity averaging from 1/10 foot candles to 2/10 foot candles is satisfactory. Series distribution is universal and 6.6 ampere series Mazda lamp is usually recommended. Single line lighting presented a clean cut appearance and increases the apparent width of road bed and is a system to be recommended. Although 60, 80 and 100 candle power lamps are used in residential districts, the 80 candle power is most common, which mounted at a height of 12 feet makes a spacing of approximately 125 feet good practice. For outlining districts and country roads, the lighting should be on the same plan as the residential districts except that light as uniform or of as high intesity is not required.

A considerable amount of cost data was presented in the form of curves, discussing cost, intensity, and distribution of each installation of lamps discussed. Arc lamp data was presented against that for incandescent lamps, showing in most cases that it was most economical in illumination, in first cost and maintenance to use of the incandescent system. According to a table of costs, comparing a four-ampere magnitite arc lamp with Mazda units, it was shown that the magnitite arc costs four times as much as the 100 candle power units to install, 5.5 times as much as the 80 candle power, and 6 times as much as the 60 candle power. Again the cost of maintaining the arc is 4.6 times as much as the 100 candle power unit, 5.5 as much as the 80 candle power unit, and 6.7 times as much as the 60 candle power unit. As a result of the study of the curves presented, it was shown that the larger Mazda compare very favorably with the arc lamp so far developed and that the small Mazda units are superior.

The discussion was taken part in by Messrs. Tucker, Starliper, Horton, Duffy, Sims and Stewart. The discussion centered around the competition that exists between the Mazda lamp and the luminous arc lamp, as well as some other types of arc lamps, information being given to substantiate the argument in favor of both units. This paper was the last one of the session, reports of the nominating committee, the committee on resolutions, and committee on the president's address, as well as the report of the secretary and treasurer, and auditing committee, being then presented.

At the election of officers, held during this session, the following members were chosen to serve the next year: president, W. F. Gorenflo, general manager of the Gulfport & Mississippi Coast Traction Co., Gulfport, Miss; vice-president, A. H. Jones, general manager of the McComb City Electric Light & Power Co., McComb City, Miss. Members of the Executive Committe: J. K. Stewart, commercial agent of the Vicksburg Light & Power Co., and R. H. Smith of Hattiesburg Traction Company.

Entertainment Features.

The entertainment features for the ladies attending the convention were complete in all details, including automobile trips about Natchez, whist parties and theatre parties. On Tuesday evening a dance was held at the Prentiss Club and on Wednesday night a banquet at the Natchez Hotel largely attended and enjoyed.

On Wednesday night the Jovian Order held a rejuvenation, when some 12 candidates were initiated. A parade was conducted through the streets of Natchez which was highly complimentary to the members taking part.

New President of Mississippi Section, N. E. L. A.

The new president of the Mississippi section of the National Electric Light Association is a man entirely familiar with the central station interests of the state having been connected with the financial and public service

W. F. Gorenflo, President of Mississippi Section, National Electric Light Association.

interests in the state for a number of years. Mr. W. F. Gorenflo, general manager of the Gulfport and Mississippi Coast Traction Company was born at Biloxi, July 14, 1877. He graduated from the mechanical department of the Mississippi Agricultural and Mechanical College in 1899, and from this time until 1903 was with the William Gorenflo & Co., oyster canners. He then secured a position as assistant cahier of the Bank of Biloxi, remaining in this position until 1903 when he assisted in the organization of the Biloxi Electric Railway & Power Co., and became its secretary and general manager. When this company was sold to the Gufport and Mississippi Coast Traction Company, October 1, 1905, he became manager at Biloxi. On June 1, 1906, he was made superintendent of the entire system and on January 1, 1911, elected general manager, which position he now holds. He was married to Miss Josephine Gregoire, of New Orleans, July 9, 1902, and they have four boys.

Convention of Oklahoma Gas, Electric & Street Railway Association.

The second annual convention of the Oklahoma Gas, Electric & Street Railway Association was held at Oklahoma City, May 6, 7 and 8. This convention was attended by 125 members and guests, an indication of the decided interest in public utility matters throughout the state. The order of business was as follows:

Address by Pres. F. W. Caldwell, of the Shawnee Gas & Electric Company, in which he advocated and advised a close and sincere cultivation of the good will of the public at large, this applying to employes and officials of public utility properties alike. A paper was presented by W. B. Clayton of the Southwest General Electric Company on, "Lightning Arresters," in which the different types were discussed. Railroads and the Safety First Movement, was the subject of another paper presented by Geo. F. Knox, of the Oklahoma Railway Company. The author discussed the prevention of accidents through educational means, instructing the public concerning the necessity for caution. It was also pointed out that campaigns to prevent accidents not only reduce preventable accidents but also reduce the expense for damages on the companies. J. W. Tabb, of the General Electric Company, presented a paper taking up lamp operation. He pointed out that full voltage was essential for good operation of incandescent lamps for with low voltage, both the central station and the customer loses. The first by loss of revenue and the customer by not securing the illumination possible. To hold voltage at a certain value the author advocated voltage surveys, measurements being taken at the sockets and the customers furnished the lamp that will operate best on the voltage at the particular point.

A paper on single-phase motors was presented by F. Johnson, of the Wagner Electric Manufacturing Company, treating especially the uses of small motors. The paper was in the form of a discussion, different statements being made and material and data given to prove the statements made. Among the points mentioned were reduction of line disturbance with the single-phase motor, higher power factor, and small investment. W. J. Dibbens discussed the differences between the public utility companies and commissions, stating that the operators can obtain a fairer and more impartial consideration by such bodies and the public. He advised the use of publicity work to keep the public in close touch with the companies' business and fair treatment of complaints in all cases.

The subject of electricity and irrigation was presented by Prof. H. B. Dwight, of the University of Oklahoma. The methods of pumping and irrigation systems in use were taken up, as well as the use of electricity for farming purposes. A paper by J. W. Dawley, of the Hugo Ice & Light Company, took up the operating features and costs of small oil engines. Referring to a 225-horsepower engine connected to a 200-kva generator, the author gave as approximate figures of cost of operation, the following: Fuel cost, 2.5 to 3.0 mills; lubricating oil, 2 gallons per twenty-four hours and about 5,000 gallons of cooling water per day. Repairs since November, 1911, had been $158.33. The problems of a natural gas plant were discussed by W. H. Bagley, of the Osage and Oklahoma Company.

A paper on liability insurance was presented by F. H. Ellis, of the Kansas Employers' Inter-Insurance Exchange, and the Illinois Indemnity Exchange. The author stated that the cause of high rates for insurance was due to the fact that the agents practically control the situation and demand high commissions which come out of the policy-holders. In order to reduce the cost of insurance, it was pointed out that a system must be devised so that the money spent for insurance is used for insurance, this being done in three ways—through self insurance, state insurance or mutual insurance. Each of these forms, however, have faults Legislation affecting public utilities was presented by Prof. H. V. Bozell, of the University of Oklahoma. This paper took up causes of recent legislation, and the effects on the utilities. It also advocated the regulation of municipally owned utilities.

The officers elected for the coming year are as follows: President, F. E. Bowman, Ada Electric & Gas Company; first vice-president, Lincoln Beerbower, Enid Electric & Gas Company; second vice-president, George W. Knox, Oklahoma Railway Company; secretary and treasurer, Prof. H. V. Bozell, University of Oklahoma.

Program of Chicago N. E. L. A. Convention.

The following is an arrangement of the program for the Chicago N. E. L. A. Convention according to the general division of subjects discussed.

General Sessions.

First, Tuesday, 10 a. m. Main Auditorium, Room No. 1. 1. Welcome to the city; 2. Address of President Tait; 3. Announcements; 4. Report of the Committee on Organization of the Industry, H. H. Scott, Doherty Operating Company, New York. 5. Report of Secretary, T. C. Martin, Secretary N. E. L. A., New York; 6. Report of Insurance Expert, W. H. Blood, Jr., Stone & Webster Corporation, Boston; 7. Report of Committee on Progress, T. C. Martin, Secretary N. E. L. A., New York; 8. Report on Question Box, S. A. Sewall, Ass't. to Secretary, N. E. L. A., New York; 9. Paper: Anticipation, Paul Lupke, Public Service Electric Company, Trenton, N. J.

Second, Wednesday, 11:45 a. m. Main Auditorium, Room No. 1. 1. Paper: Central Station Power in Coal Mines, W. A. Thomas, Westinghouse Electric & Manufacturing Co., Pittsburgh; 2. Paper: Switching Apparatus for Rural Installations, E. B. Merriam, General Electric Company, Schenectady; 3. Paper: Central Stations for Towns of 5,000 Population or Less, J. Edward Kearns, General Electric Co., Schenectady.

Third, Friday, 10:00 a. m. Main Auditorium, Room No. 1. 1. Report of Rate Research Committee, E. W. Lloyd, Commonwealth Edison Company, Chicago; 2. Report of Street Lighting Committee, John M. Lieb, New York Edison Company, New York; 3. Paper: Arc Lamps and Recent Developments Thereof, W. A. Darrah, Westinghouse Electric & Manufacturing Co., Pittsburgh; 4. Paper: Advantages of Copper Clad Wire for Series Arc Lighting, T. K. Stevenson, Duplex Metals Company, New York; 5. Report of the Committee on Underground Construction, W. L. Abbott, Commonwealth Edison Company, Chicago; 6. Lecture: Light and Art, M. Luckiesch, National Quality Lamp Division, General Electric Co., Cleveland; 7. Address: Objects of the Society for Electrical Development, Henry L. Doherty, President of Society, New York.

Fourth, Friday, 2:30 p. m. Main Auditorium, Room No. 1. 1. Paper: Transformers and Power Transmission, H. H. Rudd, Westinghouse Electric & Manufacturing Company, Pittsburgh; 2. Paper: Railway Loads for Central Stations, E. P. Dillon, Westinghouse Electric & Manufacturing Co., Pittsburgh; 3. Report of Committee on Award of Doherty Gold Medal, W. F. Wells, Edison Electric Illuminating Company, Brooklyn; 4. Report of Committee on Memorials, T. C. Martin, Secretary, N. E. L. A., New York; 5. Report of Committee on Constitutional Amendments, Frank W. Frueauff, Denver Gas & Electric Company, Denver; 6. Vote on Constitutional Amendments; 7. Report of Committee on Resolutions; 8. Report of Nominating Committee; 9. Election of Officers; 10. Adjournment.

Technical Sessions.

First, Tuesday, 2:30 p. m. Main Auditorium, Room No. 1. 1. Report of Meter Committee, (with Third Edition of Code for Electricity Meters), W. H. Fellows, Potomac Electric Power Company, Washington, D. C.; 2. Report of Committee on Grounding Secondaries, W. H. Blood, Jr., Stone & Webster Corporation, Boston; 3. Report of Lamp Committee, Frank W. Smith, United Electric Light & Power Company, New York; 4. New Incandescent Lamp Development, J. E. Randall, National Electric Lamp Association, Cleveland; 5. Paper: The Incandescent Lamp and Its Relation to Lighting Service, R. E. Campbell and W. C. Cooper, National Electric Lamp Association, Cleveland; 6. Report of Committee on Measurements and Values, Dr. A. E. Kennelly, Harvard University, Cambridge, Mass.

Second, Thursday, 10 a. m. Main Auditorium, Room No. 1. 1. Report of Committee on Prime Movers, I. E. Moultrop, Edison Electric Illuminating Co. of Boston, Boston; 2. Report of Committee on Electrical Apparatus, L. L. Elden, Edison Electric Illuminating Co. of Boston, Boston; 3. Paper: Switchboard Instruments, Paul MacGahan, Westinghouse Electric Manufacturing Co., Pittsburgh; 4. Paper: Latest Developments in Distributing Transformers, E. G. Reed, Westinghouse Electric & Manufacturing Co., Pittsburgh; 5. Paper: The Use of the Telephone in Central Stations, Angus Hibbard, American Telephone & Telegraph Co., New York; 6. Report of Overhead Line Construction Committee, Farley Osgood, Public Service Electric Company, Newark, N. J.

Hydroelectric and Power Transmission Sections.

First, Wednesday, 10 a. m. Main Auditorium, Room No. 1. 1. Address of Chairman of Section, W. N. Ryerson, Great Northern Power Company, Duluth, Minn.; 2. Report of Committee on Membership, R. J. McClelland, Electric Bond and Share Company, New York; 3. Report of Committee on Progress, T. C. Martin, Secretary National Electric Light Association, New York; 4. Report on Turbines. (Report being part of National Committee Report on Prime Movers), J. F. Vaughan, Stone & Webster Corporation, Boston; 5. Paper: The New Type of Thrust Bearing, Albert Kingsbury, Pittsubrgh.

Second, Thursday, 2:30 p. m. Main Auditorium, Room No. 1. 1. Paper: Poles and Pole Preservation, R. A. Griffin, Western Electric Company, Chicago; 2. Paper: Lightning Arresters, E. E. F. Creighton, General Electric Company, Schenectady; 3. Developments in Protective Apparatus; Paper, J. N. Mahoney, Westinghouse Electric & Manufacturing Company, Pittsburgh; 4. Lecture: The System of the Mississippi River Power Co., Hugh L. Cooper, Mississippi River Power Co., Keokuk, Iowa.

Third, Friday, 10 a. m. Lawn Tent Room No. 2. 1. Report of Committee on Receiving Apparatus, M. R. Bump, Henry L. Doherty Company, New York; 2. Report of Committee on Distributing Lines, P. M. Downing, Pacific Gas & Electric Company, San Francisco; 3. Report of Committee on Operation of Water Power Systems, D. B. Rushmore, General Electric Company, Schenectady; 4. Factors Producing Reliability in the Suspension Insulator, A. O. Austin, Ohio Brass Company, New York; 5 Paper: Transmission Line Construction, R. D. Coombs, R. D. Coombs & Company, New York; 6. Address: Investigation of Life Hazards of High Tension Lines, by the U. S. Bureau of Standards, Dr. S. W. Stratton, U. S. Bureau of Standards, Washington, D. C.; 7. Election of Officers.

Commercial Sessions.

First, Tuesday, 2:30 p. m. Lawn Tent, Room No. 2. 1. Address of Chairman of the Section, Edward W. Lloyd, Commonwealth Edison Company, Chicago; 2. Report of Finance Committee, T. I. Jones, Edison Electric Illuminating Company, Brooklyn; 3. Report of Membership Committee, J. F. Becker, United Electric Light & Power Company, New York; 4. Report of Publications Committee, Douglass Burnett, Consolidated Gas, Electric Light & Power Co., Baltimore; 5. Address: How to Protect Business from Disturbance Caused by Panics, David R. Forgan, President National City Bank, Chicago; 6. Report of Electric Salesmen's Handbook Committee, E. L. Callahan, H. M. Byllesby & Company, Chicago.

Second, Wednesday, 10 a. m. Lawn Tent, Room No. 2. 1. Report of Committee on Education of Salesmen, George Williams, Henry L. Doherty Company, New York; 2. Report of Committee on Electrical Marchandising, T. I. Jones, Edison Electric Illuminating Company, Brooklyn; 3. Report of Advertising Committee, J. Robert Crouse, National Quality Lamp Division, General Electric Company, Cleveland; 4. Advertising for a Small Central Station, N. H. Boynton, National Quality Lamp Division, General Electric Company, Cleveland.

Third, Thursday, 10 a. m. Lawn Tent, Room No. 2. 1. Reports of Electricity on the Farm Committees, (a) Eastern States, John C. Parker, Rochester Railway & Light Company, Rochester; (b) Middle States, C. W. PenDell, Public Service Co. of No. 111, Chicago; (c) Western States, Stanley V. Walton, Pacific Gas & Electric Company, San Francisco; 2. Report of Committee on Wiring of Existing Buildings, Robert S. Hale, Edison Electric Illuminating Company of Boston, Boston.

Fourth, Thursday, 2:30 p. m. Lawn Tent, Room No. 2. 1. Report of Committee on Ice and Refrigeration, George H. Jones, Commonwealth Edison Company, Chicago; 2. Report of Committee on Short Cuts in Executing Customers' Orders, George C. Holberton, Pacific Gas & Electric Company, San Francisco; 3. Report of Committee on Steam Heating, S. Morgan Bushnell, Commonwealth Edison Company, Chicago; 4. Report of Nominating Committee; 5. Election of Officers.

Accounting Sessions.

First, Tuesday, 2:30 p. m. Temple Parlor, Room No. 3. 1. Report of Committee on Uniform System of Accounts, E. J. Bowers, Kansas City Electric Light Company, Kansas City, Mo.; 2. Paper: Accounting School and Education of Employes, A. L. Holme, New York Edison Company, New York; 3. Paper: Method of Keeping Prepaid and Accrued Accounts, Franklyn Heydecke, Public Service Electric Company, Newark, N. J.; 4. Paper: Office and Mechanical Appliances, Their Uses, Economies Effected, Etc., H. L. Lohmeyer, Consolidates Gas, Electric Light & Power Company, Baltimore, Md.

Second, Wednesday, 10 a. m. Temple Parlor, Room No. 3. 1. Report of Sub-Committee on a Tentative Classification of Accounts, Including Balance Sheet and Indicant Accounts, John L. Bailey, Consolidated Gas, Electric Light & Power Co., Baltimore; 2. Paper: Handling of Freight Bills, Albert S. Scott, Public Service Company of Northern Illinois, Chicago; 3. Paper: Accounting for Replacement of Plant Retired from Service, Frank A. Birch, Philadelphia Electric Company, Philadelphia.

Third, Thursday, 10 a. m. Temple Parlor, Room No. 3. 1. Report of Sub-Committee on Statistics and Forms, C. L. Campbell, United Electric Light & Water Company, Waterbury, Conn.; H. Spoehrer, Union Electric Light & Power Company, St. Louis; 2. Paper: Obligations of the Bookkeeping Department to the Operating Department, H. Patterson, Rochester Railway & Light Company, Rochester; 3. Paper: Handling of Bond Coupons, W. J. Kehl, Virginia Railway & Power Company, Richmond, Va.

Public Policy Session.

Wednesday, 8:30 p. m. Main Auditorium, Room No. 1.

1. Reading of Report of Public Policy Committee; 2. Address by Samuel Insull, President Commonwealth Edison Company, Chicago; 3. Report of Commission on Resuscitation from Shock, W. C. L. Eglin, Philadelphia Electric Company, Philadelphia; 4. Lecture on Accident Prevention in Public Utilities, J. B. Douglas, United Gas Improvement Company, Philadelphia; 5. Musical Exercises During the Evening, N. E. L. A. Section Band, Commonwealth Edison Company.

Executive Session (12:45 Noon) Wednesday.

1. Action on Report of Public Policy Committee, Arthur Williams, New York Edison Company, New York; 2. Presentation of Proposed Constitutional Amendments, Frank W. Frueauff, Denver Gas & Electric Company, Denver; 3. Report of Treasurer, W. W. Freeman, Alabama Power Company, Birmingham, Ala.; 4. Election of Nominating Committee; 5. Appointment of Committee on Resolutions.

Chattanooga Convention of National Electrical Contractors' Association.

Plans are now complete for the 1913 convention of the National Electrical Contractors' Association, to be held at Chattanooga, Tenn., July 16-19. The following is the program:

On Tuesday, July 15, meeting of the directors and executive committee. On Wednesday, July 16, formal opening of the convention at 10 a. m. At 2 p. m. a business session will be held. At 8 o'clock a reception and dance will be given at the Hotel Patten.

On Thursday, July 17, a business session for members only will be held at 10 a. m. In the afternoon there will be an automobile trip starting from the headquarters at 2 p. m., going over the battlefields, Chickamauga Park and to Fort Oglethorpe.

On Friday, July 18, there will be two business sessions for members, one at 10 a. m., and one at 2 p. m. The ladies and guests will be given an afternoon tea at 3:30 p. m. by the Chattanooga Electric Club. The annual dinner of the association will be held at the Hotel Patten at 8 p. m. on the evening of this day, and will be followed by a very attractive vaudeville performance.

Saturday, July 19, the last day of the convention, will be given up to an outing. At 10 a. m. those attending the convention will leave the hotel for a trip over Walden's Ridge to Signal Mountain. Lunch will be served at the New Signal Mount Inn at about 12:30, and after lunch the trip will be continued, returning to Chattanooga at 2:30 in the afternoon. The return will be directly to the Union Station and from this point a special train will take the party down to the Tennessee Lock and Dam.

Those in charge of the convention arrangements are F. H. Cantrell, chairman; Joseph Fowler, W. C. Teas, J. W. Dacus, R. H. Scott, F. P. Sweet and J. Pink Lawrence.

Mississippi Electrical Association Question Box.

Under this heading will appear each month questions and answers to questions from members of the Mississippi Electrical Association. All readers are invited to discuss any question or topic presented. Address all correspondence, including questions and answers, to Clarence E. Reid, Question Box Editor, Agricultural College, Miss.

Questions Answered.

QUESTION NO. 17. A small 4-pole exciter is direct connected to a 6-pole revolving field alternator, running at 1,200 revolutions per minute. Alternate quarters of this exciter commutator become blackened rapidly after cleaning and the negative brushes wear down excessively fast. The armature is mechanically centered in the field frame. Will someone please suggest reasons for the above behavior? E. F. M.

Question 17. I would suggest that E. F. M. have the commutator turned perfectly true and then cut the mica down 3/64 of an inch deep. Smooth commutator with 00 sandpaper (not emery cloth) then fit brushes to commutator perfectly. Examine brushes at least once each day and see that there are no small particles of copper on them, which will cause a spark. These copper chips can easily be removed with the point of a knife.

A good arrangement for cutting the mica when there is no machine for the purpose is to take a piece of hacksaw about 3½ inches long and clamp between two pieces of hardwood or fiber, for a handle, if the saw-cut is wider than the mica you can grind to right thickness on an emery wheel. It takes time and patience to "slot" one by hand, but I am sure one would not regret spending the time for he will be agreeably surprised at the results. I have had the same trouble with small and large machines, and the above treatment always puts an end to the trouble.

E. M. Foster.

Question 17. Most direct connected exciters are overhung machines, that is, they have only one bearing, and the armature is placed on the extension of the main shaft. This has a tendency to make the commutator of the exciter wabble slightly, which may cause blackening. From the data given, the only reason that we could suggest for the excessive wear of the negative brushes is improper spacing. This should be checked and if found to be incorrect should be adjusted, in which case it is very possible that the blackening will cease. V. A. Clarke (Ohio).

QUESTION NO. 18. Is it possible to replace brushes in a four-pole generator, where there is only one brush to a set, without shutting down? Is there any objection to this practice, if possible.

Question 18. It is never good practice to remove brushes from a machine while the field circuit is closed and the large electrical manufacturing companies issue strict orders that this shall never be done in their factories. If the brush is dropped on the commutator while a load is on a machine, a serious arc will be formed which will probably necessitate the turning down of the commutator. With a four-pole machine having only one brush to a pole, all the current would have to be carried by the opposite brush while one was being replaced which would likely cause overheating of that brush. We would, therefore, strongly advise against this procedure. V. A. Clarke (Ohio).

See questions unanswered—Nos. 10 and 16 in March issue and Nos. 19, 20 and 21 in April issue.

New Business Methods and Results

Representing Interests of Central Station, Electrical Jobbers, Dealers and Contractors.

Current Topics and Events in Central Station Fields.

The two things apparently uppermost in the minds of central station men just now are public service commissions and ice making. Both are live topics. Public service commissions are here to stay, for their value has been abundantly demonstrated and it is useless and childish for public utility interests to raise any howl about it. To be sure, they are not perfect, but neither are central station managers. However, so far, reports of the hearings before the commissions have indicated that fair treatment will be dealt out to both company and consumer. Probably the most valuable service yet rendered by commissions has been the prevention of discrimination, the standardization of service and the promotion of safety.

The central station industry needs commissions for protection, as well as the public. There is always an insistent cry for rate reduction from those who are uninformed, or who are against corporations on principle. The unbiased decision of a public service commission may be easily the means of saving many utilities from disastrous consequences.

A. G. Rakestraw, Associate Editor Electrical Engineering, in Charge of New Business Matters.

The tendency of some state legislatures to exempt municipal plants from the jurisdiction of the commissions, can only defeat the other advantages of the system. Maine and Idaho have just passed strong and sensible public service measures. The law of Maine is to be particularly commended in that it includes municipal plants in its provisions on the same footing as privately owned plants.

The U. S. District Court has upheld control by state commissions, when opposed to municipal regulation. Control by the larger body is always better. Local authorities are apt to be prejudiced and capricious.

Note: Current Topics and Events in Central Station Fields, is a new feature of this department of Electrical Engineering to be conducted hereafter by Mr. Rakestraw, associate editor.

The Massachusetts and New Jersey commissions are both actively engaged in bettering service conditions.

The Maryland commission has decided that customers cannot demand direct or alternating current at will, but must be satisfied with that which can be reasonably furnished.

The Missouri law, just enacted, provides for the furnishing of safe, adequate and reasonable service at just and non-discriminatory rates. Standards of service will be established from time to time. Uniform accounting and annual reports are required. Rate schedules must be published and the commission duly advised of proposed changes. Provision is made for the testing of meters and adjustment in case of error. Surely no public service corporation ought to object to such regulations.

The value of combination ice and electric service is just beginning to be realized. The folly of having excess capacity lying idle in the summer, while an ice plant in the same town has its equipment practically idle for the six cool months of the year, is evident. These two industries logically belong together, and where physical union cannot be effected, the electric light company should at least make a strenuous effort to sell the ice company power for operation.

A combination plant in Virginia makes 20 per cent on the capital invested in the ice business. Another plant claims 40 per cent profit on a 15-ton plant.

A plant which only operated day service decided to go into the ice business. To do this they had to run all day. When the day service was established, several customers bought fans, others used electric irons. When the end of the season came, there was such a demand for day service that it was decided to continue it, and the motor load increased to such an extent that it is now the most profitable business that the company has.

A combination Ice-Electric Company in Tennessee, in a small town of 2,500 reports the sale of 11 tons per day. The cost at platform is $1.20 per ton and the selling price $5.00 wholesale. The investment return is 11 per cent for 5 months' operation.

The establishment of an ice plant put a struggling central station in the Middle West on its feet. "Go thou and do likewise."

There is a good deal of inquiry just now as to adequate rates for cooking. This would seem to indicate to us that present rate schedules are defective. The cooking load is not essentially different from heating, power, or any other load with about the same demand and hours of use. Any general rate system which takes fixed and variable charges into account, ought without any modification whatever, to take care of cooking business, either with or without a separate meter.

Fall River, Mass., is one of the latest of cities to join the flat rate army. The lighting company there has added 600 customers in the past six months.

How to encourage the purchase of large c. p. tungsten lamps has been well solved by the Brooklyn Edison Company. Under their new schedule, 10-15-25-40 and 60-watt lamps are all sold at the same price. It is human nature to try to get all that one can for the money and this simple fact leads many persons to take the larger sizes when they would not if the prices varied. Still another plan which would have still more effect, would be to arrange for furnishing the large lamps on a free renewal basis, and to charge for the smaller ones.

Now is the time to hustle for summer service among the owners of isolated plants, especially those who make use of the exhaust steam for heating in the winter.

Denver has developed the electrical vehicle business tc a fine point. Last year they sold over 2,000,000 Kw-hr. for this purpose. They maintain extensive garages, advise owners, and inspect batteries without charge. And yet one company that we could name uses a gasoline truck in its meter department.

As a result of active and energetic commercial policies, Worcester, Mass., has increased its output in two years from a little less than 6 million to over 12 million Kw-hrs. And still some managers think they are getting all the business that the community can stand.

Representatives of the Boston Edison Company gave 35 lectures last winter before men's and women's clubs, school classes, church societies and lodges. The total attendance was over 5,000. This may not be as spectacular as some other publicity methods, but it probably does more good for the effort put forth.

The newest thing is a popcorn party given every Saturday afternoon by the various branches of the Carolina Power & Light Company. All children are served free, and naturally the demand is great. Of course, electric poppers are used.

Mr. T. D. Crocker, of St. Paul, in speaking before the Minnesota Electrical Association, hits the mark when he says that a steady pull is better than a "whirlwind campaign."

Back porch meter installations are the coming thing. The advantages are obvious.

Just as soon as the water receded sufficiently to permit, the Dayton Power & Light Company had a number of motors at work pumping out cellars, each with a placard telling about it. The failure of underground services rendered necessary quite a number of temporary overhead connections. These were handled with neatness and despatch.

Centralization of power generation is undoubtedly on a great increase. The question is simply one of balancing the cost and upkeep of the transmission lines against the higher investment cost and running expenses of the smaller plants. Hydro-electric developments contribute very largely to this tendency.

The Supreme Court of Alabama has decided that municipal plants must stand on the same footing as any others.

It is proposed to invite to the June convention all of the members of the various state commissions. This is excellent.

The Society for Electrical Development is getting its plans under way. There is much that it can do, and some things that it should not try to do. One of these is to supercede individual effort. The man who goes into the game simply to toot his own horn, can expend his energy to better advantage at home and through local channels. Federation has its advantages and its disadvantages. There is a time to be general and a time to be specific. There is a time for the solo, and a time to join in the chorus.

The Engineering Side of Business-Getting—Work of Illuminating Engineer.

Illuminating engineering as a profession is rapidly growing in importance as the necessity for a scientific study of lighting problems is being recognized. With the introduction of units of high intensity, the consequent watchfulness necessary to prevent glare, and the more stringent requirements as to intensity and uniformity of light, we find a greater necessity for scientific analysis. In this issue we will consider the field of the illuminating engineer only insofar as it touches the commercial side of central station activity, inquiring as to the possibility of using the knowledge he possesses to stimulate the extension of service.

The employment of illuminating experts by central stations may be regarded rather as a question of expediency than of desirability. There is no question but that such talent is needed, and it is simply a matter of how much it is profitable to secure and in what manner it shall be applied. A little observation will soon convince one that the majority of commercial and industrial establishments, large as well as small, are subject to considerable improvement from the standpoint of illumination, the light being either insufficient, inefficient or badly distributed.

With the further development of the central station industry, we find that the application of scientific principles to the matter of illumination is coming to be recognized as important, and while we could hardly expect a purely commercial organization to do pioneering work, yet the general tendency is to follow those practices which are becoming standard. Nearly all of the large central stations now employ some one styled, with more or less exactness, as illuminating engineer, who, with his assistants, is ready to advise where requested regarding the lighting of any large job in prospect, working more or less harmoniously with the architect in charge. He also offers his advise to any customers who may consider a change in their present equipment, either substituting electric light for gas, oil or other illuminant, or in the discarding of older types of lamps and the installation of up-to-date equipments. Both of these functions are useful and quite necessary, but we venture to say that the department whose efforts is confined to these lines is not doing nearly all that can be done toward improving commercial conditions.

As far as new work is concerned, both large and small jobs, we have found it to be the rule that engineering advice on illumination is neither requested nor desired, and if given is quite apt to be ignored. While we by no means endorse the wisdom of such attitude on the part of architects, yet the illuminating engineers are not without blame in the matter, for it has sometimes happened that where so-called "experts" have dictated in the selection of lighting equipments, the resulting installation was not only in bad taste but was not even satisfactory from a purely commercial standpoint.

It is by no means a sign of good judgment to rashly condemn all architects as unfit to lay out lighting installations, for while it is true that there are many splendid examples of architecture which are abominably lighted, we also find that many architects have excellent taste in illumination and produce effects which are both handsome and efficient. The better class of architects are now beginning to realize the value of exact science in figuring illumination, and will accept advice offered in the proper spirit, they, however, very rightfully resent any attitude of dictation on the part of central station "experts" or others. If we really want to do the greatest possible amount of good along those lines we must do it through the education of the architect, and it seems that at present the makers of standard fixtures, lamps and glassware, have a better chance to accomplish this end than the central station, for these manufacturers are working in harmony with the architect, and developing handsome, yet efficient products.

In regard to changes in lighting equipment, it is very desirable to have expert advice, since a good deal of business may depend upon a correct analysis of the situation, and the recommendations offered. While the degree of knowledge necessary may vary in every case, yet a man engaged in such work should have studied the question of illumination sufficiently to know without hesitation the proper intensity required to display different classes of goods, the watts which must be expended under different conditions to produce this result of reflection, and the type and size of lighting unit best suited to the surroundings. In most cases this is not a particularly difficult matter, since questions like these have been made the subject of very careful study and much experiment, and the results have been worked up in such shape as to be available and useful to everyone. Indeed, what is needed is not so much a high degree of technical knowledge as good taste and judgment in applying the results of investigations already made. Of course, the larger the layout the greater the necessity of having sound advice on such matters, and the higher grade of skill it is profitable to employ.

It seems, however, that one of the most fruitful fields for the utilization of illumination knowledge is in the giving of advice to the smaller commercial customers of the central station, to that class, in fact, whose present lighting equipment is installed in the most haphazard way possible, without reference to intensity, distribution or efficiency. In New York City the illumination of several hundred small stores has recently been studied, and in these it was found that the intensity varied from one-fifth of what was necessary to secure good lighting to three times as much as was necessary. There was often a good deal of glare. Much of the show window lighting was faulty in arrangement, and excessive in the use of current, while in cases requiring a treatment out of the ordinary, such as art stores, the arrangement of the units was entirely unsuited for the purpose of display. While it might not seem that these small stores are worth the individual attention of illumination specialists employed by the central station, yet it would be a powerful stimulus to new business if every commercial customer had the light which was just suited to him, and at the most moderate outlay possible. In our experience we have invariably found that where electric light was looked upon as excessively expensive, the reason lay in inefficient equipment. It is really not necessary for the central station to employ expensive men to look after the bettering of these installations. Any young man who is technically inclined, and who will take pains to put some thorough study on the subject will soon be able to make recommendations which if followed will not only give the customer much better light, but will do so at little, if any, increase in the current consumed. To this there can only be one result, more and better pleased customers, each of which is worth many advertisements.

It may be suggested that the soliciting force, if trained, could do the same just as well as special men. While readily admitting that every solicitor should possess as much knowledge of the principles of illumination as possible, yet it must not be forgotten that a solicitor is primarily a salesman, not an engineer, and that if we try to always select the best salesmen, most of those we get will be deficient in technical training, and they will not absorb it readily, for they do not have sufficient training or perhaps inclination. Moreover, it is evident that a customer or prospect will give more weight to the advice of a man possessing expert knowledge than to one who is professedly a salesman. There are, furthermore, thousands of wasteful installations in any of our large cities, whose owners should be persuaded to make a change as soon as possible, even if the central station should have to enable them to finance the proposition. The special illumination man would, of course, get to see these customers where the regular solicitor would not.

As we have already said, for such installations as these, there are definite rules by which to go, and any person using good judgment will have little difficulty in getting good results. Of course, it would be monotonous to have all stores of a similar kind fitted up in exactly the same way, and hence it is very desirable to get men for this work who have some artistic appreciation, as well as scientific ability, and since these in moderate degree are often associated, it should not be at all impossible to obtain them.

The immediate improvement of lighting conditions in residences seems to some to be a hopeless task, largely on account of the stereotyped forms of fixtures and glassware on the market, chosen absolutely without any reference to efficiency, principally because neither architect, contractor or owner gives the question of efficient lighting a second thought. When a house is rejected the architect marks the outlets according to some conventional plan, and later on the owner goes to a convenient fixture store and selects something more or less atrocious, and the result is a matter of common experience. Of course, it is not possible to send a lighting expert to every residence customer, but a salesman visiting residences for the purpose of suggesting improvements in service, etc., might well include recommendations towards better lighting among his other suggestions. This plan is in successful operation by at least one enterprising central station.

Much can also be done by proper educational methods, such as the display of artistic and efficient fixtures, shades. reflectors, etc., by advising as far as possible with architects employed on this class of work, by public lectures and demonstrations, and in other ways that may be suggested from time to time.

In industrial work we have, of course, a much wider field and one in which scientific considerations usually have right of way. The use of sufficient illumination in mills and factories to render accurate work possible, and to safeguard against accidents is imperative. While many large concerns, of course, have their own experts on this work, others give the question of efficiency very little attention, and it therefore rests with the central station to advise them as to the methods for securing effective illumination and every opportunity should be taken advantage of to do so.

A. G. Rakestraw.

Topics for July to December Issues.

The following topics will be discussed in these columns of the remaining issues of 1913:

JULY—The sign specialist, size of city in which results can be secured—minimum—and number to handle possible sign business in a live city. Nature of their work, methods and something as to the profitableness of electric sign operation, giving operation data of several companies.

AUGUST—A discussion on power factor, load factor, and diversity factor, their relation to new business and their effect on income per Kw. possible at station.

SEPTEMBER—An analysis of various loads, showing their relative profitableness.

OCTOBER—The commercial side of white way and all street lighting business, discussing rates, types of equipment, hours of burning, etc. (Special Lighting Number).

NOVEMBER—Solicitation of special loads, steam heating, pumping loads in small towns, heating devices in laundries, etc., taking up rates and relative profitableness.

DECEMBER—Results of past Xmas schemes and plans for new schemes to secure the Christmas trade.

COMMENTS FROM READERS.

Clare N. Stannard, Secretary and Commercial Manager Denver Gas & Electric Co., Denver Colo., Writes of Recent Campaigns.

During the month of March, we carried on a campaign for the securing of Knight Templar and other convention illumination, also a campaign on national advertising by means of electric signs, and in our store for store work, seeking to secure additional window lighting.

During the month of April we are specializing on electric vehicles, electric power for irrigation work, etc.

For the month of May we have planned a campaign on electric irons and fans. In fact, we will during the entire summer work energetically on all of the above enumerated lines, aiming, however, to get a good start during the months of March, April and May, as mentioned.

Possibly a few words about our electric iron campaign will be of interest. This department maintains an electric delivery vehicle of 1,000 pounds capacity, fitted up to connect irons, toasters, percolators, fans, curling iron heaters and all kinds of electrical appliances, so that we can easily show a prospective consumer the appliances in operation by simply stepping to the wagon. Our fourteen representatives, on regular occasions, go out with the electric truck, leaving irons, toasters and other appliances on 30 days' free trial, later calling at the residence and either selling or returning the iron or appliance left on trial.

We have also inaugurated a washing machine campaign, having placed a number of machines, with the aid of the electric truck, on trial for one week in our residence section. At the end of this time the machine is either sold or moved to another prospect's home.

Our latest scheme is the selling of electrical appliances in groups. For instance, each group retails for $50.00, having as a central figure a vacuum cleaner and two other articles. The other articles of a group being, perhaps, an electric iron and curling iron, or, in addition to the vacuum cleaner which each group contains, a percolator and toaster; again, perhaps, an electric shaving mirror and a water heater, etc. A liberal discount of $11.00 is given where the group of appliances is purchased, thus the consumer buys $50.00 worth of appliances for $39.00, paying $3.00 down at the time the order is given and $3.00 per month in 12 monthly payments, as we always aim to have all appliances purchased on payments, paid for within one year's time.

H. N. Sessions, Commercial Engineer, Southern California Edison Company, Outlines Company's Power Business.

General Agent, Mr. S. M. Kennedy, directs the power business of the Southern California Edison Company, as well as other lines of new business supplied by more than 800 miles of high tension feeders to about sixty cities, towns and intervening communities within an area of over 4,000 square miles. This field is divided into fourteen districts with salesmen working under the direction of both the district heads and the general office. We are a big family proud of our lineage working to the same end with loyal devotion and confidence in each other. We have no rule of etiquette hindering a salesman or other employe seeking help, if necessary, directly from our higher heads with fear of offending his immediate superior. No man is supposed to know or to do it all, and it is with pride that a wise salesman leans to his stronger brother in some particular line for assistance. We have specialists primed in various lines of power work so that every prospect we get may be properly nourished.

Our system is in a great fuel belt with oil delivered at one dollar per barrel, equivalent to coal at four dollars per ton, and our inroad on the steam and gasoline power has crowded the second-hand dealers with engines. Due to higher first cost and rapid depreciation of the steam and gas engine, to say nothing of its other inequalities, electricity has taken first place. We are eradicating the gas engines alone to the extent of over 25-horsepower per day and maintain a special department to sell them at such a price that will banish them to territories not supplied with electric service. The strongest proof of electricity's strangle-hold on the reciprocating engine is that it is now conceded, all things considered, to be the cheapest and best power in our California oil fields where motors are rapidly being installed in face of the fact that the cost of natural gas and oil is almost nil. We educate our power consumers, showing them that with the higher first cost of the engine coupled with its quick deterioration and constant high upkeep, even with free fuel, it is a more expensive and less reliable source of power. We are giving individual attention to electrical refrigeration, a most promising income to the central station, and electric vehicles which are coming in fast and to stay. One of our cities with 45,000 population uses over 600 vehicles, or one to every 75 inhabitants.

Our most important power service is that for irrigation pumping plants ranging from 10 to 500 horsepower each.

We have a seemingly unlimited underground water supply at from 10 to 100 feet from the surface, and as our large old-time Spanish grants are being split into small farms by the younger generation, it keeps us busy supplying these ten to forty-acre sub-divisions with power. We offer special rates to encourage this valuable class of power which is used almost continuously twenty-four hours per day for the six summer months. Several exceedingly large power users, such as our electric railroads, large Portland cement plants, harbor dredgers and other manufacturing and industrial plants, most of which consume energy for twenty-four hours, afford a great diversity in the classes of service we give, and consequently an average yearly load factor of over 60 per cent, of which we are proud. Our highest monthly load factor was 70 per cent for last August. Our present total generating capacity is 86,100 kilowatts.

We endorse the statement of our president, Mr. John B. Miller: "Give us five years of good, average government, a fair deal for both capital and labor, and we can depend upon an era of development which will make all that we have accomplished down-to-date look small and meager."

Chicago Meeting of Society for Electrical Development.

The meeting of the Society for Electrical Development called in New York on May 13 was adjourned to reconvene in Chicago on May 31. Owing to the fact that the program of the National Electric Light Association contemplates the opening of its convention the evening of June 2, it has been arranged as being more convenient to the members of both associations to call the annual meeting of the Society for Electrical Development, Inc., for 11 a. m., June 2, at the Hotel Sherman, instead of May 31, as at first announced. This is to make it possible for members of the National Electric Light Association and the Society for Electrical Development to attend both meetings, without the necessity of making two trips for the purpose.

"DO IT ELECTRICALLY"

Trade Mark of Society for Electrical Development.

The trade mark shown here as selected for the Society was submitted by Philip S. Dodd, secretary of the organization.

National Electrical Code Changes.

At the meeting of the Electrical Committee of the National Fire Protection Association held March 26 and 27 at New York City, a few of the important suggested changes in the National Electrical Code were recommended as reported in the April issue of *Electrical Engineering*, while others were referred to committees for further consideration and report at the next biennial meeting.

The committee's recommendations on Rule 15 to make grounding of transformer secondaries mandatory in the Code was adopted, exempting, however, industrial power and lighting plants. This grounding applies to circuits under 150 volts. Rule 23d will be changed to include small motors and heating devices as well as lamps, not more than 660 watts being dependent on one cut-out.

The doors of cut-out cabinets will be required to shut closely at all edges against a rabbet formed as a part of the door or trim. Rule 23d will allow 10-ampere fuses on 110-volt circuits and 5-ampere fuses on 220-volt circuits. It will also permit branch circuits to be fused to 10 amperes.

The proposed change in Rule 68d caused the discussion that was predicted, when the omission of words, "and to make it difficult for it to be replaced when melted," was suggested. This action would favor the use of the refillable fuse. On account of the opposition to this recommendation, the committee referred the matter of change in the rule to the switch and cut-out committee for consideration and report at the next biennial meeting. The new code embodying these and other changes recommended at this meeting will be ready about July 1, of this year.

Gastritus on the Gas Engine.

The following letter has been sent us by H. N. Sessions, commercial engineer of Southern California Edison Company, Los Angeles. We believe it ample testimony of the success he outlines elsewhere in these columns in supplanting gasoline power by electric:

Los Angeles, Cal., April 15, 1912.

Rhyolite Hydro-Electric Company,
Garden Villa, Orange County, Cal.
W. L. Dumpling, Manager.

Dear Sir: Alas! I am compelled by terror to confess my error in trying to use gas engine for power. Six months' experience with this Marepranks and Force engine has been one nerve-racking nightmare. For a twenty-two horse it barked like a 44 Colt's; nay, its neighs were even louder. The company which reduced me to buy it is still in the "hands of a deceiver" and will not take it back, so for its disposal I am driven from the bunkman to the junkman. Oh! the misplaced confidence I put in that engine. After constant courting and the loss of one finger the ungrateful thing will not even turn over and reciprocate a stroke. Instead of a trusty one I find only a rusty ton. I have renewed every part of it except the name plate, but never again, not another part for it till I part with it. I fed the engine on gasoline, napthaline, benzine, lucine and kerosene. I greased it with glycerine, paraffine, cottolene and oleomargarine. It vacillated on vaseline and finally became a tippler on Tops, turning topsy-turvy and died on the diet. Now it rests serene a sight obscene in its oily refinery.

Come quick with your poles and wire and the G. E. whirlygig. I have seen Smith's sturdy motor softly singing with your steady service while the air surrounding still smells sweet, so spare no speed, but serve the juice. I want appliances, too, with heat that's hot, also lamps that light, and a fan when it's warm to blow up a storm, and, damn it, last but not least, I must have power with peace, not grease.

Yours for relief,

Gastritus.

Questions and Answers from Readers

Readers are invited to make liberal use of this department for discussing questions, obtaining information, opinions or experiences from other readers. Discussions and criticisms on answers to questions are solicited. However, editors are not responsible for correctness of statements of opinion or fact in discussions. All published answers and discussions are paid for.

LONG VS. SHORT SHUNT FIELD CONNECTIONS.

Editor Electrical Engineering:

(376) I would like to see a diagram published that gives the difference between a long and short shunt field connection. What factors determine the use of each and are these connections used for motors as well as generators? If so, what advantages, if any, has each in operation?

A. V. P.

EFFECT OF FREQUENCY ON READING OF METER.

Editor Electrical Engineering:

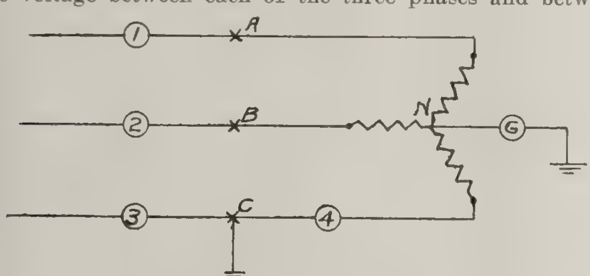
(377) We are purchasing current from a mill company that has recently changed its frequency from 40 cycles to 60 cycles. We are using the same watt hour meter with no changes. Is this meter recording more or less power, and how much? What is the effect of change of frequency on the meter?

W. F. S.

GROUNDING TRANSFORMER NEUTRAL.

Editor Electrical Engineering:

(378) In case the neutral point of a star connection of secondaries of three single-phase transformers is grounded, what will be the relative amounts of current flowing in each of the secondary wires and in the ground wire when a ground or other fault occurs on any line? What will be the voltage between each of the three phases and between



FAULTS ON 3-PHASE SYSTEM.

any one wire and the neutral point, that is each phase voltage? Referring to the diagram, when a fault occurs on line A, B and C in succession, what will be the current and voltage values at the following points:

	Current in Wires	Voltages
Fault on Phase A	1 2 3 4 G 1-N; 2-N; 3-N	1-2; 2-3; 3-1
Fault on Phase B		
Fault on Phase C.		

The transformers are 2 kva. delta primary and star secondary, with a ratio of 2,200 to 220 volts.

H. E. T.

CONNECTING A POWER FACTOR METER.

Editor Electrical Engineering:

(379) Please advise if there is any method of making connections for a power factor meter so that it will indicate properly without making several trials. What are the conditions that must be considered in making the connections?

W. E. C.

SINGLE VS. THREE-PHASE DISTRIBUTION.

Editor Electrical Engineering:

(380) The writer would like to have some reader submit information comparing the cost of single-phase distribution, taking into account cost of wire, transformers, pole material and labor. Also compare effect on regulation and power factor.

H. E. R.

BOOKS ON ELECTRICAL CONSTRUCTION.

Editor Electrical Engineering:

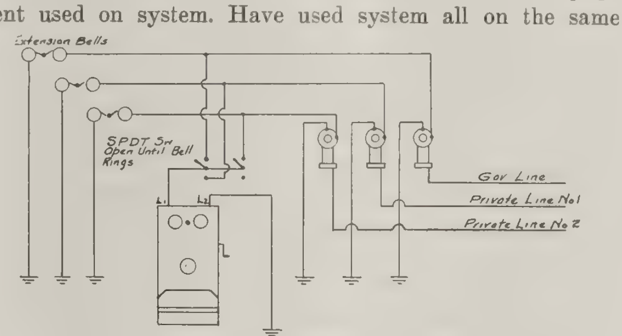
(381) Kindly request readers to give the names of books on electrical construction, including information on wiring and installation of motors, generators and transformers that have been found of use in practice. In mentioning these books please name the important information found of practical use in each, such as tables calculations and diagrams.

W. E. S.

TELEPHONE TROUBLE—GROUNDED TELEPHONE SYSTEM.

Editor Electrical Engineering:

(382) The sketch herewith is for a one-wire grounded telephone system in use in West Florida. It gives satisfaction except for cross talk. All Western Electric equipment used on system. Have used system all on the same



GROUNDED TELEPHONE SYSTEM.

ground rod and all on different ground rods wit hthe same result—cross talk. Government line is of No. 9 galvanized iron wire, other lines of No. 14 wire. Government line has 5 instruments on line, other two lines have from 10 to 20 instruments on line. Can this system be wired to eliminate cross talk with present equipment, or will it be necessary to use condensers or drops?

L. V. S.

Three-Phase Motor on 3-Wire Circuit. Ans. Ques. No. 352.

Editor Electrical Engineering:

Answering Mr. Keily's question, 352, the three-phase motor will refuse to start on a single-phase, three-wire connection, unless he provides some way of obtaining a revolving magnetic field in the stator. This may be done by splitting the phase, that is, connecting it up as a 3-phase circuit, and introducing a resistance in one pair of conductors, and an inductance in the other pair.

This will give a lagging current in the pair between which the inductance is connected, while in the pair with only resistance, the current will be practically in phase with the voltage. Under these conditions there will be a revolving magnetic field, and the motor should start. After reaching full speed, both resistance and inductance may be switched out of circuit, the motor operating then as a single-phase motor. However, results would be very unsatisfactory, should this method of operating a three-phase motor be used. Frank L. Zemp.

Grounding Secondaries—Ans. Ques. No. 357.

Editor Electrical Engineering:

If a neutral point is accessible, this point should be grounded. When no neutral point or wire is accessible, one side of the secondary circuit should be grounded. The ground should be kept outside of buildings as far as possible. The size of ground wire should never be less than No. 6 B. & S. gage, according to the National Electric Code, and for 3-phase systems, should have a carrying capacity equal to that of any one of the three mains.

George R. McNatt.

Largest Practical Size of Motor. Ans. Ques. No. 363.

Editor Electrical Engineering:

I beg to present the following information in reply to question 363 in April, 1913, number: The largest A. C. motors that the writer knows of are several 6,000-horsepower, 6,600-volt, three-phase, 150 rpm induction motors used in the rail mill of the Indiana Steel Company, at Gary, Indiana. These motors were built by the General Electric Company and have given general satisfaction. They run in one direction only, and operate on 25 cycles.

There are other and larger motors than these, but the writer is quite sure that they are all D. C. machines. Siemens & Halske, of Germany, have built a motor of the reversing type for rolling-mill work that has been reported to be able to reverse from full speed (150 rpm) one way to full speed the other in two seconds, but this report does not have the earmarks of accuracy. This is an 8,000 horsepower machine operating on D. C. Hoyt Catlin (Ga.)

Corrosion in Cables. Ans. Ques. No. 372.

Editor Electrical Engineering:

In regard to cable trouble, your correspondent, W. E. C., is experiencing, it is quite probable that electrolytic action is responsible for the trouble. Although your correspondent does not state, it is probable that the mine referred to is a coal mine, and if it is in the Alabama coal district, there is probably quite a large percentage of sulphur in the coal, from which it is possible that a weak solution of sulphuric acid might form, and due to dripping and accumulation of this water on the cable, an appreciable flow of current be established from the positive line copper to the outer covering of the cable, which is, no doubt, wet, and forms a fairly good conductor to the negative side or ground. Friction tape would doubtless aggravate the trouble, as it would have a tendency to hold the acidulated water, so that it seems quite probable that more deterioration would be expected where ordinary grades of friction tape were used.

Your correspondent does not state whether or not the cables are lead covered, but I should assume not. It is quite a mistake to use cables in such places which are not lead covered. Further deterioration of this cable can undoubtedly be prevented by using ordinary cotton tape in place of friction tape, and as the tape is being wound on, thoroughly saturate it with a good grade of asphaltum paint. The braid should be skinned off the rubber core approximately 1½ inches on each side of the joint, and before applying any tape whatever, the rubber and the copper core should be thoroughly coated with asphaltum paint. After the joint is thoroughly taped, it would be a good idea to give it a still further coating of thick asphaltum paint, which should very effectually keep out the drippings which are undoubtedly somewhat acidulated.

H. E. Bussey (Ga.)

What Causes Action on Cable? Ans. Ques. No. 372.

Editor Electrical Engineering:

A definite and conclusive answer to question 372 in the May issue cannot be given without a sample of the cable and more definite information; however, the corrosion mentioned in the question seems to be an example of electrolytic action. The general conditions underlying and causing electrolytic troubles may be stated as follows:

When an electric current flows from a positive metallic conductor, in the presence of moisture and passes through an electrolyte, which we will assume contains a salt of the metallic conductor, then the surface of the metallic conductor is subject to the decomposing effect of electrolysis, and the liberation of oxygen, or other active chemical agents by the passage of this current, will cause metallic conductors to be oxidized or changed into the form of salt of some nature. In other words, the cable would become badly corroded if the right conditions were present.

The questioner, W. E. C., states that this cable, which is rubber insulated, is installed in an airway down in some mine. He does not state the character of the mine in question, but we will make a guess that there is a large amount of sulphur in the air, and if the mine is a coal mine, that there will be a large amount of coal dust lying on the surface of the cable, and also, and perhaps this is the most important consideration, that the cable will be more or less wet, the water containing dissolved impurities of various chemical natures, so that the braided covering of this cable would form a fairly low resistance conductor for the passage of leakage current from the conductor itself. Since the negative side of the cable system is grounded, the current would have a tendency to leave the positive conductor leaking out through the friction tape surrounding the joint, and thence along the braid of the cable to a convenient point at which it may enter the earth. In all probability the negative cable is grounded at the generator, and we might suggest that an ammeter be placed in this ground lead, and any leakage current which is being picked up from the ground be thus noted. This will form a nice test to see if there is any leakage from any of the joints at various points on the cable. Of course, it will be appreciated that if other points on the cable system are intentionally grounded, that this will destroy the value of such a test, unless the intentional grounds at such distributing points on the cable are removed.

A remedy is asked for this trouble. If the trouble is caused by electrolysis, of ordinary nature, then it can undoubtedly be cured, by making a very carefully soldered joint at the branch, and carefully insulating this joint with a good grade of rubber tape, which should be more or less softened by the heat from a candle or match, and molded together so that the rubber will form a solid mass about the joint, completely insulating it. This should then be covered by a first-class quality of cotton tape, and the whole joint painted with P. B. paint. We suggest this simply as a method of securing a waterproof joint, for if water is not present in this joint, then there will be no leakage current, and if no leakage current, then there will be no corrosion. It is important to emphasize the fact that a definite answer to the question is impossible for the reason that the entire conditions present are not given. Since this is a very interesting case, however, the writer will be very glad to discuss the matter further, upon receipt of further details. We should also be very glad to receive a sample showing the trouble. Such troubles are fortunately of a very rare occurrence, but this fact makes it all the more interesting. S. S. Warner (Ga.)

Engineer Standard Underground Cable Co.

Causes of Action on Cable. Ans. Ques. 372.

Editor Electrical Engineering:

The trouble is evidently due to electrolysis caused by the leakage current from the positive wire to the negative or to the ground, and the remedy is to thoroughly insulate. Friction tape is not sufficiently waterproof to be of any value and I would suggest that the joints be cleaned and dried and then treated with hot paraffine, asphaltum or shellac.

Generators Surge and Pump. Ans. Ques. No. 371.

When alternating machines operate in parallel the engines as well as the generators should be synchronized, that is, the pistons should reach the end of the stroke at the same time. For since all engines (not turbines) run slightly faster at the middle of the stroke than at the end, it is obvious that there will be cross currents; unless the variations occur at the same time. In the present case there is no way to synchronize the engines, because they are of different speeds, but the operation might be improved by increasing the weight of the flywheels or by adding another cylinder with a crank at right angles to the first. A tandem compound might be changed into a cross compound and thereby make its speed more regular.

T. O. Seidell (Ga.)

Motor Does Not Come Up to Speed. Ans. Ques. No. 374.

Editor Electrical Engineering:

Note: The following additional information has been secured from V. K. S. in reference to question 374 in the May issue asking reasons for the failure of an induction to come up to speed: Another motor of the same type and size, 10 horsepower, was secured and connected to the D. C. generator. This motor would come up to speed when running light but with two 5-ampere 110-volt arc lamps on the generator, the motor would slow down to half speed and run at this speed as the first motor would do. The starting box was then cut out and the motor runs all right. The following answer is based upon this additional information.—Editor.

The writer has gone over the available information in connection with the motor trouble mentioned in question 374 of the May issue and the only reason that seems probable for the motor failing to come up to speed is that the resistance starter was not all cut out when the starter handle was in the running position. In other words, the main line switch had some resistance inserted in it when the handle of the starter was in the running position. This would cause the motor to run at fractional speed due to the low voltage at the motor terminals. W. E. Coles (Ga.)

Producing Electrical Energy—The Why of a Power Plant.

Editor Electrical Engineering:

It is often said that electricity is present everywhere in the air about us, and in the mind of the layman there is a vague sort of an idea that an electric generator gathers in the electricity from the air in some mysterious way and forces it out through the wires as water is forced through pipes. They often wonder what there is about boilers and steam engines and turbines that make them such an important part of the equipment of a power plant.

We don't need to know what electricity is beyond the fact that it is a form into which energy can be changed so as to make the energy more available for use. All of the energy which appears as electricity in the output of a steam power station is the result of a very wasteful series of changes through which the energy has been made to pass since it lay stored up in the fuel. The entire function of a power station is to make over this stored up (potential) energy of the coal into usable electrical energy.

A description of the various forms in which this energy appears during its transition from coal bunker to switchboard is essentially the story of the power plant. First, the coal is burned; to be more specific, the carbon in the coal is made to combine with the oxygen in the air, and in so doing the energy in the coal is liberated in the form of heat. This heat energy is liberated in such a way that it comes into contact almost immediately with the outside of a great many steel tubes which are filled with water and which transmit to the water about 70 per cent of the energy which the coal contains. This water acts as a huge reservoir for heat energy and is ideal for such use in that beside being the most plentiful liquid which nature supplies it also has the quality of absorbing more heat energy than any other substance known. Upon the continued application of heat energy the water changes to a gaseous form of immensely greater volume, and in this form, under great pressure, it is sent through the steam pipes into the engines and turbines. Here a part of the energy in the steam is imparted to the reciprocating or rotating parts, causing them to move and it is this motion, transmitted from the steam end of the machine to the electrical end, which changes the form of the energy into what we call electricity. This transition is accomplished by causing huge coils of wire to revolve rapidly through magnetic fields.

Only about 17 per cent of the heat energy which the steam brings over from the boilers can be changed into electrical energy. The reason for such a great loss is in the nature of the steam itself which retains the greater part of its heat energy and only gives it up on changing back into water, at which time it is not available for use in developing electricity. As the electric current is generated in the machines it is led away through cables to the bus bars on the switchboard, and from this point it is ready for distribution.

E. H. Tenney (Mo).

New Apparatus and Appliances

Diehl Fan Motors.

The Diehl Manufacturing Company, of Elizabethport, New Jersey, has recently announced a line of fan motors that is a departure from former fan models by the company in cast iron. The fans are of pressed metal with a cylindrical body poised upon a stem of sufficient length to admit of guard clearance. A swivel and hinge joint permits a forward tilting of the fan body as far as is practicable without guard interference and a backward adjustment to an angle 90° which converts the fan to bracket use, the base being drilled to admit screws. This joint is governed in the 12 & 16″ sizes by a wing nut, the wings of which are turned toward the ball joint. All fans are adjusted horizontally upon a swivel with the exception of the oscillator which is mechanically rotated and naturally needs no horizontal adjustment.

Oscillating fans in 12- and 16-inch desk and bracket types and 12-inch residence 6 blade desk and bracket types are unique in the fact that the oscillating mechanism is entirely concealed within the rear end cover. The horizontal overall dimensions of the fan body are shortened owing to the fact that the detachable worm which operates the oscillating mechanism is placed between the bearings instead of on an extension of shaft beyond the rear bearing. Another feature of the 1913 oscillator is the ease by which the arc of oscillation may be changed while the fan is in motion. A knurled head screw at the bottom of the oscillating disc is turned by thumb and forefinger and regulates the arc of oscillation in four distinct steps from 90° to zero inclusive, at which point oscillation ceases. An automatic safety device has been adapted to the oscillating mechanism which causes oscillatory motion to cease temporarily if the fan body comes in contact with any obstruction which would tend to interfere with its swing. This device prevents grinding and breaking of gear teeth, injury to arm lever, etc. As soon as the obstruction is removed the fan at once picks up its oscillatory motion.

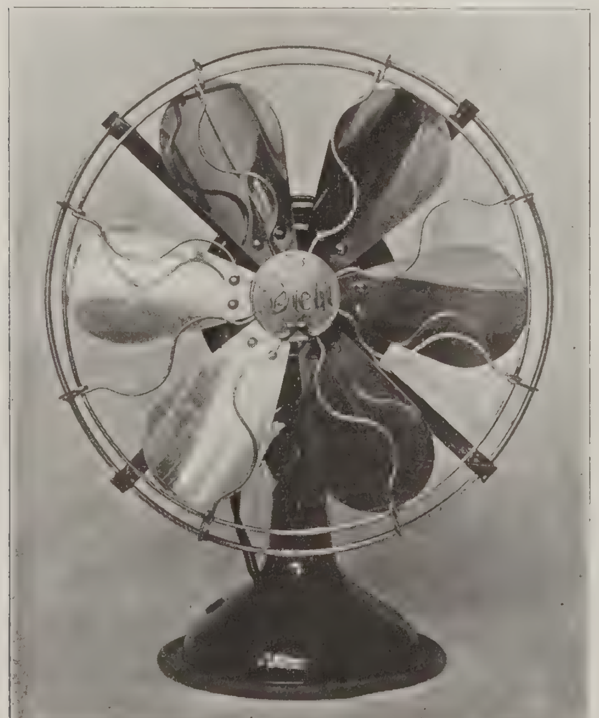


FIG. 1. RESIDENCE TYPE OF 6-BLADE FAN.

To overcome the objectionable humming of blades of some fans, a slow speed six blade fan, otherwise identical with the four blade type, has been evolved and supplements the latter line in 12-inch sizes only, this size being determined as the most desirable for the use in hand. Regulators giving three distinct speeds and a standard finish of black enamel give both distinction, adaptability, and utility to the 12- and 16-inch sizes in all currents and frequencies.

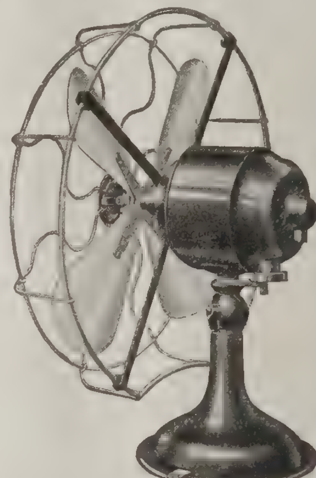


FIG. 2. OSCILLATING FAN.

The new line includes 12- and 16-inch standard desk and bracket fans, 12- and 16-inch oscillating, 12-inch residence type with six blades, also 12-inch residence type oscillating with 6 blades, and 8-inch residence and telephone booth fans with 4 blades.

A Review of the Western Electric Company's Telephone, Supply and Foreign Business.

For a period extending over thirty-five years, the growth of the telephone industry has been so closely indentified with the Western Electric Company that it is generally thought that the activities of the company do not extend beyond the manufacture of telephones. In a recent issue of the Western Electric News, Gerard Swope, vice-president, has reviewed the commercial activities of the company since 1884, showing in detail how the company's field of operation has broadened until now it has spread into every branch of the electrical industry. A digest of this review follows:

The growth of the business since 1884 has been markedly upwards with but one appreciable set-back during 1907 and 1908. In 1906 the business of the company grew from approximately forty-four millions of dollars ($44,-000,000) to sixty-nine millions ($69,000,000), or over 50 per cent. After 1908 it again grew at quite a rapid rate until for the year just completed the sales amounted to approximately seventy-two millions of dollars ($72,000,000), making 1912 the largest year in the history of the company. This business was secured from almost 40,000 customers all over the world, and in this connection the sweeping statement can be made that there is no country in which Western Electric apparatus is not used to some extent. Among the nations which have most recently entered this list are China, where the first common battery telephone exchange was installed a few years ago at Peking, and Turkey, where, just before the outbreak of the war, the contract for the first common battery telephone system was secured. Within the last month, the company has been awarded another large switchboard contract in China.

B and K Cable Racks and Guy Anchors

The illustrations in Figs. 1 and 2 show a cable rack and guy anchor manufactured by The Barnes & Kobert Manufacturing Company, New Haven, Conn. The cable bracket is built of pressed steel, ribbed for strength with electrically welded heels and capable of sustaining 200

FIG. 1. B AND K CABLE RACK AND BRACKETS.

pounds at the extreme of a 10 inch bracket. The racks are of channel iron, T slotted with 1½ inch centers allowing space economy on the racks. An offset at the bottom allows for extending the racks without additional bolts, thus making a continuous rack.

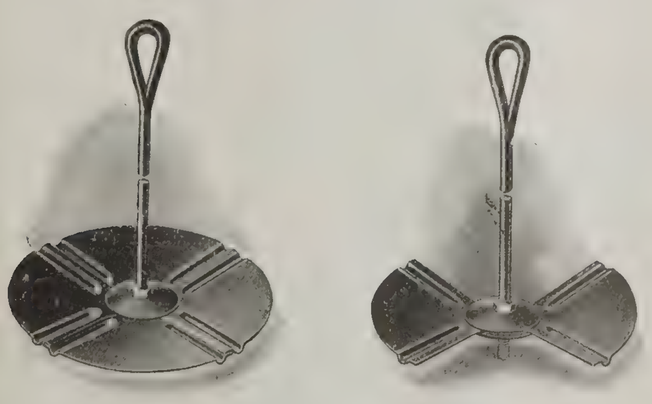


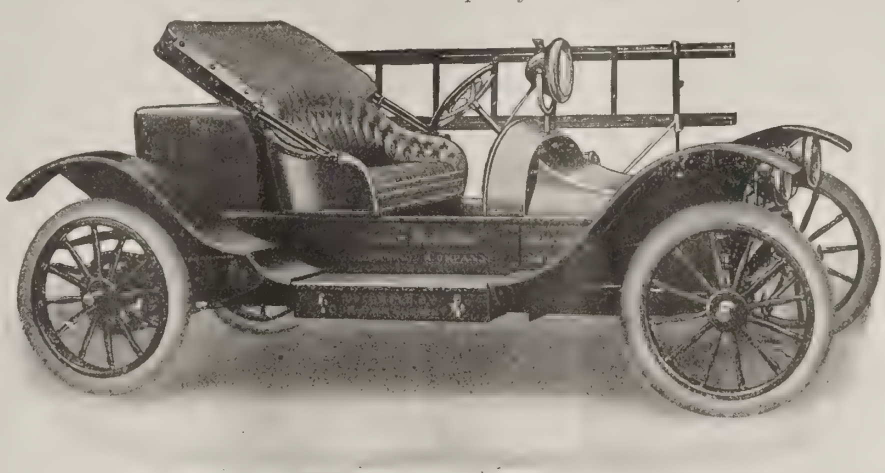
FIG. 2. B AND K GUY ANCHOR.

The guy anchors shown are known as the B and K mushroom type, designed with a liberal holding surface made possible by the use of sections as shown. These sections are of pressed steel and two, three or four can be used as conditions require.

Road Test on Electric Vehicle.

The report of a test made on an electric pleasure vehicle May 5 by the S. R. Bailey and Co., showed 93.4 miles on one charge of battery. Such a run on one charge was looked upon as an impossibility only a few years ago, even at slow speed, but on this run not only was the distance covered with ample battery capacity to spare, but the time was 4 hours and 55 minutes. On arrival in Springfield on the run from Boston, so much battery capacity remained that the car was run to Holyoke and back to Springfield, making the total distance covered 114.7 miles.

The test was made on the Bailey Electric Roadster, made at Amesbury, Mass., and was designed to take full advantage of the Edison nickel-iron storage battery. The battery carried on this run was 3½ years old and had seen hard service. It seemed to justify the claim of the manufacturers that the capacity increases with use, since it fur-



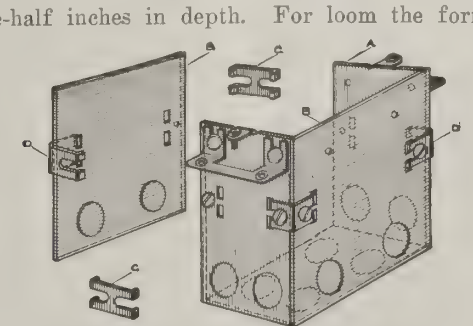
THE BAILEY ELECTRIC ROADSTER.

nished on this run a capacity of 37 per cent in excess of its rating.

Sectional Switch Boxes.

The illustration presented here shows a sectional type of wall box made by the Machen and Mayer Electrical Manufacturing Company, of Philadelphia, Pa. This wall box is furnished in single units from which any number of gang boxes can be formed by removing the sides and adding sections. Referring to the illustration, to build up a two-gang box from two single boxes, release corner-connectors (D) by loosening screws holding them, and detach one side (B). This operation is repeated on the other single box. The two sections (A) are then fastened together by section-connectors (C). By this process any number of gang boxes can be formed.

The box is furnished in two sizes, three inches and two and one-half inches in depth. For loom the former has



THE UNI-SECTIONAL WALL BOX.

12 holes, two holes in each of the four sides and 4 holes in the bottom. For flexible metallic or rigid conduit, each box has seven holes, one hole in each short side, two holes in each long side and one in the bottom. The 2½ inch size is adopted for old work but cannot be used for rigid conduit. A combination of loom and conduit boxes of 3 inch depth can be assembled to suit requirements making the style of box an all round convenience.

Greenwood Lamp-per-Letter Schedule.

The table presented here gives the number of lamps per letter for plain raised block electric sign letters and is a compilation by the Greenwood Advertising Company, of Knoxville, Tenn., manufacturers of electric signs. This information will be found of service by central station managers when figuring on signs. The table gives number of lamps for raised letters, but can be used for grooved letters by taking the number of lamps for a letter one size smaller.

Letters	12"	16"	20"	24"	30"	36"	48"	60"	72"	84"	96"	108"	120"	Letters
A	6	8	10	13	13	16	21	24	26	29	32	39	44	A
B	8	12	14	16	18	22	29	35	38	42	48	55	64	B
C	6	7	9	10	11	14	18	20	21	25	28	31	35	C
D	6	9	12	15	16	20	25	29	30	34	40	45	49	D
E	8	9	11	14	14	17	22	26	28	32	37	41	44	E
F	6	7	9	11	11	13	18	20	21	25	28	31	35	F
G	8	9	10	12	14	17	24	27	28	30	37	40	43	G
H	7	9	11	14	14	17	23	26	28	32	38	43	46	H
I	3	4	5	6	6	7	9	10	11	13	15	17	18	I
J	5	6	7	8	9	11	15	17	18	23	24	26	29	J
K	7	9	11	14	15	17	23	27	28	32	38	42	46	K
L	5	6	7	9	9	11	15	17	18	20	24	26	28	L
M	9	13	17	21	21	25	33	37	41	49	57	65	69	M
N	8	10	13	16	16	20	25	32	34	37	43	49	54	N
O	6	8	10	12	13	16	24	26	28	31	37	41	45	O
P	6	8	10	13	14	16	22	25	27	30	36	39	43	P
Q	7	9	11	13	14	17	26	28	30	33	39	44	48	Q
R	7	10	12	16	17	19	27	30	32	36	44	47	52	R
S	7	8	10	12	14	17	21	25	27	28	34	37	39	S
T	5	6	8	9	9	11	15	17	19	20	24	26	28	T
U	7	8	10	12	13	15	22	24	26	28	35	37	42	U
V	5	7	9	11	11	13	17	19	21	25	29	34	37	V
W	9	13	17	21	21	25	33	37	41	49	57	65	69	W
X	5	9	9	13	13	15	17	19	21	25	29	35	41	X
Y	4	6	8	9	10	12	17	18	19	20	25	27	30	Y
Z	7	8	9	12	13	16	22	24	27	27	32	36	39	Z
&	9	12	14	16	16	21	32	36	40	44	51	58	63	&

Greenwood Schedule of Lamps-per-Letter.

A Reverse Phase Relay.

The illustration here shows a three-phase reverse phase relay as designed by the Philadelphia Electric Company, of Philadelphia, Pa., and intended to protect motor driven elevators, cranes and other machinery from damage due to a reversal of phase and consequent reversal of direction of rotation of the motor. The device is shown with the casings removed and consists of a relay and double pole circuit-breaker equipped with a shunt trip coil. The relay is of the differential type consisting of a resistance, an impedance and an armature and so designed that should a reversal occur, the armature closes an auxiliary circuit which energizes the trip coil of the circuit-breaker, thus opening the main circuit. The circuit-breaker will not remain closed until the proper phase rotation is re-established.

The relay is designed for use on 110 or 220-volt, two or three-phase, three or four-wire, 25 or 60 cycle circuits. The capacity of the circuit-breaker has been standardized at 100 amperes covering all motors up to 30 horsepower.

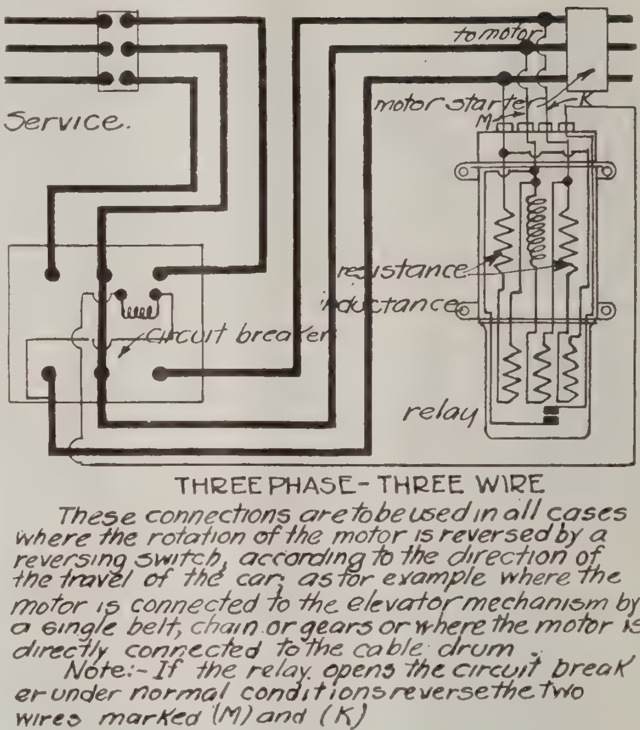


Fig. 1. Connections for Reverse Phase Relay.

When the relay is connected close to the terminals of the motor, the motor will be protected against reversals that may occur in the interior wiring or at the switches or other apparatus installed in connection with the motor.

A New Line of Meters.

A new line of meters is now being manufactured by the Holcomb & Hoke Mfg. Co., of Indianapolis, Ind., after designs and under patents held by G. A. Scheeffer. The meters are illustrated here, one of the features claimed for

The H and H Meter.

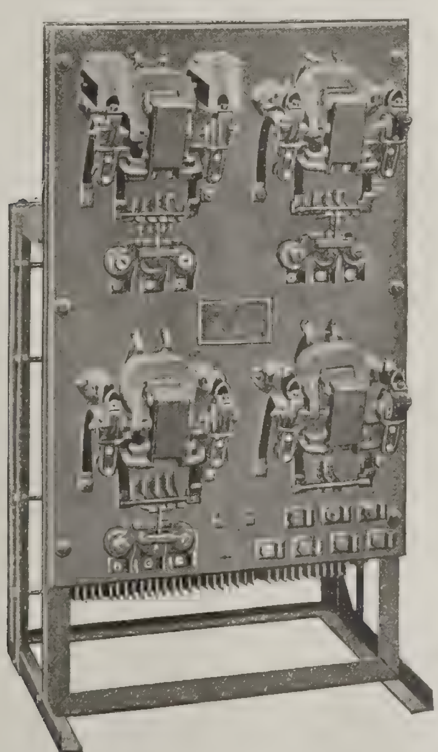
them being small size, the compactness being obtained without crowding of parts, thus making possible a light weight of five and one-half pounds. The rotating element of the meter has a disc of small diameter and rather thick, which is said to be an improvement over a disc of the same weight having a larger diameter but thinner, and which will easily bend by rough usage or should the meter be subjected to a short circuit or sudden overload.

Provision is made for removing and replacing the rotating element easily. By slightly lifting the top bearing pin, after dropping out the lower jewel, the rotating element will readily slip out sidewise, as shown in Fig. 1. It is thus independent of any other part of the meter and can be taken out and replaced by another, since all are interchangeable. The replacing of a worn pivot is also made simple. The bottom pivots fit into the bottom of the shaft by slight friction as the shaft is split at the bottom, the pivot thus being pulled out and replaced by a new one.

The construction of magnets has been such as to aim at permanency being a long tempered steel piece with a single narrow air gap. The motor system is of simple construction and consists of two laminated cores, one having the pressure coils and the other the series coil, the core for the pressure coils being U-shaped and laminated, having on each limb a coil of fine wire thoroughly insulated. The coils can be replaced if damaged by slipping on new ones as the laminations are not built around the coils. It is said that the motor construction prevents a vibration of the rotating element and humming.

Self-Starters for Alternating Current Motors.

Automatic or self-starting is particularly advantageous for motors driving reciprocating pumps, air compressors and other machines that must be started under full load and which require a starting torque equal to or in excess of the normal full load torque of the motor. By means of the new type of polyphase motor self-starters made by the Cutler-Hammer Manufacturing Company, Milwaukee, and shown in the accompanying illustration, the motor can be safely



A NEW TYPE OF SELF-STARTERS FOR A.C. MOTORS.

accelerated in the shortest possible time consistent with a predetermined starting current. The acceleration is controlled by resistance in each phase of the rotor circuit, balanced on all steps which is cut out of circuit by magnetic switches. The closing of these switches depends upon the action of three-phase current relays in the rotor circuit, which allow successive steps of resistance to be cut out only after the current has dropped to a safe value and the motor properly accelerated.

These self-starters are of the multiple solenoid type, entirely self-contained, made in standard capacities up to 200 horsepower. The primary switch and magnetic starting switches are of the open construction, clapper type. The plungers of the current relays are controlled directly by the starting current and the rate at which the motor is accelerated can be adjusted by varying the spring tension on the relay plungers. The secondary starting resistance is of the cast metal grid type, having ample capacity for starting the motor intermittently under load conditions. Where used in connection with motors operating on compression or open tank systems, the motors can be started and stopped automatically by means of pressure regulation or float switches. A parallel line of controllers has also been standardized for use with motors driving centrifugal pumps and machines of smalled load characteristics.

New High Speed and Powerful Electric Locomotives for New York Central Railroad.

Ten passenger electric locomotives, said to be the most powerful type ever built, are under construction and will soon be placed in commission by the New York Central & Hudson River R. R. Co., on lines out of New York City. An order for these locomotives was the result of a very exhaustive series of tests and trial runs of an experimental locomotive of the same type recently made on the Harlem Division. The electric locomotives in service in the Terminal previous to the introduction of the new engine weigh approximately 115 tons. While the new locomotives are considerably lighter, weighing 100 tons, they are much more powerful, are provided with ample forced air ventilation and designed with a view to continuous high speed service. All the 100-ton weight is carried on motor-driven axles, while the former locomotives have but 70 tons weight on the driving wheels. The new electric engines will exert sufficient tractive effort to haul a train weighing 1,000 tons at 60 miles per hour. In regular service they have a capacity for developing 1,400 horsepower continuously, and can develop as high as 5,000 horsepower for short periods.

The New York Central & Hudson River R. R. Co. is operating at the present time forty-seven electric locomotives in the New York Terminal service. Of these, thirty-five were built in 1906 and twelve in 1908. They are all of the 115-ton 484 type and are each equipped with four bipolar, gearless motors. The new electric locomotive adopted by the company is likewise a bipolar gearless design, but it is equipped with eight direct current, 600-volt motors. Each motor is approximately three-fourths the capacity of the motor used on the previous engines, making the aggregate capacity of the motors on the locomotive approximately 50 per cent greater than before and affording approximately 25 per cent higher speed.

In general, the locomotive may be described as having an articulated frame with bogie guiding trucks at each end. The cab containing the engineer's compartments and that for the operating mechanism is swung between the two parts of the frame on the center pins. Each section is equipped with two two-axle trucks having a driving motor mounted on each axle. These cannot be distinguished as main driving or leading trucks, since all the axles are driving axles; but they are termed for clearness, rigid trucks and swivel trucks, respectively.

The eight bipolar, gearless motors each have the armature mounted directly to the axle, the field poles being carried on the truck frame, which forms the magnetic circuit. There are four independent magnetic circuits in the locomotive corresponding to the four trucks. The magnetic flux path on each truck passes in series through the fields and armature of one motor, through the center transom and the fields and armature of the second motor to the end frame, and then returns to the starting point through the two side frames and a reinforcing magnet bar lying parallel with the frames. Each motor at its one-hour rating has a capacity of 325 amperes on 600 volts or a continuous rating of 260 amperes on 600 volts under forced ventilation. For the complete equipment of eight motors, this corresponds to a capacity of 13,500 pounds tractive effort at 54 miles per hour for the one-hour rating, and 10,000 pounds tractive effort at 60 miles per hour continuously.

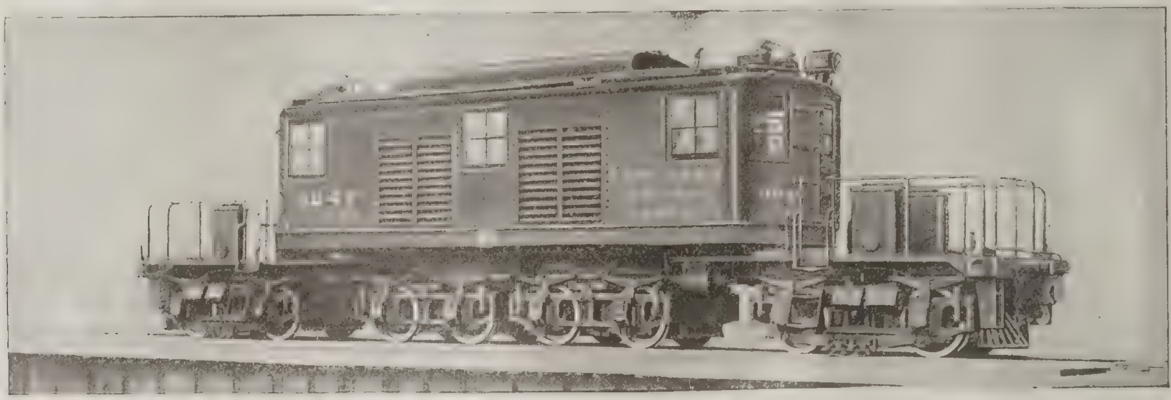


Fig. 1. Side View of Powerful Electric Locomotives for New York Central Railroad.

The motors are electrically connected permanently in parallel in pairs, and the pairs can be connected in three inations, *viz.*, series, series-parallel and parallel. They are insulated for 1,200 volts, so that if at any future time it should be desired to operate the locomotive on 1,200 volts, the pairs of motors could be changed from parallel to series connections and the same speeds and control combinations obtained as on 600 volts.

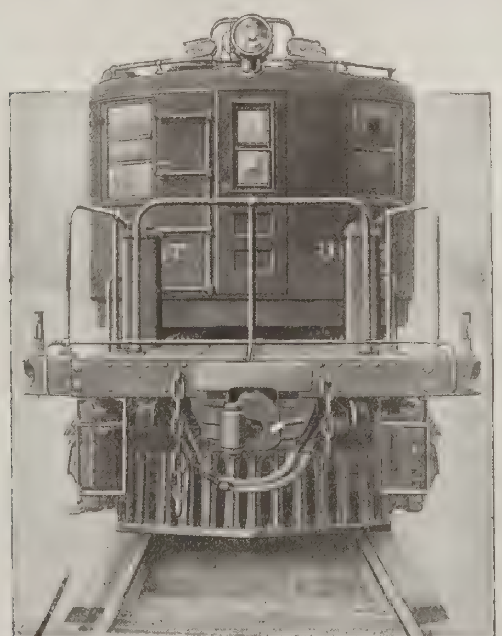


Fig. 2. End View of Locomotive in Fig. 1.

The control equipment on the locomotive is the Sprague-General Electric, known as Type M, and is designed to operate the eight motors connected in the three combinations: series, series-parallel and parallel.

Current is collected by eight underrunning third-rail shoes, or by two overhead trolleys when on gaps on the third rail. The overhead trolleys are the pantograph type and are pneumatically operated. They can be put into service from either engineer's position by a foot-operated valve. The trolley is designed for intermittent use and is therefore arranged to be held in a raised position only while the valve is held open by the engineer's foot.

The headlights are the incandescent type with parabolic reflectors 16 inches in diameter. The interior illumination of the car is provided by ten incandescent lamps arranged in two circuits, two lamps being located in each engineer's cab and the balance in the central compartment. In each lamp circuit is a portable lamp with extension cord 25 feet long. One lamp switch is located in each engineer's compartment, so that from either end of the locomotive the lamps can be controlled in that compartment, as well as half of the lamps in the central compartment. Electric heaters are placed in the two engineers' compartments.

The blower set provided for ventilating the driving motors is located in the central compartment. The blower has a capacity of 24,000 cubic feet of air per minute and is driven by a series-wound motor of the railway type.

The order for these locomotives was received by the General Electric Company and they are being constructed at their works at Schenectady, N. Y.

The Ventura Reverible Fan.

A new addition to the American Blower Company's electric fans is the Ventura reversible. This fan is especially suited for ventilation of small offices, kitchens, apartments, toilets, etc., and can be simply installed in top sashes of windows, transoms or ends of skylights. The fans vary in sizes from 11 inches to 48 inches, the 11-inch being driven by a motor that takes no more energy than a 16 candlepower lamp.

The reversing mechanism makes it possible to discharge the air out of the room or blow it in straight ahead, upward toward the ceiling or downward toward the floor.

Electrical Construction News

This department is maintained for the contractor, dealer, manufacturer and consulting engineer.

ALABAMA.

ALEXANDER CITY. A transmission line is to be constructed and pumps, switching equipment, instruments, protecting devices, transformers, insulators and meters are to be purchased during the next few months. Electricity for operating the municipal system is to be purchased from the Industrial Light & Power Co. J. A. Coley is superintendent.

ATTALLA. The Municipal electric light and water works system has been leased by the Alabama Power Co., for a period of 30 years. Electricity for operating this system will be obtained from the East Gadsden station which will be completed in June.

HUNTSVILLE. The Huntsville-Chattanooga, and Birmingham Railway, Light & Power Co., has prepared plans for the installation of an ornamental street lighting system around the public square and on Washington street to Clinton. Twenty-four ornamental standards carrying five lamps will be used.

ARKANSAS.

COTTER. The Dixie Power Co., with offices at 1118 State National Bank Bldg., Little Rock, Ark., is contemplating the construction of a hydro-electric plant on the White River to be sufficient to generate 15,000 H. P. The dam will be of the hollow construction type and its estimated cost together with transmission lines is $2,000,000. Power will be used to develop industries in central and western Arkansas. J. A. Laird of St. Louis, Mo., is consulting engineer for the company.

FLORIDA.

CHIPLEY. The Chipley Light & Power Co. is asking bids for construction of an electric light system; four valve, high-speed automatic engines of 115 H. P. direct connected to a three-phase 60 cycle, 2300 volt, A. C. generator, switchboard, line material for distribution system, and seventy-five 100-watt incandescent lamps are desired.

GAINESVILLE. It is understood that a committee is investigating the installation of an ornamental street lighting system in the business district. The plans call for the erection of 80 standards carrying five lights. J. D. Goodwin is chairman of the committee.

JACKSONVILLE. A new battery of boilers with a rating of approximately 1040 H. P., three 1000 K. W. step down transformers of a voltage of 6660 to 2300, are to be purchased. Also two 50 lamp tub transformers to operate 100 additional four ampere magnetite-arc lamps will be purchased during the year. A new power house with a capacity of 10,000 K. W. was completed in November, 1912. W. A. Tucker is superintendent.

WEST PALM BEACH. The Ariston Ice & Electric Co. are planning to extend a transmission line north and south at Palm Beach to furnish electric service to residences along the lake shore.

GEORGIA.

COLLEGE PARK. The College Park Electric Light Co., is to soon extend its service and will probably purchase hydro-electric power or install a 60 K. W. generating set. Transformers, meters and lamps as well as other electrical appliances will also be purchased at that time. C. B. Biddle is superintendent.

COLUMBUS. It is understood that additional power equipment will be installed in the power plant of the Eagle & Phenix Mills, including a turbo-generator, transformers, motors, etc., to increase the capacity to 1000 horsepower. Lockwood, Greene & Co., 96 Federal St., Boston, Mass., are the engineers.

CORDELE. The property of the Citizens Electric Light and Power Company, of Cordele, has been purchased by J. G. White Co., 45 Exchange Place, New York City. Improvements will be made to the property. The plant will be taken over about June 1st.

LAGRANGE. The Columbus Power Co. is to build a substation at LaGrange with an installation of transformers to supply 2500 horsepower.

MADISON. On June 2nd a 24 hour service will be established and a market opened for electrical appliances. A motor driven pump is to be purchased of a capacity of 500 gallons per minute, under a head of 100 feet. G. W. Hubbard is superintendent.

MONROE. This place will establish a 24 hour service and purchase a five panel switchboard, instruments and motors, heating devices and other appliances, in connection with the installation of day service. J. W. Butts is superintendent.

QUITMAN. Additional electrical equipment is to be installed in the electric plant. G. B. Garwood is purchasing agent.

WEST POINT. The Columbus Power Co., of Columbus, which have recently built a transmission line through West Point, has closed a contract with the Lang Mfg. Co. to supply electricity to its plant. A substation will be erected at West Point, equipped to handle 2,500 H. P.

MISSISSIPPI.

HATTIESBURG. The Hattiesburg Traction Co. has submitted a proposition to the city for improving the street lighting system. At present the company furnishes 70 arc lamps and 26 tungsten lamps. According to the new arrangement 45 arc lamps will be removed and 135 tungsten lamps installed, giving the city a total of 177 tungsten lamps and 31 arc lamps.

NORTH CAROLINA.

CONOVER. The Conover Electric Co., incorporated by C. S. Coyney, A. L. Shuford, and others, has awarded a contract for a three mile transmission line to cost $2,500. Power is to be secured from the Southern Power Co.

MURPHY. Bonds have been voted to build a hydro-electric plant across the Hiawassee River, six miles from Murphy. A power house will be constructed and electrical equipment installed of a capacity to develop 800 horsepower. J. B. McCrary Co., of Atlanta, Ga., are the engineers.

WINSTON SALEM. The local street railway system and electric light plant owned by the Fries Mfg. & Power Co., has been purchased by the Southern Power Co., and plans are being made to improve the system, expending about $50,000.

WINSTON SALEM. The Southern Power Co., is to expend about $50,000 in improving the electric light and street railway system at this place.

SOUTH CAROLINA.

RAEFORD. The Raeford Power Co. is to build a hydro-electric plant on Rockfish Creek. The development will be of a capacity of 750 H. P. and furnish electrical energy to cotton mills at Raeford, also a new oil mill and fertilizer factory. T. V. Upchurch is president of the Raeford Power Co.

TENNESSEE.

ELIZABETHTON. The Watauga Power Co., of Elizabethton, has been purchased by the H. L. Doherty and Co., of New York City. It is understood that the new owners are to construct other developments of about 7,000 horsepower in the territory.

ROGERSVILLE. The Rogersville Hydro-Electric Power Co., is to construct a hydro-electric plant on Big Creek four miles from Rogersville, to cost about $5,000.

BOOK REVIEWS.

ELECTRICAL METERS. By Cyril M. Jansly, B. S., B. A., Associate Professor Electrical Engineering, University of Wisconsin. Published by McGraw-Hill Book Company, New York City. 360 pages. Price $2.50.

Little practical and therefore useful material on meters was available in convenient form before the appearance of the N. E. L. A. Meterman's Handbook last year. This work, compiled by engineers with a thorough knowledge of meter construction and operation for the requirements of the central station generating plant, test room and distribution system, is intensely practical.

The work mentioned here by Mr. Jansly is also practical, but practical from another view point than referred to in the Meterman's Handbook. It is a practical interpretation of operating principles by which meters indicate, measure and record current, votage, watts, kilowatt-hours, power-factor, frequency, etc. From this standpoint it is clear cut in its presentation and far from a catlogue compilation as such works have a tendency to be. It is a work that supplements in an admirable way the meter handbook already mentioned and any one who is fortunate to possess both will have much complete and useful meter information. To the man who desires to know meter operation thoroughly this work will appeal as about two-thirds of the work, some 250 pages, are devoted to distinct types of meters, their construction, connection and operation. The discussion of operation of A.C. meters is free from complicated mathematics and many vector diagrams used to clearly indicate the conditions. The last third of the book is given to a discussion of testing methods for the various types of meters,. Here, again, the requirements of the practical man have been considered and many diagrams, curves and other data given besides the necessary calculations.

The contents of the work speaks for it, the headings of the chapters being as follows: 1. Fundamental Electrical Principles; 2. Classification of Instruments; 3. Current and Pressure Instruments; 4. Fundamental Principles of Alternating Currents; 5. A. C. Circuits; 6. Induction Principle; 7. Induction Type Ammeters and Volt Meters; 8. Electrodynamic Ammeters and Volt Meters; 9. Miscellaneous Ammeters and Volt Meters; 10 Power Measuring Instruments; 11. Phase Relation and Frequency Instruments; 12. Recording or Graphic Meters; 13. Integrating Meters—Watt-hour Meters; 14. Integrating Meters—Ampere-hour Meters; 15. Demand Indicators; 16. Instrument Testing; 17. Testing Ammeters; 18. Testing Volt Meters, Watt Meters, Power-factor and Frequency Meters;

19. Testing Watt-hour Meters; 20. Methods of Obtaining Different Power-factors; 21. Special Tests of A. C. Watt-hour Meters; 22. Instrument Errors.

GAS POWER. By Prof. C. F. Hirshfeld and T. C. Ulbricht, of Power Engineering Department, Cornell University, Published by John Wiley and Sons, New York City. Pages 209. Price $1.25.

This work is a simple, non-mathematical presentation of the use of gas, gasoline and oil in suitable engines for the generation of power. It is primarily intended for a test in training schools and those devoted to industrial education and for this very reason the simple but thorough treatment of the subject makes it especially interesting to the man who may be connected with a plant where this source of power is used and the subject of special interest. Besides treating generally the subject of fuels and internal combustion principles, such subjects as methods of cooling, ignition, governing, carbureting, generating gas, and types of engines are gone into fully. Many practical curves and tables are given and the work well illustrated with instructive diagrams.

EXPERIMENTAL WIRELESS STATIONS, by Philip E. Edelman, Minneapolis, Minn. 224 pages. Price $2.00.

This work takes up the design, construction and operation of wireless stations with particular reference to the requirements of the new wireless law. It is written by an experimenter who knows the field and his subject in such a way that he writes in a clear and practical way. It contains full instructions for complying with the law, building and operating apparatus and stations, modern instruments, simplified calculations, formulas and designs. For those interested in wireless work this book will be found a valuable help.

THE 1913 UNIVERSAL ELECTRICAL DIRECTORY. Published by H. Alabaster, Gatehouse & Co., 4 Ludgate Hill, London, E. C. Price $5.10.

This edition has been as carefully revised as previous issues, and no pains spared to make it as accurate and reliable as ever. The contents are divided into four sections; the British with 14,040 names; colonial and general with 6,550 names; continental with 7,640 names; U. S. A. with 6,255 names; totalling 34.485 names, although unimportant entries are omitted. Each section is subdivided into alphabetical and classified sections, while in the case of the British a geographical section has been added, which is a necessity for all travelers. Any section can at once be referred to by means of a thumb index.

WIRING DIAGRAMS OF ELECTRICAN APPARATUS AND INSTALLATIONS. Published by McGraw-Hill Book Company, 239 West 39th St., New York City. Price $2.00. Pages 253.

This work is made up largely of diagrams of connections and layouts of circuits for the different types of electrical apparatus and systems. The necessary text to explain the diagrams is small, usually consisting of not more than half a dozen lines, so complete and self-explanatory are the illustrations. There are in all 439 diagrams covering the following subjects:

D. C. Generators; A. C. Generators; Feeders; Transformers; Potential Regulators; Synchronous Converters; Batteries and Boosters; Sub-Stations; D. C. Motors and Speed Control; Constant Potential Distribution; Constant Current Distribution; Lamp Mechanism Connections; Rheostats and Controllers; Lightning Arresters; Measuring Instruments; Remote Controlled and Automatic Switches and Circuit Breakers; Railway Controllers and Equipment; Railway Signals; Miscellaneous Interior Wiring.

(1) PRACTICAL MATHEMATICS FOR ECHNICAL STUDENTS. AND (2) PRACTICAL GEOMETRY AND GRAPHICS FOR TECHNICAL STUDENTS by Edward L. Bates and Frederick Charlesworth. Published by D. Van Norstrand Co., New York. Prices $1.50 and 2.00.

The first book named above contains 520 pages and over 320 illustrations, being designed as a practical text-book and presenting all the mathematics that the average technical student or practical man requires to follow technical subjects and solve average practical problems. It is most complete and plainly written.

The second book contains 620 pages and over 600 illustrations and is a companion work to the above. It is divided into three sections; plane geometry, graphics, and descriptive geometry. It is an excellent text on these subjects and will be found useful to the practical man on account of its clearness and many illustrations.

I THE ELECTRIC MOTOR and II ALTERNATING CURRENTS SIMPLIFIED, by Elmer E. Burns, published by Joseph G. Branch Publishing Co., Chicago. Price $1.50 each.

In these two books the author has taken up the electric motor and the electric circuit treating each in the simplest possible manner, presenting illustrations, comparisons and examples to make plain the features discussed. To the man who knows little or nothing of electricity these books will be of interest. They are evidently not intended for the man who has a working knowledge of the principles of motor operation and the practical behavior of alternating current circuits.

PRACTICAL MATHEMATICS FOR THE ENGINEER AND ELECTRICIAN, by Elmer E. Burns and Joseph G. Branch. Published by Joseph G. Branch Publishing Co. Price $1.00.

This book takes up in a practical way the parts of arithmetic and algebra that are of most use to the engineer and electrician in practical work. Numerous problems and their solutions are given, in each case the problem being one that may come up in any plant. However, the problems are all very simple and illustrate principles rather than furnish information of use to men who have a working knowledge of mathematics.

ELECTRICITY IN THE HOME. Published by Commonwealth Edison Company, Chicago, Ill. This is the title of a very attractive and instructive booklet discussing the use of light and the small motor in the home. The requirements of each room including kitchen and laundry are taken up presenting through illustrations the effects that can be secured. The book-

MACHINE DESIGN. By H. D. Hess, Professor of Machine Design, Cornell University. Published by J. B. Lippincott Co., Phila., Pa. Pages 368. Price $5.00.

This work contains a discussion of the design of hoists, derricks and cranes presented in such a way as illustrate the solutions of design problems and thus be an aid to the designer in any field. While it is intended especially as a text book for college use it will be found of practical use in all design and drawing rooms. Frames and Girders; Brakes and Clutches; Winches and Hoists; Cranes of all types and Hoisting Engines are subjects treated, numerous practical solutions, all illustrations being given under each heading.

AMERICAN TELEGRAPH PRACTICE, by Donald McNicol, member of engineering staff, Postal Telegraph-Cable Co., New York. Published by McGraw-Hill Book Company, New York City. Pages 507. Price $4.00.

It is readily acknowledged that the technical literature treating telegraph practice has not kept pace with the development of the art and those who appreciate this fact will welcome such a complete and authorative work as the one mentioned here. The author has recorded all the essentials of the subject and discussed the systems and apparatus representing practice of today in a manner that makes the work more or less of a cyclopedic reference on telegraphy. It contains material of special interest to operators, wire chiefs, quadruplex attendants and repeater attendants and treats simultaneous telegraphy and telephony.

"ENTROPY-TEMPERATURE and TRANSMISSION DIAGRAMS FOR AIR," by Professor C. R. Richards, has just been issued as bulletin No. 63 of the Engineering Experiment Station of the University of Illinois. This bulletin presents the theory and use of three graphical charts, by the aid of which all problems pertaining to the compression, expansion and transmission of compressed air may be solved with a minimum of labor and with a degree of accuracy which is satisfactory to engineering work. Copies of Bulletin 63 may be obtained upon application to W. F. M. Goss, Director of the Engineering Experiment Station, University of Illinois, Urbana, Illinois.

LEFAX. A standard filing system and loose leaf notebook for engineers. Published by Standard Corporation, Penn. Bldg., Phila., Pa. Subscription price, $1.00 per year for 12 numbers.

This scheme of publishing and filing engineering data and information has been devised by John Clinton Parker, and is planned for the busy engineer to keep up to date on standard engineering information. The sheets are 6 3-4 by 3 3-4, punched for a pocket book, desk and general loose leaf file. The sheets will cover all branches of engineering and mill data that seems greatest in demand. The scheme has been approved by prominent engineers and there is no reason why it will not find a useful place. We suggest that those interested in data of this character investigate Lefax.

Personals.

MR. ARTHUR WILLIAMS, president of the Association of Edison Illuminating Companies, was given a dinner on May 2 by the trustees of the American Museum of Safety on the occasion of his decoration with the Cross of the Royal Order of Isabella la Catolica conferred on him by the King of Spain.

ROSS B. MATEER, who for the past year has acted as manager of agricultural sales for the Great Western Power Company, has recently been elected sales manager of the company with jurisdiction over the sale of current in the Oakland division of the company's territory which includes Oakland, Berkeley, Richmond and 50 miles of surrounding territory. He will be responsible for the promotion of industrial, commercial, domestic and agricultural sales in this territory and have headquarters at Oakland. Mr. Mateer was for a number of years prior to his connection with the Geat Western Power Company, electrical engineer for the Denver Gas & Electric Light Company, and established in this connection as well as in his present position an enviable reputation as a successful promoter of new business schemes.

D. R. SHEARER, E. E., a consulting engineer of Knoxville, Tenn., has been secured to prepare plans and estimates for a hydro-electric plant on Ball Creek. This plant will be of a capacity to furnish light and power to Lone Mountain and Tazwell, Tenn.

WALKER BROS., of Butler, Tenn., have organized the Butler Electric Co., and commenced the installation of a hydro-electric plant. D. R. Shearer, of Knoxville, Tenn., is engineer in charge.

A. EUGENE MICHEL and STAFF, advertising engineers, New York, have removed from 21 Park Row, into larger offices, Rooms 1001-7 Woolworth building.

LOUIS STEINBERGER, president and general manager of the Electrose Manufacturing Company, Brooklyn, N. Y., has won a decision on the Disk Strain Insulator suit. On April 7 the Court of Appeals of the District of Columbia handed down a decision affirming the decision of the Commissioner of Patents that Louis Steinberger is the original inventor of a disk strain insulator comprising suspension members partially enveloped by a mass of insulating material and having a disk portion provided with annular collars or flanges extending in opposite directions therefrom and generally parallel with the suspension members. The details of the decision have already been given in the technical press, Electrical World, Dec. 21, 1912, and Electrical Review, April 19, 1913.

Industrial Items.

ALLIS-CHALMERS MANUFACTURING COMPANY on April 16, 1913, took over the properties and entire operation of the business of Allis-Chalmers Company, which latter company during the past year has been in the hands of a receiver. This change marks the end of the Allis-Chalmers receivership and the commencement of the administration of the new company. Beginning with April 16, all business has been and will be conducted by Allis-Chalmers Manufacturing Company, which starts out under conditions promising success. The new company will operate all departments of the business as conducted by its predecessor and will carry out all contracts on hand for the sale of its products. It has no bonded indebtedness nor liabilities of any character. In addition to all assets of the former Allis-Chalmers Company the new company has over four million dollars additional cash for new working capital which has been raised through the recent reorganization.

The new company will continue to operate the large West Allis Works and Reliance Works at Milwaukee, the Chicago Works, and in addition will control the operations of The Bullock Electric Manufacturing Company, at Cincinnati. Otto H. Falk, of Milwaukee, who for the past year has been receiver of the Allis-Chalmers Company and under whose management as receiver the operations of the business have shown marked improvement, has been elected president of the new company. The general offices will be at Milwaukee.

ELMER P. MORRIS, 90 West street, New York City, reports a number of recent sales for ornamental lighting fixtures. These include 40 G. E. luminous arc lamp posts for Ocean City, N. J., 85 for Wildwood, N. J., and 170 for Rochester, N. Y. Also 36 G. E. luminous arc brackets for Utica, N. Y., and 65 for Rochester, N. Y. Tungsten 5-light poles have been sold as follows: 75 at Quebec, Canada; 76 at Geneva, N. Y.; 86 at Asbury Park, N. J.; 36 combination railway and luminous arc lamp poles at Wildwood, N. J.; 10 single light poles at New Brunswick, N. J., and 250 single light poles for Blackwells Island, N. Y.

THE CUTLER-HAMMER MFG. CO. of Milwaukee, has issued under date of March, 1913, bulletin 8650 which illustrates and lists all of the C-H push button switches, attachment plugs, receptacles, cord connectors, sockets and plates. This bulletin supersedes one of the same number published in January, 1912. A number of new devices are listed and the size of the bulletin increased.

THE ROCKY FORD POWER CO., of Manhattan, Kansas, has recently closed a contract with the Manhattan Interurban Co. to furnish the latter power for all its uses during a period of 10 years. To fill this contract the power company will at once install a 1,000 horsepower steam station as an auxiliary to their hydroelectric plant and improvements will be made costing upward of $75,000. Stations will also be built at Manhattan and Ogden, Kansas.

THE ELECTRIC PRODUCTS COMPANY, manufacturers of the Wotton Automatic battery charging panels, have moved from 6536 Carnegie Ave., Cleveland, Ohio, to their new building at 10514 Dupont Ave. During the past year this company has shown a 277 per cent increase in sales.

THE FEDERAL GRAPHITE MILLS, Cleveland, Ohio, and Milwaukee, Wis., will mail to those interested, upon request, a booklet entitled, "Actual Experience of Engineers with Boiler Graphite." This booklet opens with the reprint of an editorial from a leading technical paper regarding the use of graphite in boilers, then follows results obtained from the use of graphite in boilers, then the method of applying graphite, and its action on the impurities found in boiler waters, the cost of the treatment and the saving to be effected, and the various methods of application.

THE WESTERN MARYLAND RAILROAD COMPANY has recently ordered telephone equipment for dispatching trains on its lines. The apparatus to be used is the Western Electric type selector set containing the No. 50 selector. Twenty-three waystations will be equipped with selective signaling and telephone apparatus. Miscellaneous equipment and line material is also being furnished. The present equipment will be installed over a circuit extending from Hagerstown, Maryland, to Cumberland, Maryland, a distance of eighty miles. This section of road is the first of four hundred miles to be equipped with telephone train dispatching apparatus.

THE AMERICAN CARBON AND BATTERY CO., of St. Louis, Mo., has recently announced the addition of flash light batteries to its line of wet and dry batteries and carbon products. The new line is to be known as the AMERICAN RADIUM flash light battey.

THE STERLING ELECTRIC LAMP WORKS of the G. E. Co., advise that the new Heard National Bank building of Jacksonville, Fla., the tallest office building in the "Peninsular State," has been equipped throughout with Mazda lamps. With the exception of the banking room the lighting units consist of Mazda lamps provided with Holophone Reflectors. In the small rooms a single 100-watt unit gives ample illumination, while the larger rooms are provided with two 60-watt units. The John I. Bronson Company, who made the installation, have endeavored to make the Heard National Bank one of the best lighted office buildings in this country.

THE COLUMBIA RECORD of Columbia, S. C., issued under date of April 8th, a magnificent 64-page edition in five sections devoted to the water power situation in South Carolina. Few if any daily papers in the South have ever in any one issue done such credit to the subject as is done editorially in this issue of the Record, in fact it rivals in its completeness of waterpower and industrial features in South Carolina the voluminous edition of a recent Manufacturers Record. Great credit is due the pubilsher of the Columbia Record and his staff of able assistants for the nature of edition mentioned and we are sure that those who come within its immediate range of circulation have reason to be proud of it as many others will when they have been privileged to peruse its columns. It has already won a protected place in the editorial files of this publication.

THE STEEL CITY ELECTRIC COMPANY, of Philadelphia, Pa., has issued bulletin A, cancelling bulletin K, of December, 1911, and giving prices and information on bushings and lock nuts. Their representative in the South is L. M. Robertson, Empire Building, Birmingham, Ala.

THE TUNGSTOLIER WORKS, of General Electric Company, at Conneaut, Ohio, are doing an important work for the fixture trade in their magazine, the "Fixtureman." This publication is complete with full information on all the latest developments in the fixture industry and contains an abundance of helpful suggestions which must prove valuable to the fixture dealer. The growth of the Tungstolier business in the past few years has been such as to make necessary the building of a new factory at Cleveland, Ohio, and a view of the plans of this most modern plant indicates that it will be the greatest fixture manufacturing institution in the country.

THE CENTRAL TUBE COMPANY has, since March 24, occupied new offices on the 18th floor of the First National Bank building, Pittsburgh. The sales of black and galvanized steel pipe, and rigid electrical conduit has increased decidedly, making this move necessary to secure larger quarters.

THE DETROIT INSULATED WIRE COMPANY, at a recent annual stockholders' meeting, presented one of the most satisfying reports in the company's history. It was shown that the successive annual increase in business during previous years had been largely surpassed in 1912, the sales approximating a 75 per cent increase over 1911. The finances of the company are in exceptionally fine shape, and with the prevailing optimistic outlook for 1913, an even beter record is anticipated. Extensive additions have been made to the manufacturing facilities of the factory, embracing the provisions of increased floor space and new machinery and equipment, which will permit of a 50 per cent increase in the present capacity. This company is now manufacturing all sizes of solid and stranded rubber insulated wire, including the largest size cable, and has just completed more than a mile of two million circular mil for one of its prominent customers.

THE DIEHL MANUFACTURING CO., of Elizabethport, N. J., which has been in existence since 1887, then known as Diehl and Company, has taken title to 12½ acres of property fronting on Newark avenue. The greater portion of this property lies in the city of Elizabeth, Union county, although there is a 16-foot frontage in the city of Newark, Essex county. The property is bounded by Alina St. Elizabeth, fronting on Newark avenue, Virginia St. Newark, and in the rear by the Pennsylvania railroad. The frontage on Newark avenue measures 832 feet, with a depth of 630 feet to the Pennsylvania railroad. The Union and Essex county line between Elizabeth and Newark is drawn through the Virginia St. side of this property.

The large influx of business during the past few years has caused the Diehl Manufacturing Company to outgrow its present works at Elizabethport, N. J., and in the spring Factory No. 2 will be built on the premises heretofore described to care for the overflow. The new site is an advantageous one from many viewpoints, having a siding on the Pennsylvania railroad, and being in the 5 cents fare zone from both Elizabeth and Newark, which opens both labor markets.

ILLUMINATION. "How to Figure Illumination," is the title of a 20-page booklet recently published by the Sunbeam Incandescent Lamp Works, of General Electric Company, Chicago and New York. The object of this bulletin is to acquaint the general public with the most simple and up-to-date method of figuring commercial and industrial illumination. It also includes a complete catalog of Sunbeam Mazda lamps. The desirability of issuing this fourth edition became apparent in view of the general appreciation with which the preceding editions were received. Copies of this booklet will be gladly furnished to anyone, upon application. Requests should be addressed to the Sunbeam Incandescent Lamp Works of General Electric Company, or to any of the distributing houses of the Western Electric Company.

Trade Literature.

NEW AUTOMATIC CONTROLLER. The Cutler-Hammer Mfg. Co., of Milwaukee, has issued Bulletins 9630, 9532, 9640 and 9642 illustrating and describing a new line of automatic controllers for use with slip ring polyphase motors operating on low and high voltage circuits. New types of magnetic switches are used on these controllers, the construction and functions of which are fully described. Bulletins 6090, 6095, 6100 and 6105 describe types of automatic starters for direct current motors, which are used in place of hand starters where it is desired to get proper acceleration regardless of the carelessness of the workmen and where convenience of control is essential. These starters can be placed out of the way and the motor started by merely pressing a button or closing a small switch.

PRICE LIST ON STERLING WIRE. A new standard price list on "Sterling" new code rubber covered wire has been issued by the Standard Underground Cable Co., Pittsburg, Pa. The price list is in convenient and durable booklet form and gives prices on "Sterling" wire for bases ranging from 13 to 20 cents for solid and stranded wires of all commercial sizes. Appended are explanatory notes and a list of electric wires and cables and cable accessories manufactured by the company. The price list will be sent on request.

THE THORDARSON ELECTRIC MANUFACTURING COMPANY of 507 S. Jefferson street, Chicago, has recently announced a late model New Junior Bell Ringer. Much original thought and painstaking endeavor was brought to bear by the Thordarson experts to create a superior, low-priced, highly-efficient bell ringer, suitable for residence door bells, buzzers and all classes of light signal work. Their long experience in the manufacture of electrical apparatus and expert knowledge of exact service conditions is represented in this New Junior Bell Ringer. The new model has the same output and capacity as the previous Junior Bell Ringer, but it is much smaller, neater in appearance and lower in cost.

HIGH TENSION SWITCHES. Bulletin No. 5 (copyrighted) issued by the Delta-Star Electric Company, Chicago, is an interesting treatise of high tension switching problems and will be found of value to those managers selling power from high tension lines. Complete information is given as to the installation of switches on poles, insulation tests, etc., and operating characteristics.

THE UNIVERSITY OF WISCONSIN, at Madison, Wis., has announced the thirteenth annual six weeks summer school of the College of Engineering which opens on the twenty-third of June. Courses of instruction and laboratory practice are offered in Electrical, Hydraulic, Steam and Gas Engineering, Mechanical Drawing, Applied Mechanics, Testing of Materials, Machine Design, Shopwork and Surveying, in addition to which subjects may be taken in College of Letters and Science. For bulletin address F. E. Turneaure, University of Wisconsin, Madison, Wisconsin.

SWITCHES. Bulletin No. 100, issued by the Electrical Engineers Equipment Co., 1-10 N. Desplaines St., Chicago, Ill., takes up a new type of pole top disconnecting switches which they are now marketing. These switches are described in detail in the New Apparatus and Appliance section of this issue.

TELEPHONE FACTS. In addition to sending out a New Year's edition of Telephone Facts, to the trade containing some interesting sales items and publicity stunts, with readable telephone articles by different members of the sales and other departments, the ellogg Company have been sending to their customers and friends, a beautifully engraved card 6x3½, the upper left hand corner of which is a fine reproduction of the Kellogg Desk Telephone, surrounded by green holly sprays, sprinkled with red berries.

ELECTRIC SIGN FIXTURES. Pass & Seymour, Inc., of Solvay, New York, has issued bulletin 760, under date of February 21, 1913, devoted to sign and outlet box receptacles, ready wired sign receptacles as well as other sign fixtures. Numerous signs are shown in which these fixtures are used, showing the field of application. The signs shown include many on Broadway, New York City, and other large cities.

SPRAGUE FAN MOTORS. The Sprague Electric Works, of the General Electric Company, has issued a very attractive catalogue devoted to the fan motors offered for the season of 1913. The catalogue has a very appropriate cover design suggestive of the cool breezes of the seashore. Throughout 40 pages enclosed in a border design of colors, the different types of fans are described and illustrated. General Electric types of fans are shown in the 8, 12 and 16-inch sizes, besides the usual types of Sprague fans, possessing the well-known Lundell features.

FORT WAYNE SMALL MOTORS. The Fort Wayne Electric Works, of the G. E. Co., has issued a bulletin devoted to fractional horsepower motors and their applications. The bulletin, besides discussing the design features of these motors, gives a number of views, showing the motors in actual operation. The bulletin itself is attractively designed with special borders and half-tones printed on heavy coated stock.

MOTORS. The Century Electric Company has issued bulletin No. 19, under date of January, 1913, devoted to "Invincible" split-phase constant speed motors. These motors have been developed to supply the demand in the industrial and domestic fields for a small power motor to operate on various classes of apparatus not requiring a motor of heavy starting torque. The bulletin describes these motors in detail and gives numerous applications.

Electrical Devices
Recently Passed by Underwriters

These devices and materials have been examined under the specifications given in the National Electrical Code and working in practice, and are approved by the Underwriters Laboratories, Incorporated.

DEVICES APPROVED.

Cabinets.

F. BISSELL COMPANY, 226-230 Huron street, Toledo, Ohio. Standard designs labeled. Approved March 24, 1913.

COLUMBIA METAL BOX CO., 226-228 E. 144th street, New York City. Sectional sheet steel cabinets. Approved April 18, 1913.

LEONARD BUNDY ELECTRIC CO., Cleveland, Ohio. Standard designs, labeled. Approved April 1, 1913.

TRIO MANUFACTURING CO., 2424 Third avenue, Rock Island, Ill. Standard designs, labeled. Approved April 1, 1913.

WORCESTER ELECTRIC CO., 42 La Grange street, Worcester, Mass. Standard designs, labeled. Approved April 1, 1913.

Conduit Boxes.

ADAPTI MANUFACTURING COMPANY, Winter and Leonard streets, Cleveland, Ohio. "Adapti-boxes." Outlet boxes for use with rigid conduit. Approved April 29, 1913.

W. H. HOPE, 33 Green street, Newark, N. J. Cast iron outlet box for use with flexible steel conduit or armored cable. Approved March 29, 1913.

Flexible Cord.

FLEXIBLE CONDUIT COMPANY, Penn Yan, New York. Armored flexible cord with strips of galvanized steel armor over pendant flexible cord. Approved and labeled April 2, 1913.

WESTERN CONDUIT COMPANY, Youngstown, Ohio. "Real-Flex" armored flexible cord labeled. Approved April 18, 1913.

DRIVER-HARRIS WIRE CO., Railroad avenue and S. 4th street, Harrison, N. J. Double conductor cord. Approved April 14, 1913.

GENERAL ELECTRIC CO., Schenectady, N. Y. Cord for electric heaters. Approved April 7, 1913.

SIMPLEX WIRE & CABLE CO., 201 Devonshire street, Boston, Mass. Cord for electric heaters. Approved April 7, 1913.

Panelboards.

GENERAL ELECTRIC CO., Schenectady, N. Y. G. E. metering panelboards. Approved April 29, 1913. New Haven Electric Switch Mfg. Co., Blakesley avenue, North Haven, Conn. Two and 2-wire ponelboards, 125, 125-250 and 250- volts. Approved March 24, 1913. Labeled.

LEONARD-BUNDY ELECTRIC CO., Cleveland, Ohio. Standard design. Approved April 1, 1913. Labeled.

WORCESTER ELECTRIC MFG. CO., 42 La Grange street, Worcester, Mass. Two and 3-wire panels 125, 125-250 and 250-volts. Approved April 1, 1913. Labeled.

ELECTRICAL ENGINEERING

PUBLISHED MONTHLY

Vol. 45. JULY, 1913 No. 7

PUBLICATION OFFICE
DALTON, GA.

EDITORIAL and ADVERTISING DEPARTMENTS
GRANT BUILDING ATLANTA, GA.

D. H. BRAYMER, Editor.
A. G. RAKESTRAW, H. H. KELLEY, F. C. MYERS, L. L. ARNOLD — Associate Editors.

SUBSCRIPTION RATES

Domestic .... $1.00 For Two Years
Canada .... $1.00 Per Year
Foreign .... $1.50 Per Year

Complaints of failure to receive ELECTRICAL ENGINEERING regularly or of any errors of any nature, should be promptly made to the Atlanta office.

Advertising copy or change orders for standing advertisements must reach the Atlanta office by the 5th of the month preceding the month of publication.

Entered at Dalton, Ga., Postoffice as Second-class Matter.

CONTENTS.

Tariff Reduction and Electrical Business.

For some four months and at the present time, the tariff situation has been and is of general interest. The effect of the proposed reduction in protection of the electrical business from practically 45 to 25 per cent has been variously estimated, the majority of manufacturers, however, believing that the reduction will not seriously affect their business. This opinion seems to be well founded and based upon the history of attempted invasions of this country by powerful electrical concerns. It is further substantiated by the fact that our electrical exports are extensive and steadily increasing, the reports showing the total exports for the ten months ending April 31, as $21,899,197 as against $16,317,914 for 1912 and $15,402,421 for 1911, an increase for 1912 of over 34 per cent. Electrical imports at the present time are at the rate of $500,000 per annum or a little more than one-tenth of one per cent of the total production of electrical goods in this country for 1912.

The following editorial remarks from a leading financial journal of this country on this situation are of interest. The *Wall Street Journal* says: "The fate of those foreigners who have attempted to invade the electrical field here is sufficient proof that the smallness of imports is not due to a sheltering tariff wall. The Siemens & Halske corporation of Germany, fourth in the list of the world's greatest electrical manufacturing companies, and which turns out not only large power equipments, motors, incandescent lamps, etc., but also manufactures telephone apparatus, started a factory in the central West some years ago, but abandoned it after operating several years at a loss. Another large and successful telephone manufacturer from abroad opened a factory in the United States but its activities were never large nor its career prosperous.

"Counter invasions of foreign countries by Americans have met with better success, although our foreign ventures have never grown so large or proved as prosperous as the home enterprises. The General Electric Company has a plant in England and for years has enjoyed a large and growing export business. The Western Electric Company has also built up a large export business in its lines. The development of that company's foreign business, has, however, been peculiar. The Western Electric Company is principally a manufacturer of telephone apparatus, and since in Europe and many other foreign countries, the governments operate the telephone service, they have been the chief if not only customers for telephone apparatus.

"On account of the policy of most foreign governments of purchasing only from home manufacturers, it has been necessary for the Western Electric Company to build many factories abroad. It has plants in England, Germany, France, Belgium, Austria, Hungary, Russia, Italy, Japan and Canada. The Westinghouse Electric & Manufacturing Company has plants at Manchester, England; Harve, France; Ligure, Italy; Vienna, Austria; St. Petersburg, Russia, and at Hamilton, Canada. The company's foreign business suffered from the same causes that exerted an unfavorable influence on its affairs here, namely, over-expansion, but since its reorganization the foreign investments are getting into better shape. The St. Petersburg plant, however, is in process of liquidation.

"This country leads in electric manufacturing because we have never lost our position as pioneers in electric invention and development and also because the high efficiency of American labor is second to none in the world."

President E. C. Deal of Southeastern Section Elected Vice-President of N. E. L. A.

Through a constitutional amendment adopted at the recent Chicago convention of the National Electric Light Association, two additional vice-presidencies were created, making the executive staff include four of these officers. For one of these new positions Mr. E. C. Deal, president of the Southeastern Section of the association was chosen. While the Southeastern Section is officially not five months old, yet the activities of the agencies back of the movement in the persons of the past presidents of the Georgia State Section combined with the strenuous work, official and personal of President Deal in bringing the organization of the Southeastern Section into actual being, has created such interest in the Section that the recognition of this activity in the South and the honor tendered to President Deal by the National Organization is decidedly merited.

Referring to this activity, General Secretary Martin is responsible for the following remarks in the first issue of the Convention Daily distributed at the convention, appearing under the heading of "Organization of Territorial Groups:" "The tendency seems to be in the association rather toward the organization of group associations than the creation or merging of individual state bodies. The New England Section is a notable example of success in this direction and it was followed in 1911-12 by the affiliation of the Great Northwestern Association with several states in one group; and now during the current year it has been followed again by the creation of the Southeastern Section with its vast area of five Southern states stretching down the Atlantic seaboard."

Mr. Deal as a vice-president of the National body is well fitted to look after Southern central station interests on behalf of the stations as well as the association due to his familiarity with the needs of the section and his experience in association work along varied lines. He has been connected with the N. E. L. A. affairs through membership and in other capacities for the past fourteen years, having served the past two years as a member of the committee on organization of industry and at the same time been actively identified with the work of the American Street Railway Association serving at present as a member of the fair committee. Mr. Deal's experience in the central station field has also been varied both as to capacities and location, having been responsible for management of different properties for the Stone & Webster organization, the W. N. Coler interests, and J. G. White & Co. He was for sometime identified with the Coler interests which included forty municipalities in New Jersey, now organized as the Public Service Company of New Jersey, and later managed the North Carolina properties of the same concern. In 1911 he became connected with J. G. White & Co., Inc., of New York City as general manager of the electric properties about Augusta, Georgia, controlled by the Augusta-Aiken Railway & Electric Corporation to which concern he has recently been elected vice-president. As a manager of public service properties, Mr. Deal is known for progressiveness of policy and thoroughness of administration along modern lines, having built up every property with which he has been connected, both physically and in the opinion of its customers. We are proud of the fact that his influence and ability have been recognized by the association and that he will direct the interests of the South in N. E. L. A. affairs.

The interests of stations in the states of Georgia, North and South Carolina, Florida and Alabama, are now centered on the first convention of the Southeastern Section to be held in Macon August 14th, 15th and 16th. Plans are now well underway and not only a profitable meeting, but the largest gathering of Southern central station men is assured.

A New N. E. L. A. Publication—Rate Research.

Within the year a new publication, *Rate Research,* published by the Rate Research Committee of the National Electric Light Association, has entered the technical field and is doing a good work in compiling and digesting the decisions of the courts and commissions upon matters relating to the public service regulation of electric properties. This committee started out over a year ago to supply certain members of the National Electric Light Association with current information upon this subject, and the need of a regular printed publication manifested itself.

The committee has just completed its first printed volume, which is No. 2, containing 420 pages, the last number being a complete classification and index, which renders all of the information readily available. This index is probably the best bibliography of rate regulation information that is published and should be very beneficial in preparing briefs and other memoranda upon regulation matters. One interesting feature of this publication is the fact that it is not published for profit and carries no advertising, and therefore is, in no sense, a rival of the technical papers. It supplements the work that such papers are doing by calling attention to all of the important articles which such papers publish on the subject of rate regulation. It is pleasant to record that the publication has been given a warm welcome, as the committee announces that it is already on a self-supporting basis.

Wire for Long Distance Transmission.

The use of aluminum wire as a conductor in long-distance power-transmission schemes is not new, but recent departures from the ordinary practice bids fair to enlarge this application of the metal. It is reported that a steel reinforced aluminum cable, consisting in all of seven strands, has been placed upon the market. The six outer strands are made of aluminum and the inner strand is made of steel of very high tensile strength. It is asserted that this conductor both transmits the electric current and has the requisite strength for use on steel towers which are rapidly displacing poles for transmission lines. The Pacific Light & Power Co., of Los Angeles, Cal., has adopted this product for its new transmission line.

Report of Chicago National Electric Light Association Convention

(*Reported Exclusively for* ELECTRICAL ENGINEERING.)

The 36th convention of the National Electric Light Association held in Chicago June 2 to 6 has now become history and will occupy an important place in the annals of the association. The total attendance while breaking no record was such as to be thoroughly representative of the industry, the total registration being 4,077, the largest attendance with the exception of the New York convention when this figure was 5,150. Throughout the four days during which 18 sessions were held, ideal weather conditions obtained, a feature which enabled the carrying out of all the plans as originally made, including the holding of tent sessions with equal success to those held in the assembly rooms o fthe Medinah Temple.

This year the manufacturing companies and other Class D. companies displaying apparatus at the convention were handicapped by the nature of the exhibit hall. This hall was located in the basement of the Temple and had a very low ceiling making necesary special arrangements for lighting and schemes to overcome the distance of less than nine feet between floor and ceiling in order to make the displays show up for what they were worth. For all of this, however, the general opinion was that the displays were up to the convention standard, some 68 booths being ocupied. A list of exhibitors is found elsewhere in this issue

Acording to regular custom, the convention was formerly opened by reception to the president, followed by a dance and the throwing open of the exhibits of Class D members for inspection. The real convention work began Tuesday morning and was carried on practically as scheduled, the last session being held late Friday afternoon.

J. B. McCALL, PRESIDENT PHILADELPHIA ELECTRIC COMPANY, ELECTED PRESIDENT OF N. E. L. A.

In what follows a brief report is given presenting the nature of business and the important features of papers and discussions. The actual order of events at the convention will not be followed in this report as it seems most convenient and advantageous to readers to review the subjects according to their general divisions and nature. The report will therefore follow the general plan of the program outlined in the June convention issue of *Electrical Engineering.*

N. E. L. A. PRESIDENT, 1913-14.

The president-elect of the National Electric Light Association, Mr. Joseph B. McCall, is president of the Philadelphia Electric Company, and has spent practically his entire life in the management of public utility properties. He was born in New York City in 1870, and early became connected with the Pennsylvania Globe Gas Light Company, becoming secretary of the company. He later helped organize the Pennsylvania Heat, Light & Power Co., in 1895 and became its secretary and treasurer. This company was absorbed by the Pennsylvania Manufacturing Light and Power Co., and Mr. McCall made its president. When this company was again absorbed by the Philadelphia Electric Co., in 1889 he was elected president of the corporation. While Mr. McCall has devoted little of his time to outside interests, he has served as president of the the association of Edison Illuminating Companies, during the period between 1904 and 1907, and is a member of the American Institute of Electrical Engineers, the Franklin Institute, and several clubs of Philadelphia.

ENTERTAINMENT FEATURES.

The entertainment features of the Chicago convention were elaborately planned and well carried out. These features included entertainment for both gentlemen and ladies attending the convention. On Tuesday a musical was held at the Blackstone Hotel, and on Tuesday night a circus vaudeville entertainment by the Commonwealth Edison Co., in the auditorium of Medinah Temple. On Wednesday afternoon excursions to the Hawthorne Works of the Western Electric Co., and to the Northwest generating station of the Commonwealth Edison Co. The annual baseball game between the New York Edison Co., and the Commonwealth Edison Co. was held on the baseball grounds of the Edison Company, the score being 6 to 1 in favor the New York team. On Wednesday afternoon also an excursion was made to the hydro-electric plant of the sanitary district, the electric freight tramway tunnels of the Chicago Tunnel Co. and stockyards. On Thursday an excursion was made to the steel works of the Indiana Steel Company of Gary, Ind., and in the morning an automobile ride along the North shore of Lake Michigan given the visiting ladies.

REJUVENATION OF JOVIAN ORDER.

On Thursday evening a decidedly successful rejuvena tion of the Jovian Order took place at White City, when 200 candidates were initiated and a successful dinner held.

General Sessions.

With the welcoming address by Hon. Lawrence E. McGann, commissioner of public works of Chicago, at 10:30 Tuesday morning, the real convention work began. The speaker was introduced by President F. M. Tait, who explained that Mayor Carter Harrison was unable to be present. In welcoming the convention delegates and guests to the city Mr. McGann's remarks were particularly fitting. Especially interesting were his comments on electrical activity in Chicago, which included the lighting of public streets and how such lighting has served as a measure of protection. He referred to the work of the association in standardizing and classifying accounts, contending that inasmuch as a great part of electric lighting business is conducted with municipalities, the public is entitled to much consideration.

PRESIDENT TAIT'S ADDRESS.

Following this address Vice-President J. B. McCall took the chair while President Tait delivered his presidential address. This address as in times passed was especially interesting as it forms a record of the important features of convention work for the year. President Tait reminded the convention that this meeting in Chicago was the seventh to be held in the city, the last one being in 1908. At that time the total membership was 1,327 a decided contrast with the present membership of 12,442, showing a gain of 846 per cent in five years. He referred to the special efforts put forth to place the main office of the association on an efficient operating basis, and the appointment of an assistant secretary to assist Mr. Martin in his work. He repeated the suggestion of the former presidents that the number of vice-presidents be increased from two to four so that the responsibility of the administration would have a wider and more general distribution. The expansion and increased value of the monthly bulletin and question box was touched upon and credit given to the editor and his assistants for their capable work. In regard to the lecture bureau recently established, Mr. Tait announced that 27 lectures on various subjects interesting to the electric service industry are available and that greater use should be made of the bureau. The company sections and others may have the benefit of these lectures and interesting addresses.

Three new company sections and one geographical section have formed during the past year, the company sections being the Pacific Gas & Electric Co., the Northern Illinois Utilities Company of Chicago and the Roanoke Railway & Light Co., of Roanoke, Va. The new geographical is section is known as the Southeastern Section, an enlargement of the Georgia State section, embracing the states of Georgia, North and South Carolina, Florida and Alabama. President Tait referred particularly to the work of a large number of able committees and to the commercial section work which has been active and responsible for much valuable information in regard to electrical service for the farm. The interesting work of the hydro-electric and power transmission section was mentioned.

In order to further increase the efficiency of the hydro-electric and power transmission section, President Taft recommended that the work of this section be closely associated with that of the technical committee, eventually developing into a national special session to be called the "Technical Session," and to embrace the whole technical endeavor of the society. This suggestion was given as one for increasing membership and the benefits from the work of all connected, rather than as a criticism of its present arrangement and the same plan was suggested in reference to the subject of accounting.

President Tait believes that the last year has demonstrated a more friendly understanding between member companies and the various state public utility commissions having jurisdiction over the companies. Rates are being steadily reduced by member companies and service becoming cheaper. The work of the rate research committee was complimented as very helpful. The association work on resuscitation from shock President Tait mentioned, voicing the opinion that nothing has been done under the auspices of the N. E. L. A. that has attracted such wide and favorable attention. Over 100,000 copies of the booklet and chart have been issued to date and the demand continues.

In the past year the consolidating of various companies or groups of companies and interlocking them with parent companies has continued and said President Tait, much good has resulted to the territories served. He further mentioned that the rate of growth of the various central station companies seems to have been well up toward normal and that the association has cause to feel that the past year has been a satisfactory one.

The next subject taken up was the report of the committee on organization of the industry by H. H. Scott, of New York City. This report showed the membership as 12,442 consisting of Class A. 1,093; Class B. 10,256; Class C. 53, Class D. 242; Class E. 798. There are 42 company sections with an approximate membership of 8,400, five new sections having been formed during the year. While the Class A. membership shows a decrease of 43 over last year, due to the fact that there has been 118 registrations due to consolidated of properties, the membership of the 42 company sections is 8,400 as compared with 7,700 from the 37 company sections of last year.

The report of Secretary T. C. Martin outlined the detail work handled at the main or New York office. He showed that the association sold or distributed last year, an excess of 39,000 copies of the miscellaneous publications issued, exclusive of 4,000 copies of old Electrical Solicitor's Handbooks, over 1,100 copies of the report of overhead line construction committee, and a large number of copies of classification of accounts and question box revisions. Last year nearly 3,000 copies of the meterman's handbook were sold, and it is anticipated that the entire edition of 5,000 copies will be disposed of by the end of this year. 85,000 copies of the chart and booklet on resuscitation from shock have been circulated, a work which has brought great credit to the association. A special piece of statistical work mentioned in the secretary's report was the compilation and classification of some 10,000 forms and blanks used in the central station business. Secretary Martin showed that of an income of $100,000 more than 50 per cent is spent on publications and about $20,000 on the convention, the remainder being left for maintenance of headquarters and regular work of the association, which is scarcely adequate.

The report of the insurance expert by H. H. Blood, Jr., of Boston, made known the fact that during the year, the industry has been comparatively free from annoyance of litigation brought by insurance companies. This is attributed to better construction and the insurance companies realizing the importance and solidarity of the national organization. Mr. Blood recommended the employment of inspection bureaus to look after properties of lighting companies both from a fire hazard and accident standpoint.

The report of the committee on progress by Secretary T. C. Martin contained its usual amount of interesting and history-making data for the association and the central station industry. Perhaps no report is looked forward to with more interest than the one that has been given the members of the industry by Mr. Martin for so many years. This report is further appreciated because it comes from one who is vitally connected with all features of the work. Mr. Martin's 1913 report is divided into two portions, one dealing with general progress and the other with progress in hydro-electric and transmission fields. It is useless to endeavor to present a review of this report in the space here available, but we advise all who are interested in the central station industry generally to secure a copy of this excellent work. In brief, the report takes up the many subjects affecting the industry in its relation to the public, such as conservation, extensions of public commission regulation, the nature of decisions affecting the industry as to rates and character of service, the advance in engineering in generating stations, the use of electricity in different fields and the development of new fields of activity as in the electric vehicle, ice and refrigeration fields. Another part of the report is devoted to relations existing between companies and their employes, and another to illuminants of the day, and progress made in the art illustrated by examples. The main part of the report contained 103 pages.

The next subject taken up was a paper on "Anticipation," by Paul Lupke, of Trenton, N. J. This paper gave excellent information to the younger members of the industry as well as to the older ones. The author touched upon education, discussing its importance. He echoed the statement of his boss, that "the man who cannot do his stunts with a smile on his face, I won't have in my organization. He sours the dough." This paper was one of advice on advantages of thrift as well as on making of investments, closing with an appeal for that enthusiasm which is inspired by anticipation and which is one of the opportunities of youth.

The report of the Question Box was presented by S. A. Sewell, assistant to the secretary and took up the details in connection with preparing the bulletin since the work has been taken over by the association. Mr. Sewell urged the smaller members of the association to make more use of the question box.

SECOND GENERAL SESSION.

The first paper of the second general session, held immediately after the hydro-electric and transmission session shortly before noon Wednesday, was one dealing with the application of central station service in mines and delivered by W. A. Thomas, of the Westinghouse Electric & Manufacturing Company, of Pittsburg. This paper analyzed costs in an average isolated plant supplying electricity for mine service and showed the general character of mining loads and the probable requirements on a tonnage output basis.

J. E. Kearns, of the General Electric Company, next read a paper on "Switching Apparatus for Rural Installations," prepared by E. B. Merriam, of the same company. This paper pointed out that recent outdoor switching apparatus has opened to central stations a wide field for application of service in small towns, mines, quarries, farms, etc. This equipment comprises semi-portable and portable sub-stations, for supplying energy from existing high tension transmission lines.

The last paper of this session took up central station service in small towns of 5,000 inhabitants, or less, this paper being prepared and read by J. E. Kearns, of the General Electric Company. The scheme presented by the author was to consolidate several small stations and distribute energy from one main central station through substations containing modern apparatus. A method for doing this was presented and the necessary information to determine whether or not a proposed consolidation would be profitable.

EXECUTIVE SESSION.

At the close of the second general session on Wednesday an executive session was held when proposed constitutional amendments were presented, and the report of the treasurer and the necessary nominating committees appointed, as well as a committee on resolutions.

JOHN A. BRITTAIN, VICE-PRESIDENT AND GENERAL MANAGER PACIFIC GAS AND ELECTRIC CO., ELECTED A VICE-PRESIDENT N. E. L. A.

The report of the treasurer, W. W. Freeman, of Birmingham, showed for the fiscal year of 1912 a revenue of \$132,255, and expenditures of \$113,133, leaving a surplus of \$19,121. The gross assets of the association at the end of the year were \$50,331 and the liabilities \$28,430, leaving \$21,900 of which \$15,063 is invested in bonds of public service companies, the remainder being in cash.

THIRD GENERAL SESSION.

The third general session was held Friday morning and opened with the report of the rate research committee, by E. W. Lloyd, of Chicago, its chairman. This report took up a discussion of existing schedules of some of the larger companies and embraced practically every type of electric rate it being the object of the committee to show that while rates may differ to a great extent they can be presented in an absolutely uniform manner and in a way as to be clear and concise. The committee recommended and criticised certain schedules of various companies in its report. The report is a very valuable one and should receive the attention of member companies.

Following the rate research report, Preston S. Miller, of New York, read the report of the street lighting committee, of which John W. Lieb, of New York, was chairman. This report took up a review of the history of street lighting specifications and discussed the various measures of illuminating power of street lamps which have been proposed. It also gave recommendations regarding the contract basis for street lighting. In its recommendations the committee outlined the nature of street lighting contracts best suited to central station conditions.

Flame Arc Lamps and Recent Developments Thereof, by W. A. Darrah, of Pittsburg, was the subject of a paper next presented. The author took up the design of flame arc lamps from the viewpoint of the operating and central station man, discussing the mechanical and electrical features. Operating conditions were especially noted and the paper illustrated with views of lamps and mechanisms showing up the performance of arc lamps.

A paper on Advantages of Copper Clad Wire for Series Arc Lighting, was next read by T. K. Stevenson, of New York. The author showed that the economical size and type of wire to be most efficient as a conductor for overhead circuits must meet electrical requirements as to conductivity and mechanical requirements as to strength. The properties of copper clad wire were discussed briefly, mentioning its use for telephone circuits and for power transmission circuits carrying small loads at high voltage. For long spans, such as river crossings, it was mentioned as particularly applicable. In electric railway construction it is used both for span and trolley wire and for messenger and catenary construction.

Following Mr. Steven's paper the report of the committee on underground construction was presented by its chairman, W. L. Abbott, of Chicago. This report took high tension transmission cables and discussed periodic testing, carrying capacity, graded insulation, conductors, current-limiting reactance, protection of cables in manholes, parallel routes, trouble reports, practical hints as to operation and specifications for paper and rubber-insulated cables for underground operating pressures.

Following this report, J. W. Wakeman, general manager of the Society for Electrical Development, outlined the work of the society and gave its plans in some detail. In the discussion following Mr. Wakeman's remarks, Henry L. Dougherty, of New York, discussed further the work of the society and the results that may come from it. He was very optimistic in regard to the benefits of the society for central stations.

FOURTH GENERAL SESSION.

The fourth general and combined technical session was the last convention meeting and held Friday afternoon. This session opened with a report of the committee on amendments to the constitution presented by F. W. Frueauff. The amendments called for the establishment of seven classes of membership including a foreign membership class. Four vice-presidents are hereafter to be elected instead of two. The bulletin of the association is to be a monthly publication issued at the direction of the secretary and to bear a subscription price of $3.00.

OFFICERS FOR 1913-14.

The report of the nominating committee was next presented and the following officers elected: President, Joseph B. McCall, president of the Philadelphia Electric Co., of Philadelphia, Pa.; treasurer, W. M. Wells, of the Edison Illuminating Co., of Brooklyn, N. C.; vice-presidents, John R. Britton, of the Pacific Gas & Electric Co., San Francisco, Cal.; H. H. Scott, H. L. Doherty & Co., New York City; E. W. Lloyd, Commonwealth Edison Co., of Chicago, and E. C. Deal, Augusta-Aiken Railway & Electric Corporation, Augusta, Ga. The members of the executive committee are W. C. L. Eglin, W. W. Ryerson, R. S. Orr, H. C. Able, and A. C. Einstein.

Following the election of officers the report of the committee on award of the Doherty gold medal was presented by W. F. Wells, of Brooklyn. This medal was awarded to T. F. Bloodworth, of the New York Company Section for a paper entitled, "Adaptability to Service."

A lecture on "Light and Art," by M. Luckiesch, of the National Quality Lamp Division of the General Electric Company, of Cleveland, Ohio, was next presented, followed by a paper entitled, "Transformers and Power Transmission," by H. H. Rudd, of Pittsburg. This paper took up the development of outdoor transformers and the necessary switching and protective devices, cost data being presented for the installation of different capacities and various voltages. The economical voltage for transmission lines feeding a number of small communities was shown to be 22,000 to 33,000. The author recommended the standardization of transformer design as regard taps, and believed that much good would come to the industry and to the manufacturer.

Railway Load for Central Stations, was the subject of the next paper read by E. P. Dillon, of Pittsburg. The author showed the combined requirements of railway systems and power systems served from one generating system. He mentioned the fact that improvements in transformer apparatus, notably 60-cycle rotary converters, were strong factors in developing this business as practically all companies which have a light and power load are now operating at 60 cycles. Typical load curves were shown indicating improvements in load factor as a result of combining railway load with light and power load.

The address scheduled under the heading of "Life Hazard of High Tension Lines," to be given by Dr. S. W. Stratton, of the United States Bureau of Standards, Washington, D. C., was presented by Dr. E. B. Rosa. The speaker outlined the work of the Bureau of Standards in investigating the life hazard of high tension lines, with an idea of securing advice from authoritative sources and preparing comprehensive data on the subject. A set of rules will be prepared for the purpose of guiding operators in safeguarding their systems and employes in safeguarding their own work.

Following this lecture, reports of the committee on the president's address as well as on resolutions were presented. The committee on resolutions extended thanks to the various members of the association and outside parties that had given assistance in making the convention the success it had been, as well as to the central station companies that had so generously contributed to every need of the convention.

Public Policy Session.

The one session which seemed to be set down by the various members as decidedly successful was the public policy session, held Wednesday evening. At this session the report of the public policy committee was presented by Samuel Insull, president of the Commonwealth Edison Company. This report took up the work of the year done by the committee under the direction of Arthur Williams, its chairman. The committee through its report voiced the feeling that when an electrical corporation is rendering good service at fair prices, treating its employes fairly, and otherwise holding itself in alignment with the public, it should be protected against destructive competition. It also went on record as favoring adequate compensation for employes of the industry at all times. The service-annuity plan of the Edison Electric Illuminating Company, of Boston, was outlined in detail. Safety and sanitation, accident compensation, important commission and court decisions, relations with other associates, states and municipal ownership, the proposed New York state hydro-electric development and commercial education were topics touched upon. In concluding the report, the committee has the following to say: "Much good can be accomplished in continuing our policy of the past in approaching problems in a spirit of earnest interest, fair play, mutual good will and sincere regard for those associated with us in the conduct of the industry—all with a determination to render unto others that which we would have others render unto us."

Following the report of the public policy committee, W. L. C. Eglin, of the Philadelphia Electric Company, presented the report of the commission on resuscitation from electric shock. The report took up detailed descriptions of several of the devices producing artificial respiration and illustrated with lantern slides a demonstration of resuscitating a victim.

H. H. Scott, H. L. Doherty Company, Elected a Vice-President of N. E. L. A.

J. B. Douglass, of the United Gas Improvement Company, of Philadelphia, Pa., closed the session with an illustrated lecture on the subject of accident prevention in public utilities. He pointed out that by prevention methods accident costs can be reduced from 30 to 40 per cent. He showed common hazards about utility plants and simple methods and means to eliminate sources of accident.

Technical Sessions.

The first session opened at 2:35 p. m., on Tuesday with Vice-President J. B. McCall presiding. The first matter presented was the report of the meter committee by chairman W. H. Fellows, of Washington, D. C. This report contained 47 pages and was a complete review of the work of the committee during the past year. An investigation of metering rapidly fluctuating loads made by the committee showed that the error in measuring the energy consumed by flashing signs, welding machines, etc., falls under one and one-half percent, except in extreme cases. The report gave descriptions of latest meter developments and the information for future revision of the meterman's handbook. With this report the third edition of the code for electrical testing meters was submitted. This report contained nine sections devoted to definitions, standards and measuring instruments, metering, specifications, installation methods, test and maintenance methods.

The report was discussed by Messrs. J. C. Parker, Rochester, N. Y.; F. G. Vaughn, Schenectady, N. Y.; and C. W. Wilder, New York City. The importance of securing a satisfactory demand meter was pointed out, it being explained that such a device is more desirable from the monetary standpoint than improvements of a small percentage in the accuracy of Kw.-hour meters.

The report on grounding secondaries was next presented by W. H. Blood, Jr., of Boston. This report stated that the revised National Electrical Code now requires the grounding of secondary circuits of 50 volts. The author suggested that all companies adopt this practice in anticipation of the code ruling and emphasized the practical importance of permanent and efficient grounds.

The report of the lamp committee was presented by its chairman Frank W. Smith, of New York City, and showed the declining popularity of the carbon lamps, giving statistics showing the increased sales of tungsten lamps in 1912.

"New Incandescent Lamp Development" was the subject of a paper next presented by J. E. Randall, of Cleveland, Ohio. This paper pointed out the increase in efficiency of 0.15 watts per candle power secured on the larger sizes of lamps by use of chemicals, retarding the blackening of bulbs. It was shown that this enabled smaller bulbs for a given wattage to be used and enlarges the field of usefulness of such lamps. This paper, as well as the report of the lamp committee were discussed jointly by Messrs. J. W. Howell, of Harrison, N. J., and E. W. Willcox, of New York, and Norman Macbeth, of New York. It was pointed out that 60 and 100 lamps give double the light and efficiency of a year ago. The ten watt standard voltage lamp is five times as good as a year ago. Mr. Wilcox gave a resume of the last two years progress in Great Britain in the application of tungsten lamps and Norman Macbeth urged the importance of rating lamps on the basis of total light output.

The report of the committee on measurement and values was presented by Dr. C. P. Steinmetz, of Schenectady, N. Y., on account of the absence of Chairman Kennelly. This report discussed the latest recommendations of engineering societies in regard to abandonment of the horsepower unit and substitution therefor. The report made no specific recommendation.

The paper entitled, "Incandescent Lamp and Its Relation to Lighting Service," by R. E. Campbell and W. C. Cooper, of Cleveland, Ohio, took up voltage drop in interior wire installations and showed the need of greater attention to problems of wiring in order to extend the use of energy consuming devices. In the discussion following the paper the importance of greater co-operation with architects in laying out wiring installations was mentioned.

SECOND TECHNICAL SESSION.

The second technical session was held Thursday morning, Chairman W. C. L. Eglin presiding. The report of the committee on prime movers, presented by I. E. Moultrop, of Boston, was the first business. This report outlined the development of the steam turbine and auxiliary apparatus during the year and gave the status of the fuel oil situation. The advance of the high pressure steam turbine both for main and auxiliary service was mentioned, and the opinion expressed that the gradual abandonment of the steam engine will do away with the low pressure turbine as a factor in central station work. Considerable attention was given to efficiency of condensers and other auxiliary station apparatus.

The report of the committee on electrical apparatus was next presented by Chairman L. L. Elden, of Boston. This report took up the latest developments in generators, exciters, motor converters, transformers, regulating apparatus and other commercial equipment. The discussion brought up the question of noisy operation of sub-station machinery and the opinion stated that there is room for progress in this direction.

F. B. H. Paine, of Buffalo, N. Y., presented the report of the committee on overhead line construction in the absence of Chairman Osgood. This report presented full specifications for overhead crossings of electric light and power lines and signaling circuits involving protection against 5,000-volt potentials and over. Information was also included regarding sags, factors of safety in line construction, conductors, insulators, poles, foundations, galvanizing, properties of wire, and other data of engineering interest. The discussion brought out the fact that the specifications could not be adopted in certain sections, yet the speakers regarded the material as of decided interest and chiefly as a working guide.

Paul MacGahan, of Pittsburg, Pa., next presented a paper outlining the desirable features of switchboard instruments and emphasizing the space economies of induction types of instruments and their freedom from influence by stray fields.

The Latest Developments in Distributing Transformers was the subject of a paper presented by E. G. Reed, of Pittsburg, in which improvements in distributing transformers were outlined. It was pointed out that betterments result from the use of a guttered winding with a machine type of coil, the use of improved machine-formed insulating barriers, and arrangement of oil circulating ducts.

W. R. Abbott, in the absence of the author, Anguss Hibbard, of New York, read a paper describing the use of telephone service in the load dispatching of the New York Edison Company's system.

Hydro-Electric and Transmission Sessions.

The first hydro-electric and transmission session was held Wednesday morning, Past President W. W. Freeman, presiding. Chairman W. N. Ryerson, in his report which opened the session, voiced the belief that public opinion is slowly being molded in the right direction and that there are signs of more enlightened conservation policy on the part of the government. The report touched upon evils of overcapitalization.

The report of the membership committee was read by Chairman R. J. McClellan, of New York, and showed that there are at present 65 members with a vigorous campaign for increasing the membership. The country has been divided into four geographical sections with a vice-chairman in charge of each district.

Secretary Conklin read the paper on "Failure of Conservation to Conserve," in the absence of the author, E. H. Thomas, of Seattle. This paper severely arraigned the conservation policies sponsored by Mr. Pinchot and maintained by the government with restrictive effect in connection with water powers on public lands. The author ridiculed the idea of a water-power trust control in the hydro-electric field. A discussion followed in which D. B. Rushmore, of Schenectady, mentioned the need of educating the public to a real understanding of the situation and advocated closer relations between citizens and government representatives in dealing with these problems.

Secretary T. C. Martin's progress report in connection with the hydro-electric section reviewed the year's events in regard to conservation policies and other hydro-electric matters. The report also touched upon features of engineering design in connection with water power plants. In the discussion following the report, Dr. Steinmetz gave an interesting resume of the relative value of A. C. and polyphase transmission, showing that in a majority of cases A. C. methods are best.

I. E. Moultrop abstracted the report of the committee on hydraulic turbines in the absence of Chairman J. E. Vaughan, of the sub-committee on prime movers. The improvements in water wheel design, testing of water wheels and forms of stop and relief valves were discussed.

A paper was next presented by Albert Kingferry, of Pittsburg, on a new thrust bearing of which he is the inventor. Service tests and data were given to show the application of the design to eliminate the objections of vertical shaft turbines.

SECOND HYDRO-ELECTRIC AND TRANSMISSION SESSION.

The second session of the hydro-electric and transmission section was held Thursday afternoon and the first paper presented by R. A. Griffin on poles and pole preservation. This paper took up the physical characteristics of trees with reference to chestnut and cedar as pole material. It was shown that electric light and power companies now purchase poles at the rate of 700,000 a year and that the total production in this country is about one-fifth of the consumption. The author pointed out that any coal tar creosote passing the association specifications can be used. It is only necessary with the brush treatment to apply the preservative to points not over two feet above and below the ground line. Two coats of oil on a 30-foot butt require about 0.5 gallons of preservative.

Protection Against Lightning, was the subject of a paper delivered by E. E. Creighton, of Schenectady, N. Y., in which the author took up common apparatus, such as multigap arresters and so-called compression chamber arresters and aluminum cell equipment. The advantages of pipe grounds and overhead ground wires were also taken up.

D. B. Rushmore, chairman of the committee on operation of hydro-electric systems, presented the report of the committee, setting forth the efforts now being made to insure reliable and uninterrupted service. The report touched upon the efficiency of operating forces, communication, system layout, load characteristics and water conditions. The considerations involved in the selection of hydro-electric station apparatus given considerable space.

A paper accompanied with lantern slide illustrations was next presented by A. O. Austin, of the Ohio Brass Company, New York, taking up results of tests of suspension type insulators under varying temperature conditions, frequencies and mechanical loads.

Hugh L. Cooper, chief engineer of the Mississippi River Power, at this session delivered an illustrated lecture on the development at Keokuk, Iowa.

THIRD HYDRO-ELECTRIC AND POWER TRANSMISSION SESSION.

The third session of the hydro-electric and transmission section was held Friday morning, H. H. Scott, presiding. The session was opened with a report of the committee on receiving apparatus, read by W. N. Ryerson in the absence of the chairman, M. R. Bump. The report was short and showed a considerable work to be done in order to secure the necessary co-operation to carry out the work already laid before it.

L. A. McArthur, chairman of the committee on distribution lines, next read the report of his committee. The systems considered and the construction touched upon showed principally the practice of Western states. Voltages to be used and connections of transformers, the use of direct current and batteries were subjects touched upon. The relation of gross income to cost of investments in new line extensions was touched upon in connection with long time contracts with customers. The discussion brought out the fact that long spacing of poles of from 300 to 400 feet when using 35-foot poles gives excellent results in the San Joaquin Valley.

Developments in Protective Apparatus, was the subject of a paper next presented by J. M. Mahoney, of Pittsburg. This paper took up oil and carbon circuit breakers and lightning arresters now in general use and described various types and sizes to meet various breaking capacity requirements at voltages up to 165,000 and conducting capacities up to 4,000 amperes. The author pointed out that aluminum electrolytic arresters have displaced all others for severe service.

Following Mr. Mahoney's paper, R. D. Coombes presented a paper on Transmission Line Construction. The author discussed mainly the structural features of transmission lines, rather than electrical or operating conditions and considered the physical characteristics of the pole or tower as deserving careful attention.

The report of the committee on nominations, presented by H. H. Scott, was as follows: Chairman, W. W. Freeman; first vice-chairman, M. R. Bump; second vice-chairman, J. B. Foote, secretary, S. A. Sewell.

COMMERCIAL SESSIONS.

The first commercial session was called to order Tuesday afternoon, President Tait presiding. Vice-Chairman W. E. Lloyd, of Chicago, in his address as chairman of the section, outlined the work of its third year and complimented the various committees for results accomplished in way of publications, co-operative advertisements, etc.

The report of the chairman of the committee on finance showed a total revenue of $5,241 received during the past year, with a balance of $502.87 on hand. Chairman J. F. Becker, of the membership committee, reported a present enrollment of 1,222 active members; 482 new members have been secured for the section during the past year and a prospective list of 2,000 names are being circulated, and a scheme of organization with state capitains is to be worked out in connection with the membership campaign during the coming year.

Mr. Samuel Insull, president of the Commonwealth Edison Company, introduced David R. Forgan, president of the National City Bank of Chicago, who delivered an address on, How to Protect Business from Disturbances Caused by Panics. Mr. Forgan's address was one of the important features of the session and presented an appeal for a more elastic currency system through a great centralized bank closely identified with the government itself. He remarked that the present administration will probably submit to Congress a central banking plan which is not dissimilar in principle from those recently proposed by expert banking commissions.

The report of the publication committee was read by Douglass Burnett, of Baltimore, Md., and showed 187,000 publications distributed during the past year. The discussion following the report was of a complimentary nature on the publication work accomplished, pointing out the need of more effective distribution among member companies.

E. W. Lloyd, General Contract Agent Commonwealth Edison Company, Elected a Vice-President N. E. L. A.

The session closed with the report of electric salesmen handbook committee by E. L. Callahan, of Chicago. A collection of loose leaf data containing some 338 compilations was prepared during the past year in addition to 64 abstracts, making in all 681 compilations on 175 different industries.

SECOND COMMERCIAL SESSION.

The second commercial session was opened Wednesday forenoon, E. W. Lloyd, of Chicago, presiding. In the absence of Chairman George Williams, the report of the committee on education of salesmen was presented by F. R. Jenkins, of Chicago. This report took up the requirements of successful salesmen. The training courses for salesmen by the Chicago Central Station Institute and the New York Edison Company, as well as electrical manufacturing companies, were discussed.

The report of the committee on electrical merchandizing was abstracted by T. I. Jones, of Brooklyn, N. Y. Emphasis was laid on the importance of placing the merchandizing branch of the central station on a sound basis, such that appliances may be sold at prices that will produce a profit over all cost. Trial and installment-sales methods and campaigns were discussed, it being recommended that such trial offers be limited to irons. The discussion brought out a criticism of the plan of one-day, half-price appliance sales, stating that such methods were both unbusinesslike and unnecessary. This practice was, however, defended by others.

The report of the advertising committee, presented by J. Robert Crouse, of Cleveland, Ohio, paid special attention to advertising needs and requirements of companies operating in small towns. The report took up character of copy to be used and outlined campaigns for house-wiring, heating and cooking appliances and lighting and motor-service campaigns. Co-operative electrical newspaper advertising was recommended and the use of literature prepared by the commercial section.

The last paper of the session on advertising the electric industry by means of reading matter was presented by J. G. Learned, of Chicago. The commercial value of electrical publicity through the channels of regular news matter and fiction stories of interest were brought out. The author mentioned especially articles in popular magazines as being of much value to the electrical industry.

THIRD COMMERCIAL SESSION.

The third commercial session was held Thursday morning and continued the program of the second meeting. Edward E. Witherby, of the General Vehicle Company, presented a paper on The Central Station's Greatest Opportunity, the Electric Vehicle. The author voiced the opinion that lighting companies should foster the use of electrical vehicles in their respective territories and further stated that only a small percentage of central station men are trying to help the cause. The discussion brought out interesting points in regard to electric vehicle campaigns now being carried on, as well as electric garage activity. Douglas Burnett, of Baltimore, described the garage owned by his company and stated that through its activity over 100 vehicles were in use in Baltimore. F. L. Morgan, of the Standard Electric Car Company, of Jackson, Mich., mentioned the field for the pleasure vehicle due to the large number of families in the United States that can afford a low-priced electric pleasure car. In summing up the discussion, Mr. Witherby said that 75 per cent of central stations of the West are opposed to electric vehicles and little development is insured in a neutral territory.

J. C. Parker, of Rochester, N. Y., as chairman of the committee reporting use of electricity on farms for the Eastern states, reported practically no accomplishments in extension of electric lines into rural districts. The reason given was the low density of business to be secured and lack of faith in the movement. The committee recommended that a special man study the farm problem, believing that earnest work and proper advertising will produce results. S. V. Walton, in presenting the subject of electrical development on the farm in the Western states, showed that there is a wide use of electricity for farm purposes in the states of Washington, Oregon and Colorado. In the great majority of cases the same method of distribution obtains 11,000-volt primary being run through the district and sub-stations for 11,000 volts or 2,300 volts distribution supplying the consumer. The latter furnishes the transformer and the cost of the line, yet in recent installations the farmer is only asked to pay for his motor. There is a great diversity as to rates for this service. Mr. Walton's paper was supplemented by statistics presented by S. M. Kennedy, of the Southern California Edison Company, outlining the use of electricity in California. This load is chiefly pumping and the company extends 10,000-volt lines to members of suburban pumping stations located in its territory. The transformers used in a great majority of cases are rated at 2 Kw. and step down from 10,000 to 220 volts directly.

The report of the committee in the central states on electricity used for farming purposes was presented by C. W. Pendell, of Chicago. He pointed out that the expense incurred in securing the business does not justify the central station in soliciting it. When a line is extended across the country, the farm business is picked up as a by-product. The committee showed that there are industries in rural districts which it will pay to connect up and brought out data which has not been covered by other reports to the convention.

FOURTH COMMERCIAL SESSION.

The afternoon session of the commercial session on Thursday continued the reports of the committees on electricity in rural districts read at the third session on Wednesday morning. The discussion brought to light the fact that farm circuits cannot be expected to pay at the start, and that the problems are not those of today, but those of the future. The loads to be secured in the territories were pointed out to be brick yards, stone crushers, village lighting and highway lighting.

The report of the committee on Wiring of Existing Buidings was presened by the chairman, R. S. Hale, of Boston. This report took up co-operation between central station and wiring contractors, the committee favoring the central station soliciting and securing of business, the actual work of construction to be turned over to wiring contractors. A section of the report took up the question of standardizing of plugs and receptacles, referred to the committee late in 1912. The discussion following this paper brought up the question of drop in voltage in buildings due to improper wiring, and how it affects the service on irons, lamps, etc. Wiring campaigns were touched upon and the methods of carrying them out satisfactorily.

The report of the committee on refrigeration was presented by the chairman, G. H. Jones, of Chicago, and took up various methods of making ice by means of motor driven apparatus, the committee expressing the opinion that refrigeration business should be given thoughtful consideration by central station companies. The report included much data on typical electrically driven ice plants. The discussion brought out the fact that the yearly load factor obtainable in Chicago in ice plants is 50 per cent, although the monthly load factor from April to October reaches 75 per cent.

S. M. Bushnell, of Chicago, as chairman of the committee on steam heating, presented the report. The committee went into the details of features which effect profitableness of central station steam heating plants. The discussion, however, brought out some of the unfavorable features especially where high pressure steam must be used in the system.

At the end of this session the committee on nominations made its report and T. I. Jones, of Brooklyn, elected chairman for the coming year.

Accounting Sessions.

The first accounting session was called Tuesday afternoon at 2:30, Chairman H. H. Scott, of New York City, presiding. Mr. Scott called upon E. J. Bowers, of Kansas City, Mo., to point out the features of the papers which were delivered in the meeting which followed. The report of the committee on uniform accounting was then read by Mr. Bowers. It was shown that a classification of accounts has been prepared and recommended by a sub-committee of the committee on accounts for uniform use which, if adopted, will assist in inducing the public service commission to accept same. Copies of the classification were distributed and members requested to criticise them before the next session.

A paper on Accounting School and Education of Employes, presented by A. L. Holme, of the New York Edison Company, discussed the establishing of an accounting school in conjunction with the business of the New York Edison Company, stating that its purpose is to bring out the ambitious and talented employes from the uninterested ones.

"The Method of Keeping Prepaid and Accrued Accounts," was the subject of a paper by Frank Heydecke, of Newark, N. J. The author gave numerous examples of how financial management is aided by accruing of liabilities. Also the separation and establishment of prepaid and accrued accounts relating to taxes and insurance was explained.

E. C. DEAL, VICE-PRESIDENT AND GENERAL MANAGER AUGUSTA-AIKEN RAILWAY AND ELECTRIC CORPORATION AND PRESIDENT SOUTHEASTERN SECTION, ELECTED A VICE-PRESIDENT N. E. L. A.

"Mechanical Office Appliances, Their Uses and Economies," was the subject of another paper delivered by H. E. Lohmeyer, of Baltimore. The author took up the classes of work that machines can be used upon and the actual saving of time and money resulting in the use of automatic calculators and tabulators. In the discussion, it was recommended that the cost of accounting per customer be compiled for future reference as to the advisability of installing automatic office machines.

SECOND ACCOUNTING SESSION.

The second accounting session of Wednesday morning was devoted to presenting and discussing the report of the committee on tentative classification of construction and operating accounts as prepared by J. L. Baily, of the Consolidated Gas & Electric Light Company, of Baltimore. Items of various accounts were presented and discussed individually. On account of the fact that small companies do not require an elaborate system of inticant accounts, a group of accounting divisions which could be enlarged as occasions demanded, was recommended. As to income accounts, the least number recommended for use by smaller companies was eight main divisions of operating expenses, namely, production, transmission, storage battery, distribution, utilization, commercial expense, new business and general. Income accounts should be segregated to show operating expenses to the extent that control of outgo is secured as well as the revenue in order to show that the thing sold is accounted for. A motion was made to appoint a sub-committee to report before the general accounts committee before August 1 on the classification of accounts, connected with the hydro-electric industry. It was stated that the classification of hydro-electric accounts as compiled several years ago is not up to date.

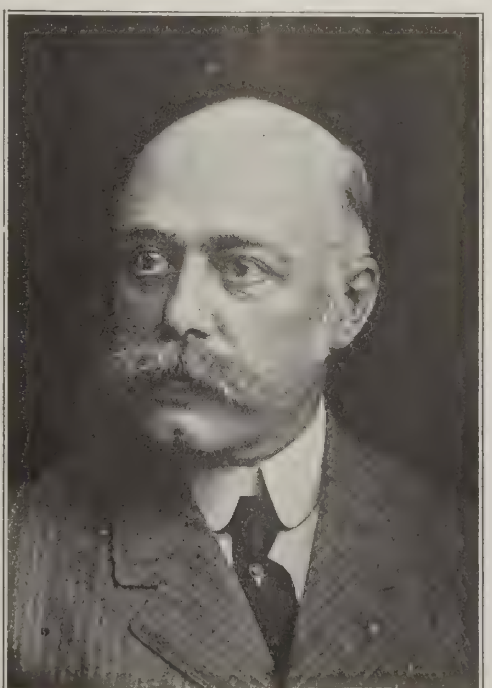
Mr. H. M. Edwards, of New York, next discussed the results of an interview with the public policy committee on the subject of depreciation. Both the public policy committee and the committee on accounting were of the opinion that the estimation of a depreciation reserve fund as well as the accrual thereof should be at the disposal of the company. Several public service commissions in appraising properties, estimate the cost of producing the properties and deduct a certain value for depreciation. In place of a depreciation fund, Mr. Edwards recommended that the property be kept up to 100 per cent value by repairs and the amount of such repairs charged to operating expenses.

THIRD ACCOUNTING SESSION.

The third and last accounting session was held Thursday morning. At this session the work of the second session held over was presented as well as the work scheduled for this session. Handling of freight bills was the subject of the first paper and was delivered by A. S. Scott, of Chicago. The report embodied a scheme devised to eliminate as many of the evils of the present methods of handling freight accounts as possible, the scheme in brief being one to pay freight bills by draft.

Accounting for Replacement of Plant Retired from Service, was the subject of a paper by F. A. Birch, of Philadelphia. This paper took up the practical conclusions reached as a result of previous consideration of the subject of depreciation. The author pointed out the tendency for large companies in absorbing small plants to charge to property accounts the construction which it does prior to merging, unless correct accounting methods are used. A review was made of operations involved in the work-order system and several forms for this system were given.

The report of a sub-committee on forms and statistical exchange was read by Mr. Herman Spœhrer, of St. Louis. A file of forms used by the various member companies and



T. C. MARTIN, EXECUTIVE SECRETARY, N. E. L. A.

compiled by the accounting committee in 1910 has been brought up to date and an effort will be made to maintain it. This file is available to all members and should be of material assistance to a company in revising forms. The forms, totaling about 10,000 copies, have been arranged in volumes which will be kept on file in the main office. A form has also been devised by means of which operating companies may send statistics to the N. E. L. A. on various classes of service. In this manner representative statistics can be compiled and furnished to any member of the company upon request.

The Relation of the Accounting Department to Other Departments of the Company, was the subject of a paper read by F. H. Patterson, of Rochester, N. Y. This paper touched upon the relations existing between the accounting committee and the board of directors, general manager and operating department.

A paper on Handling of Bond Coupons, bq W. J. Tehl, was read by F. Schmitt, of New York, in the absence of the author. The paper took up the methods in which coupons are used, paid, cancelled and entered on books and the records kept of the matured coupons and their final disposition.

Before the adjournment of this session, four resolutions were adopted, the first authorizing the accounting committee to make changes in the classification of accounts submitted in the session of Thursday, according to suggestions which were made in the discussion. J. C. Van Duyne, of Brooklyn, submitted a resolution to the effect that a committee of three, including the chairman of the accounting committee, be authorized to confer with a like committee from the public policy committee on depreciation reserves. H. M. Edwards, of New York, submitted a resolution that the accounting session be made a national session of the N. E. L. A. The fourth resolution was to the effect that all company sessions be canvassed by mail to ascertain which had not adopted a uniform accounting system.

The Characteristics of Metallic Vapor Lamps

(*Written Exclusively for* Electrical Engineering).

BY A. G. RAKESTRAW.

CONTINUING the subject of vapor lamps from the March issue, the study of that class in which the conducting medium is not a gas, commonly so called, but a vapor of some substance ordinarily solid or liquid will be taken up. To be scientifically exact we should perhaps say that this distinction between vapors and gases is made only as a matter of convenience, as there is no strict dividing line. What we term the boiling point of any substance is simply that temperature at which vaporization takes place violently through the entire mass of the liquid. Water boils at 100°C., and yet vaporizes at all temperatures, indeed, ice will vaporize at a point far below the freezing point of water. If a long glass tube be filled with mercury and inverted over a bath of the liquid, the upper part of the tube, while apparently a vacuum, will be filled with the vapor of mercury. Such a condition is called a Torricellian vacuum, and possesses some characteristics quite different from those of other rarefied gases.

When a tube containing mercury is exhausted of air, and sufficient voltage is applied by means of electrodes, the mercury vapor becomes luminous, giving forth a powerful, efficient and penetrating light. This is the principle of the mercury vapor or Cooper-Hewitt lamp. It is similar to the Moore tube, only in that it employs a glass tube filled with vapor, and provided with electrodes, and differs from it in length and shape of tube, the material employed as conductor, the auxiliary devices used in connection and the electrical and illumination performance.

The essential construction of the mercury vapor lamp is shown in Fig. 1. The glass tube is one inch in diameter and from 25 to 50 inches in length according to the voltage applied, and contains a small quantity of mercury at the lower end, which is enlarged to form a condensation chamber. The upper electrode is of iron, with platinum lead fused in. Since vapor is not a good conductor when cold, the lamp will not start on normal voltage, and some means has to be employed to overcome the initial resistance. Two methods are in use for this purpose. In the one, the tube is simply tilted until a thin stream of mercury flows along the tube and comes into contact with the positive electrode, thus closing the circuit. The tube is then immediately returned to the normal position, and as the stream of mercury breaks an arc is formed and the whole body of vapor at once becomes incandescent and continues to give light as long as normal voltage is applied. Of course, a series resistance is necessary to prevent too great a rush of current when the tube is tilted. While this operation is usually performed by hand, there are now automatic forms of this lamp, in which electromagnets are placed in series with the starting resistances and automatically tilt the lamp, releasing it as soon as the current is established. The great advantage of this is that if the current supply be momentarily interrupted, the lamp will relight itself without any attention. In the other automatic type, advantage is taken of the high voltage produced when a circuit possessing a high inductance is suddenly interrupted. In this type of lamp the current flows at starting through a small glass tube

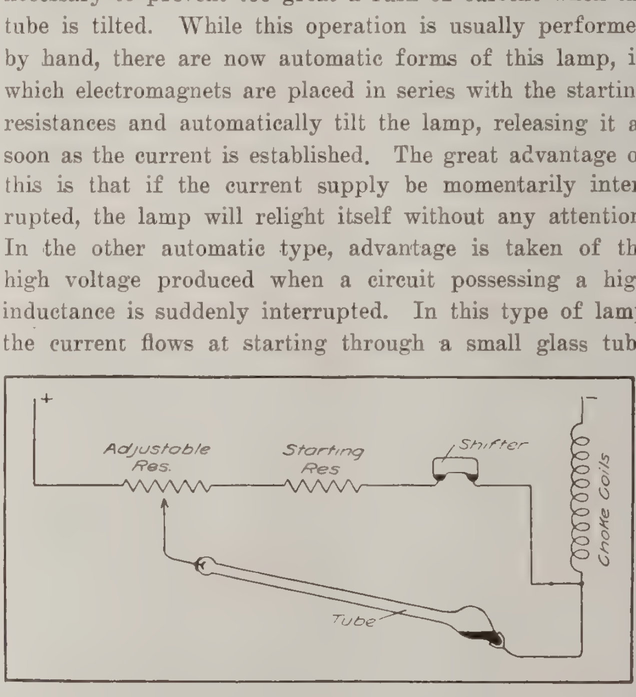


Fig. 1. Essential Construction and Connections of Mercury Vapor Lamp.

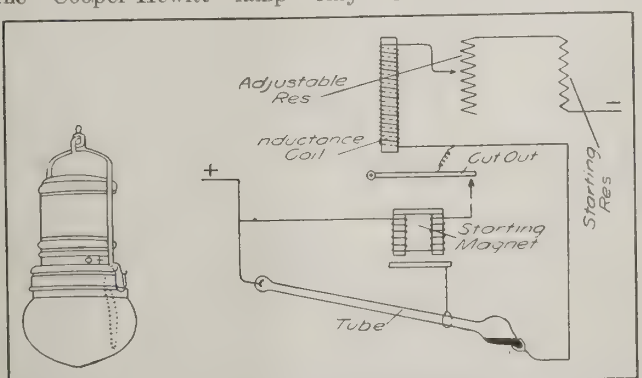
containing two electrodes and a small quantity of mercury, and then through the starting resistance and also an adjustable resistance which is used for the purpose of varying the voltage on the tube. This small glass tube is known as a shifter and when the current is applied, the choke coils attract an armature, turning this small tube in such a way as to lift the terminals out of the mercury and breaking the circuit, upon which the high voltage induced breaks down the initial resistance of the tube and the lamp continues to operate on normal voltage. As an aid in

FIG. 2. AUXILIARY OF MERCURY VAPOR LAMP.

starting there is deposited a coating of metal around the outside of the tube near the lower end, which is connected with the positive terminal. This is called the starting band, and when the reactance discharges, it acts as the one plate of a condenser, thus intensifying the effect. Fig. 2 gives a view of the auxiliary, which is a name given to that group of apparatus used in connection with the lamp proper.

As we have frequently noted, the efficiency of light units depends largely upon the temperature of the conductor, and this is true of vapor lamps as well as of those in which the light is given by a solid filament. In this type of lamp the limiting temperature must necessarily be below the melting point of glass. It is evident that if a transparent tube can be made having a higher melting point that the vapor can be run at a higher temperature, with consequently higher current density and greater efficiency. Such a material has been discovered in fused quartz.

The construction of the quartz lamp differs from the Cooper-Hewitt lamp only in that due to the higher temperature and greater current density, it is possible to use a higher voltage and a much shorter and smaller tube. Not only is the current density over ten times as much as with the glass tube, but the pressure is very much greater. The vapor in the glass tube is under a pressure of only about 2mm of mercury, while the quartz tube is operated at one atmosphere, and can be raised to two without fusing, but at this point mercury vapor begins to escape. Another advantage that quartz has over glass is that quartz is transparent to the ultra voilet rays, while glass absorbs them. This makes the



FIGS. 3 AND 4. APPEARANCE AND CONNECTIONS FOR QUARTZ LAMP.

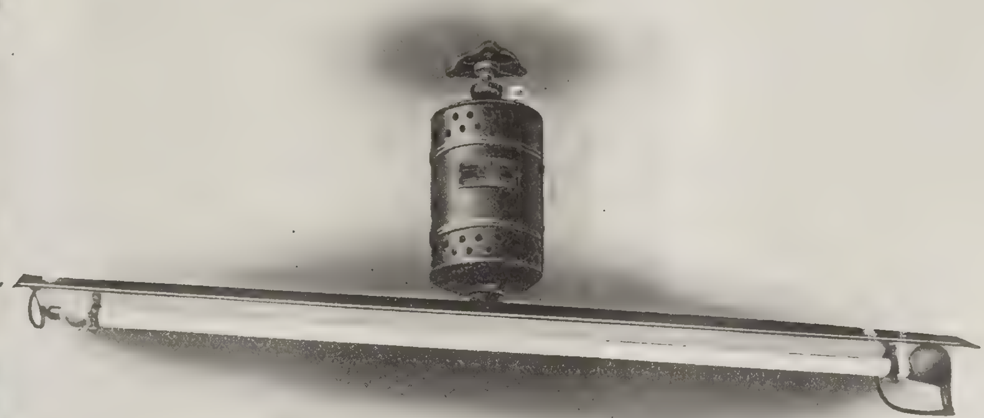


FIG. 5. THE COMPLETE MERCURY VAPOR LAMP.

glass run hotter than otherwise would. Fig. 3 shows the appearance of the quartz lamp, and Fig. 4 its internal connections. The operation is as follows: When a circuit is closed the current, limited by the starting resistance, passed through the inductance and the tilting magnets which incline the tube sufficiently to bridge the vapor gap. The current then passing through the mercury is sufficient to attract the armature of the inductance coil, which cuts out the starting magnets and the tube returns to its normal position, in so doing starting an arc and causing the vapor to become incandescent. After starting, the burner voltage gradually increases, and the current and watts decrease, becoming steady in from 6 to 10 minutes.

The electrical and illumination performance is shown in Table 1. As will be seen, the short Cooper-Hewitt tubes are operated in series on 110 or 220 volts, being provided with compensating devices which operate in just the same way as those used for power circuit arc lamps. The longer tubes are always used on 110 volts. The standard voltage for the quartz lamp is 220, although a special tube is made for 110 volts. Both of these lamps are very efficient, being approached only by the luminous or flaming arcs. This is due to two reasons: First, the filament type of lamp is limited, of course by the fusing point of the metal employed, and since the filament is an extremely slender wire, having but small heat capacity, the limit is soon reached in that direction. In the case of vapor lamps, the vapor filling as it does the entire tube, the temperature for a given input is considerably lower. The carbon arc follows the law of black body radiation, and since it is operated at a very high temperature is probably the most efficient of all light sources, were we to consider the light from the crater only and able to utilize it. However, due to several causes, we cannot do this.

Another reason for the superior efficiency of the mercury vapor lamp lies in its activity. As we have seen in the case of the luminous arc, the total radiation is greatly in excess, and also different in color from that due to temperature alone, and to this fact it owes its remarkable efficiency. This is the case with light from the vapor of mercury, the entire radiation being in the green and in the yellow green, with the fault lines in the blue and strong radiation in the ultra-violet. This creates a light unique in quality and possessing both advantages and disadvantages.

TABLE 1. PERFORMANCE OF MERCURY VAPOR LAMP.

Kind of Lamp	DC or AC	* Length	Amp	Volt	Watt	[illegible]	[illegible]	[illegible]
[illegible] H	DC	22	3½	** 55	132	300	[illegible]	4000
[illegible] K	DC	42	3½	110	385	700	55	4000
[illegible] P	DC	50	3½	110	385	[illegible]	48	4000
[illegible] F	AC	50			400	800	50	4000
Quartz	DC		4	110	440	1000	[illegible]	2000
	DC		3½	220	770	3500	.308	2000

* Length of Light-Giving Portion
** Used 2 in series on 110 Volts
" 4 " " 220

The latter are mostly connected with questions of appearance. This light, containing as it does no red rays, distorts the whole scale of color values. Blue and green are intensified, yellow and white are given a strong bluish-green cast, orange becomes brown or chocolate color, and red appears almost black. Such a light of course cannot be used for any place of public assembly, for the most startling color transformation is made in the faces of persons. The countenance appears ghastly, the lips and cheeks are a deep blue, while the lighter surfaces are a yellowish green. However, when used around commercial establishments one soon gets used to these color changes. Another limitation which the color imposes upon this light source is that colors cannot be matched under it. This precludes its use in dry goods stores, dye works, etc. Another caution which must be particularly observed when working under this light is to avoid too strong intensity. This caution is of more importance with this light than with those containing red rays, because while the eye is more sensitive to the yellow green radiation, yet the automatic action of the iris which protects the eye from excessive radiation is principally effected by the red and yellow rays. As a result of this it

FIG. 6. BLUE PRINTING OUTFIT.

is possible to have the light too strong for the eye and yet the eye be unable to protect itself.

As we have seen, there are certain substances which possess the power of changing the wave length of radiation which they receive. This is called fluorescence. The change is invariably a reduction of the frequency, that is, the radiation is shifted towards the red end of the spectrum. If, therefore, the mercury vapor lamp be partly surrounded by a reflector coated with calcium fluoride or other fluorescent material, the blue and green radiation which it receives will be altered and light reflected having red rays. It is possible by using a proper reflector to get light fairly white in color, but at the expense of efficiency, as the fluorescent reflector is not as efficient as a white one.

FIG. 7. MERCURY VAPOR LAMP FOR PHOTO-ENGRAVING.

The advantages of the mercury vapor lamp are its efficiency, its penetrating power, and its superior actinic qualities. Not only is the light more efficient than most other sources, but the light emitted is at or near the point of maximum sensibility. That is, the retina is more powerfully affected by a certain amount of energy expended in producing yellowish green light, than in light of any other color. Another advantage of a monochromatic color is in the absence of chromatic abberation. We know that different wave lengths have different indices of refraction, and therefore it is impossible to get a simple lens which will focus all colors at exactly the same point. Hence, when the crystalline lens is in focus for blue light it is slightly out of focus for red, and vice versa, while with the peculiar wave length of mercury vapor, it is possible to get a perfectly sharp focus. This advantage is of especial value in all operations requiring sharp vision, and hence this lamp is in favor for drafting rooms, press rooms, composing rooms, textile mills, and the like. The lines and figures on blue prints, in particular, stand out much more prominently than in their natural color.

Another great advantage in the use of this light lies in its almost perfect diffusion. There are no deep shadows. It is therefore much used for lighting warehouses, train sheds, piers, etc., and with quite a low expenditure in watts per square foot. It is possible to read anywhere with ease, which is quite important in the case of goods piled up with only a narrow space in which to walk. The use of these lamps in machine shops often does away with the necessity for local illumination, owing to the better diffusion and the increase in visual acuity, while for foundries, steel mills and the like, it has been found that the rays are of good penetrating power in the midst of smoke, steam and dust.

Table 2. Data for Different Lamps.

	Cloudy Sky	Cooper Hewitt	Same with Rhodamine Reflector	Quartz
Blue	1.00	0 77	0 97	0 58
Green	1.00	088	0.80	0 78
Yellow-Green	100	1 00	100	100
Red	100	0	62	04
Deep Red	100	0	0	0

The abundance of actinic rays, that is, the rays affecting the photographic plate, has opened quite a field to the mercury vapor lamp, for taking photographs and printing. It is possible by means of a Cooper-Hewitt "skylight" to take moving pictures in shops and factories, something not before possible.

The foregoing remarks are also true in general of the quartz lamp, although the higher temperature affects the color for the better. It is, however, distinctly greenish. Table 2 shows the proportion of different colored light given by each lamp, also that from a mercury vapor lamp with fluorescent reflector, as compared with that from a cloudy sky, being equated with reference to the radiation in the yellow green. These figures are from Dr. W. Voege, and show very clearly the color variations. The fact that quartz is transparent to the ultra-violet radiation renders it necessary that the quartz lamp be always operated with an outer globe of glass, for while the invisible radiations are not noticeably unpleasant at the time, yet they are very destructive to the tissues of the eye, and cause very painful and dangerous results.

A number of experiments have been made on the metallic vapor lamp by mixing other metals with mercury with the view of supplying the lacking red rays, but so far these have not proved commercially successful. An alloy of mercury, lead, tin, bismuth and cadmium, has been used. This gives a white light for about 200 hours, but the color changes slowly to the spectrum of pure mercury. Another lamp now under experiment by Dr. Wolfke, uses pure cadmium with 3-10 per cent of mercury. This lamp is peculiar in that the electrodes are both solid. The lamp is started by means of a piece of graphite attached to an iron chain. The tube is tilted and the graphite slides along the tube, and closes the circuit in the same way as is accomplished in the mercury vapor lamp. Cadmium has a strong radiation in the red, and it is stated that the resultant light is entirely white.

Further experiments are in progress along these and other lines, and it is stated that an efficiency of 0.16 watt per lower mean hemispherical C.P. has already been reached experimentally.

The Design of Steam Power Plants

(*Contributed Exclusively to* Electrical Engineering).

BY EARL F. SCOTT, M. E., MEMBER A. S. M. E., MECHANICAL ENGINEER, ATLANTA, GA.

Section 3. Layout of Station Equipment and Design of Piping.

AT THIS point in the discussion of the design of our plant we are ready to assemble it from the detailed drawings received from the manufacturers furnishing the machinery. The nature of the building for a plant of this size should be a secondary consideration as compared to good arrangement of the machinery. With this in view, therefore, the writer will arrange the machinery in a manner best suited for the most economical layout from an operating standpoint. The building may then be considered.

For a plant of this character the best arrangement is that with the boilers placed in a row with the turbine machinery, the steam ends setting at the rear of same. The turbines should be arranged parallel to each other with good working space around them and with the steam end as near the boilers as possible.

In Fig. 1 a plan is presented showing this general scheme. Beginning in the turbine room, we will discuss each item separately. For convenience, it is well to have about four feet of clear space between wall and the turbine, and at least this much at the sides. On the opposite side or "electric end" there should be more space as a general rule so that the rotor and shaft may be easily removed from the machine. Usually the space required for this purpose is specified on the detail turbine drawing and may be easily cared for in the design.

The switchboard should be placed near the electric end of the machine, and at a point most convenient for future extension, as the plant grows. With the board located at a central point as noted above, it makes the leads to the board from the machines shortest and also admits of easy exit from the board to the outside lines.

The two exciters should be placed at such a point, where they may be easily reached from both a wiring standpoint and for the steam connections. The best place for these machines then would be at one end of the turbine room. The motor-driven machine being placed nearest the switchboard for shortness of wiring and the steam driven machine nearest the boiler or partition wall for short steam connections. By placing them at these locations it is probable that with the future growth of the plant they will not be in the way.

The boiler room is the next subject to be taken up. For economy of floor space as well as other advantages, it will be well to place the boilers in batteries as shown in Fig. 1. This arrangement admits of convenient space for cleaning each boiler and is the most economical of floor space. In order not to prevent the future growth of the plant, it will be well to assume one end as the finished end and work from this wall. The space between the building wall and boiler wall should be about six feet, and between each set of boilers and the rear of the boilers there should be about the same space.

It is convenient to place the boiler feed pumps and heater at such a point that when the plant doubles in capacity this part of the installation becomes a central part. With this in view, we would place the machinery along the wall of boiler room arranged in tandem. In order to have sufficient working space, it is necessary to allow about ten feet between the boiler wall and building wall, as this gives plenty of room for easy access to each pump and also to the heater, which should be placed near the turbine room wall, since the auxiliary exhaust line must be run from the machinery in the turbine room basement to heater.

To get the best results from an open heater, it is necessary for it to be elevated above the suction of the boiler feed pumps at least three feet. If convenient the heater can be elevated more, and to give more floor space may be placed on a steel platform supported by columns or beams placed in the two walls. With such an arrangement the heater may be elevated eight or ten feet and allow easy access under it.

The two boiler feed pumps should perform a dual purpose, one used to pump cold water into the heater from a source which would not flow into the heater by gravity, while the other pump is taking hot water from the heater and pumping into the boilers. A low duty pump to handle the water to the heater could be used, but since it is desirable to have two boiler feed pumps, it is not necessary to go to the extra expense for the third pump when the boiler feed pumps can be used, as mentioned above. By studying the pipe arrangement for the pumps, it is easily seen that either pump may be used for the heater pump while the other is being used for the boiler feed.

In selecting the pumps mention was made of the fact that since the pumps would have to handle hot water, it would be necessary to make them large. The reason for this is due to the fact that as the pump pulls a vacuum in making a stroke, the hot water is flashed into steam, which causes the pump to "race" and hammer. This trouble is overcome mainly by placing the heater high, as noted above, and running the pumps slowly. The first mentioned remedy allows the hot water to flow by gravity into the pump cylinder, while the latter aids on account of the fact that the piston velocity is less than the water velocity due to gravity.

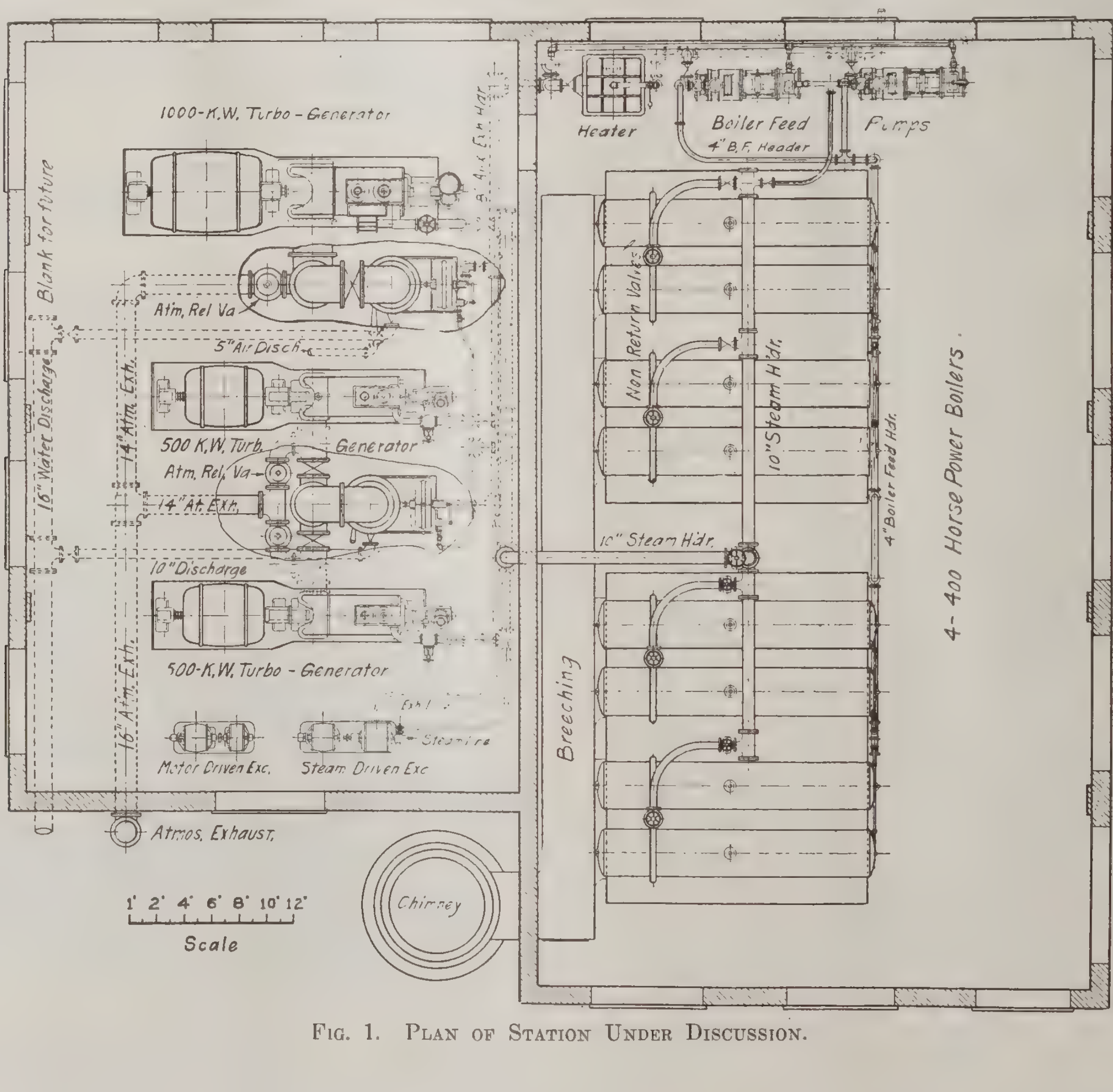


Fig. 1. Plan of Station Under Discussion.

In selecting stack and breeching arrangement for a plant, two questions come up, one, shall we make the stack large enough to care for a future growth of the plant, or shall we decide on this size of plant for the selection of our present stack and figure on installing a new stack when our plant increases in size? The writer believes that for a plant of this size and condition, it would be better practice to arrange the stack and breeching as shown in Fig. 1, selecting the stack or brick chimney, as the case may be, large enough to care for about 1,600 horsepower capacity. Then arrange the breeching accordingly to care for the same number of boilers, and allow this to be a complete unit within itself. If we should decide to install a stack or chimney large enough to care for twice the plant capacity, this stack would be so large that the drafts would be killed from slow gas velocities and counter currents, and might prove disastrous to the operation of the plant. By making this part of the plant complete at the start the future growth may be accommodated by making the line through the boiler feed pumps a central axis about which we may double the capacity and still maintain the uniformity of the plant.

By a study of the elevations, of Fig. 2, we see that the floor line of the boiler room is about half way between the turbine room and basement floors. This arrangement lends itself to modern turbine room practice most admirably. It allows us to get the condensing machinery low, which usually is necessary in order not to have too high a lift (12 to 18 feet) on the condenser. Our next study is the condensing machinery or machinery in the basement. From the plan, Fig. 1, it will be seen that the condensers are placed as closely as possible to the outlet of turbines. If it were not for the extremely high basement it would be an advantage to place the condenser (top inlet) directly beneath the turbine. This construction is sometimes followed in very large units, but the extra cost of building is so great as compared to the advantages gained it is seldom followed for this size of plant. The arrangement used in this design gives practically the same advantages and eliminates the above disadvantages.

By placing the large fittings between turbine and condenser above the floor it allows us to still decrease the height of the basement floor and also allows an opening around the condensing machinery so that the turbine room operators may watch the condensing machinery while performing their duties above. It also allows the main controlling valve between turbine and condenser to be at a point of easy access. This valve, of course, does not have to be opened or closed very often especially on the larger installations except when repairs are being made on condenser, and the turbine should be running non-condensing. On the smaller units where one condenser is used for both machines, the valve on one side would be closed whenever the corresponding turbine should not be running.

In the first section of this article we assumed the location of the plant site at such a point that we could get sufficient condensing water at the plant at an elevation of not over 12 to 13 feet from the injection inlet to the condenser. With this assumption we would arrange a cold well on the outside of the plant about 4 to 6 feet in diameter, and such a depth that the water will flow to the well by gravity. This is an ideal condition, yet often found in practice.

The main injection line shown on plan Fig. 1 should be run to the cold well and extended far enough down so that the intake of pipe will be sealed by water at least 4 feet at all times. In running this pipe from cold well to condenser, it should be arranged so that it will not have air pockets in it. This condition can be produced by arranging the pipe in an ascending position at all times.

The discharge line should be run so that none of the hot water will be returned to the cold well. This is essential, particularly if the condensing water is not in abundance. If the water source is from a river or ocean, it matters little about this as the hot water will have very little effect on the large volume.

The discharge from the air pump may be discharged directly into the cold well if this arrangement is more economical. In the event this line is run to this point, it is not necessary to seal the end of the pipe, but on the other hand it should be left open above the water line so that

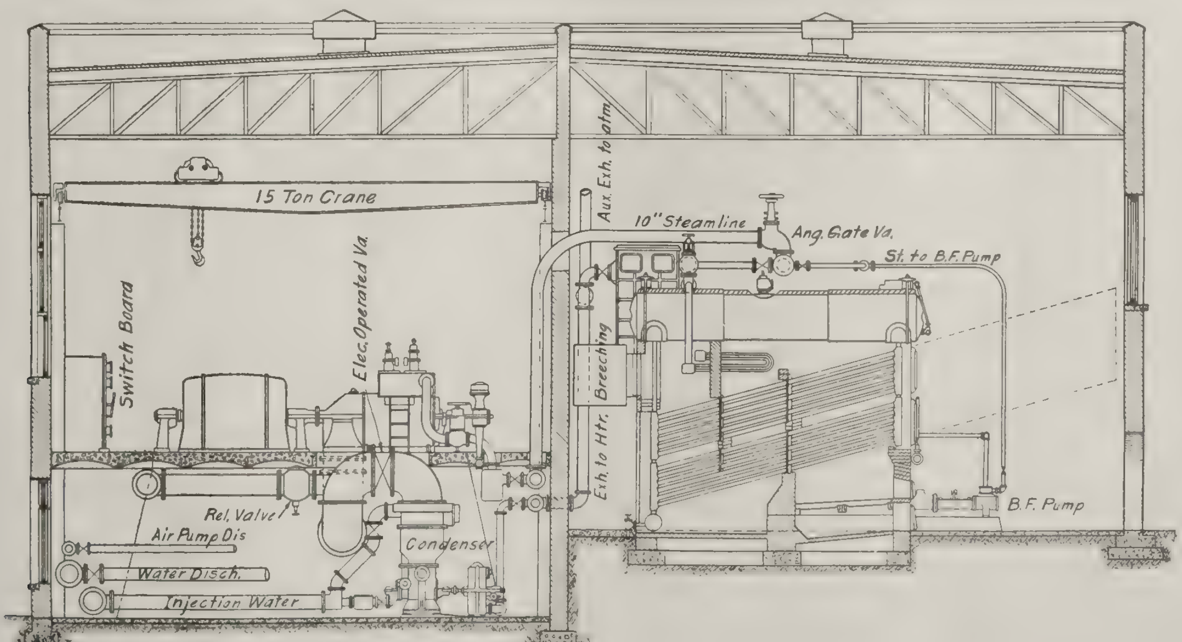


FIG. 2. ELEVATION OF STATION UNDER DISCUSSION.

air would not be carried back to the condenser. There is no particular advantage of discharging this line into the cold well beyond the fact that it shortens the pipe line.

If the conditions will permit (not too expensive) it may prove of advantage to seal the end of the condenser discharge line which would give us the full benefit of a "closed circuit" on the water intake and discharge and after the pump (condenser) is started the only work required of it would be to overcome the friction in the water lines. This produces a great saving in the operation of the pumping machinery.

PIPE ARRANGEMENT.

Thus far we have said nothing about the pipe arrangement for the plant. As to the regular pipe specification, we will leave this for the following article. It may, however, be in order to discuss the general arrangement of this part of the work in this article. Going back to the boiler room, we will take up the lines in a logical way. In modern power plant practice, it is good engineering to figure pipe sizes to give high steam velocities—which reduces the pipe sizes very considerably. For instance, from 4,000 to 7,000 feet per minute may be used as the steam velocity in the pipe lines. In the layout we have shown a 10 inch main steam header, which will transmit the full capacity of the four (4) boilers or 48,000 pounds of steam per hour at a velocity of 4,100 feet per minute. At a 25 per cent overload capacity, or 60,000 pounds per hour, we get a velocity of 5,000 feet per minute. While we may not have this amount of steam to pass through the pipe with the present installation, still it is good practice to design this part of the equipment for future growth as shown by the blank flanges in the drawings.

The connection to the main steam header from each boiler should be made through long radius bends, the size of the outlets on the boiler. The main header is carried over to the basement of the turbine room through a 10 inch line which connects to a second header run in the basement as shown on the plan in Fig. 1. From this header, the different lines are run to the several machines. The lines to each machine should be made the size of the outlet on the machine, provided the distance from header to machine is not great, in which event it is good practice to increase the line one size of pipe from the size shown on the machine. From the elevation, Fig. 2, it will be seen that this construction puts all steam pipe in the basement leaving the turbine room free for good appearance as well as to give free operation of the overhead traveling crane. There should always be a steam separator in the steam line between the header and machine as near the machine as possible, also a cut-off valve at the point where the branch to machine leaves the header. This valve insures a good means of cutting off the steam line in order to make repairs on any one machine without interfering with the operation of the other part of the plant. A valve should be placed near the header over the boilers on each boiler branch for the same reason.

It may not seem consistent to readers for us to place a separator on the lines to the different machines since we are using superheated steam; however, the extra safety and precaution this appliance gives, makes it a good investment and for this reason it will always be found in a well-designed power plant.

The sizes of the exhaust lines between the turbines and condensers may usually be determined from the size of outlet on the two machines, however, it is well to know just how these sizes may be determined. In a 1,000 Kw. machine using 22 pounds of steam, we have 1,000 Kw. $\times$ 22 pounds (approx. see first section) = 22,000 pounds of steam per hour at a vacuum of 27 3/4 inches. At this vacuum the steam has a volume of 317 cubic feet per pound of steam. At a high vacuum we may figure very high velocities for steam, 350 to 400 feet per second being usually used for this class of work, and this high vacuum. With this data we are in a position to determine the size of the pipe line between turbine and condenser.

$22{,}000 \div 3{,}600 = 6.1$ pounds steam per second.

$6.1 \times 317 = 1{,}933$ cubic feet per second.

$1.933 \div 350$ (velocity steam) $= A \times 12$ inches. Where A equals the area of pipe in inches. Thus $A = \pi d^2 \div 4$ where d equals the diameter.

Therefore we have from the above $1933 \div 350 = (\pi d^2 \times 12) \div 4$.

From this formula we find that a 32-inch pipe is required and this is the size furnished on the turbine shown in cut.

Our attention is now directed to the free, or atmospheric exhaust from each turbine. Note the small size of this pipe as compared to the line running to the condenser. We will now see how this line may handle all the steam from the turbine and be as small as it is. First, we will in all probability find that the turbine will not give more than 0.8 of its rated capacity when running noncondensing. The machine under these conditions will practically double the amount of steam required per Kw. over that required when condensing. With this condition we have the following problem: 0.8 of 1,000 Kw. = 800 Kw. Assuming 45 pounds steam for noncondensing operation, then 800 $\times$ 45 = 36,000 pounds of steam per hour for our turbine instead of 22,000 pounds as noted above when running condensing. The volume of steam at atmospheric pressure is 26 cubic feet per pound as against 317 cubic feet at 27 3/4 inches vacuum. We also have a change in velocity under these conditions as the steam cannot travel as fast in this case since the differential is small (the difference of pressure in turbine at exhaust outlet and the atmosphere). Under these conditions, we may assume about 200 feet per second (note these velocities are per second, which is correct). We are now ready to select the atmospheric pipe size, for the 1,000 Kw. machine.

$36{,}000 \div 3{,}600 = 10$ pounds per second. $10 \times 26 = 260$ cubic feet, the volume to be passed through pipe per second at a velocity of 200 feet.

$260/200 = A \times 12$ inches $= \pi d^2 12/4$.

Where d = 15½ inches. As this is an odd size, we should make this pipe 16 inches.

It is a very common error in the design of pipe work to make the atmospheric exhaust the same size as the exhaust between turbine and condenser. This error has two effects, one being the cost of the pipe work; when large it is expensive particularly the automatic relief valve. Second, this valve is extremely hard to keep tight when very large, therefore it is desirable to keep this pipe as small as possible without violating the rules given above.

The auxiliary atmospheric exhaust line should be the next subject to consider. There is very little to be said regarding this further than it will only require a comparatively small pipe for a plant of this size. Therefore, we will use a main header running as direct to the heater as possible, to which we connect all the exhaust lines of machines that are to be run noncondensing. This includes the exciter engine, condenser turbines and boiler feed pumps. This header should be about the size in area as the sum of the areas of the different lines running into it. A gate valve should be placed near header for each machine branch, so that repairs may be made on any one machine without causing the other part of the plant to be shut down. The header should be so piped that all the exhaust steam may be passed through the heater or bypassed around same. Note the bypass in drawing, Fig. 2. This is the construction for a vacuum type of heater, the arrangement for the thoroughfare type would be slightly different and will be discussed later in another design.

The suction to the condenser will be discussed next. The total amount of water to be passed through this line for both condensers will be found as follows: Since this part of the work should be designed for full capacity we may assume the pipe to be large enough to care for, say, 2,000 Kw.

Then, 2,000 $\times$ 22 = 44,000 pounds steam to be condensed per hour. 44,000 $\times$ .002 = 88 gallons per minute. Since the condenser will handle the condensed water up to within two degrees of the vacuum temperature, each pound of condensing, or cooling, water will convey the following amount of heat away. The initial temperature of the cooling water is 80 degrees (see first section) final temperature 105 degrees (temperature of 27 3/4 inches vacuum = 107 degrees — 2 degrees). Therefore, each pound of water will convey 105 degrees — 80 degrees = 25 degrees temperature or 25 B.t.u.

There is approximately 1,050 B.t.u.'s in a pound of steam at 27 3/4 inches vacuum, thus 1,050 $\div$ 25 = 42 times as much cooling water as the amount to be cooled, or 42 $\times$ 88 gallons = 3,696 gallons per minute. Since water in a suction line should not travel faster than 300 to 350 feet per minute, we must have a 16-inch pipe for this line from the cold well and it must run to a point from which branches to the condensers may be taken. There should be a gate valve placed near the header so that each machine may be cut out without effecting the running of any other part of plant. If the lift is great, say, 12 to 18 feet, it would be well to install a foot valve on the header in the cold well, or a check valve placed near the cold well in the horizontal part of header.

The discharge line should be selected in a similar manner to the suction, except that we may figure on 400 feet per minute for the water velocity, and if the line is long, we will have to take into consideration the friction in the line. The line from condenser to point of discharge is not more than 50 to 100 feet. If we use the above mentioned velocity we may then neglect the friction element.

In this section we have discussed the pipe work only in a general way, while in the following section we will prepare a specification covering pipe work for a plant of this type.

Importance of Magnetic Quality in Laminae of Magnetic Circuits

(*Contributed Exclusively to* ELECTRICAL ENGINEERING).

BY JOHN G. HOMAN, RESEARCH ENGINEER FOLLANSBEE BROTHERS COMPANY.

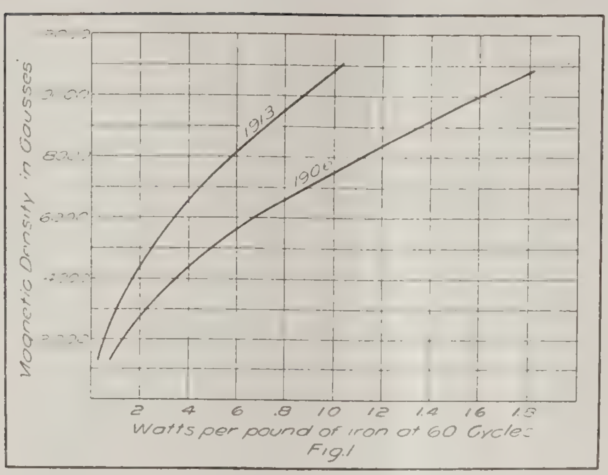
LAST year there were made in America more than one hundred thousand tons of sheet steel, and consumed by the electrical manufacturing industry in the production of dynamos, motors, transformers, instruments, etc. All concerns of consequence in purchasing such material now require that it meet their definite electrical or magnetic specifications. Ten years ago buyers were not so particular and about the only specification on their electrical sheets was softness. It is different today; the buyer talks about a certain working quality, and he is thinking about his dies; but he demands a certain core loss guaranty and assured permeability characteristics.

Considering sheets of .019-inch thickness, which is probably the more common gauge used, the average core loss at a frequency of 60 cycles and magnetic density of 10,000 lines per centimeter square was likely more than three watts per pound of laminæ ten years ago. Today it is probable that the average core loss for the same gauge of material is half of this amount. Most of this improvement has come during the last five years.

Steel makers who have realized the trend of the electrical manufacturing business and its demands have undertaken the matter in a rational way. They have employed scientific men who could assimilate enough practical metallurgy along with their physics to produce what was wanted. They have installed laboratories with experimental equipment, and while some few looked askance at the proposed manipulations and compositions, they were broad enough to tolerate it.

In this connection the writer has the personal recollection of asking for steel—only a few years ago—in which the carbon content was as low as .05 per cent and the manganese something close to .20 per cent, and this from a small finely working basic open hearth furnace. At the time he was not only assured that such material only happened by rare accident, but that it was considered ill luck and unfit for anything save scrap. Today we make our carbons as low as .015 per cent and manganese contents as low as .04 per cent, and we have learned to work it in spite of the woeful predictions of very practical and well-meaning steel workers.

Working together, steel makers and electricians have produced valuable results; they have cut core losses in half in a very short period of time. To appreciate in terms of dollars what core losses mean, consider the 120,000 tons of electrical sheets entering the dynamo, motor and transformer making. It is safe to say that a fourth of this quantity is lost as scrap; this leaves 90,000 tons to be magnetized and subjected to the conditions giving rise to the energy losses of hysteresis and eddy currents. Two watts per pound seems an exceedingly conservative guess at the average rate of energy loss for present designs and operating conditions, yet this for the 90,000 tons of magnetic circuits made last year is 1,500,000,000 Kw. hours per



CURVES OF CORE LOSSES OF TRANSFORMER STEEL.

year based on half-time operation only. This at 1 cent per Kw. hour is more than $15,000,000. This is a safe estimate of core loss cost for the average operating year of last year's electric sheet production.

Perhaps if the improvement in the material had not come about, the production would not have amounted to 120,000 tons of sheets, it might have been only half as much, but even then at practically double former average core loss, the saving based on the above liberal estimation rounds out to be something like $7,500,000 for each year. Of this saving we are almost ashamed to remind the consumer how little he has contributed to the advance and betterment of the hand that feeds him. In Fig. 1 a curve is shown, comparing the core losses of present transformer steel with that available in 1906.

In the manufacture of dynamos, motors, transformers and the like, the production of which seems to be growing in a geometric proportion, there are three important active materials, iron, copper and insulation. Of these three, by far the largest opportunity for improvement rests with the iron. Copper has shown no tendency toward improved conductivity and up to date no substitute even suggests itself. Insulation likely will be improved, but the economies to be accomplished with such improvement when compared with similar betterment of the magnetic circuit, are small. Cut the core losses in half and we will save $20,000 per day for each of the twenty or more years' life of the apparatus into which it goes. I say twenty years or more because the lower energy losses mean longer life of insulation, the deterioration of which is stimulated by the heat of the core losses.

Some Practical Features of Safe Moulding Wiring

Contributed Exclusively to ELECTRICAL ENGINEERING.

BY E. B. MUNSEY.

IT is now generally recognized that electrical wiring that makes use of wood moulding is a type of construction that should be discouraged and in its place metal moulding or approved conduit systems or even open wiring used instead. However, due to the fact that wood moulding is a part of early construction yet in use, it will be only possible to eliminate it in construction work gradually. For this reason and because such systems will be extended and maintained in some cases in connection with conduit systems, it is advisable to observe the best methods of installation to reduce the fire hazard. It is not the purpose, therefore, of this article to treat in detail the methods employed in erecting wooden moulding wiring, but rather to call attention to certain features in connection with this work that have a practical value, will probably save time and money for those using same and at the same time make a safe wiring job.

Two methods of mitering moulding and capping at turns is shown in Fig. 1. The arrangement shown at I and Ia is the one that should be used in all cases, and is the only one that will be accepted by an alert wiring inspector. The method shown at IIa, Fig. 1, is sometimes used by wiremen in an effort to save time, and while it is true that it does save time, in that the mitering is eliminated, the job that it makes cannot be considered altogether safe, nor is it sightly.

In Fig. 2 a length of moulding is shown supported to a fireproof ceiling with a toggle bolt and is inserted principally to indicate how the base should be cut at an angle at each splice. Where this is done the piece that rests on top of another one tends to support it in position. It is not always necessary to cut the base at an angle where the moulding is to be erected on a surface where it is possible to insert plenty of nails or screws to hold the base in position, but on surfaces where toggle bolts must be used, which are rather difficult and expensive to install, considerable time can be saved by making the splice as indicated in Fig. 2, and a more substantial job will result where this method is followed.

Where it is necessary to carry conductors, supported in wooden mouldings, through floors, some sort of protection

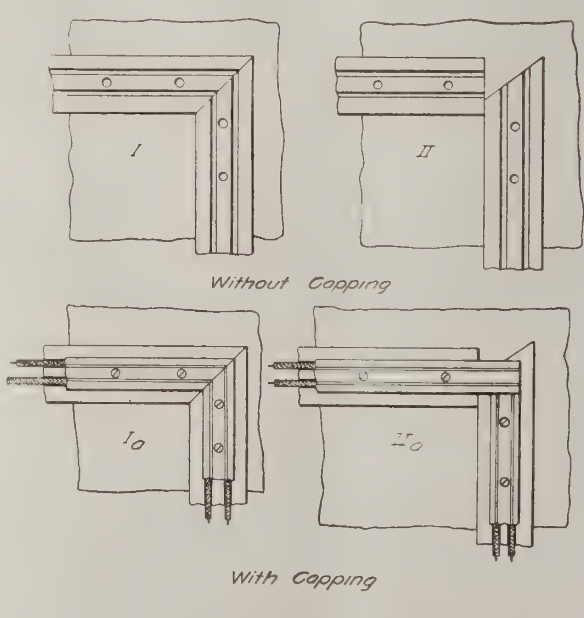


FIG. 1. METHODS OF MAKING TURNS.

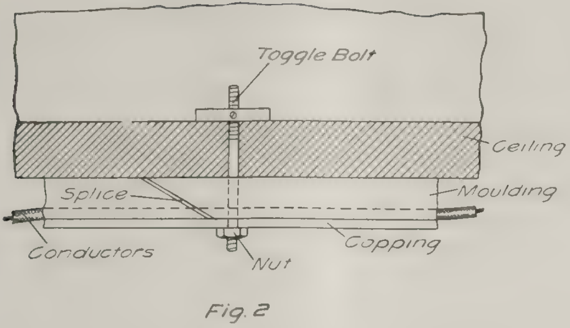
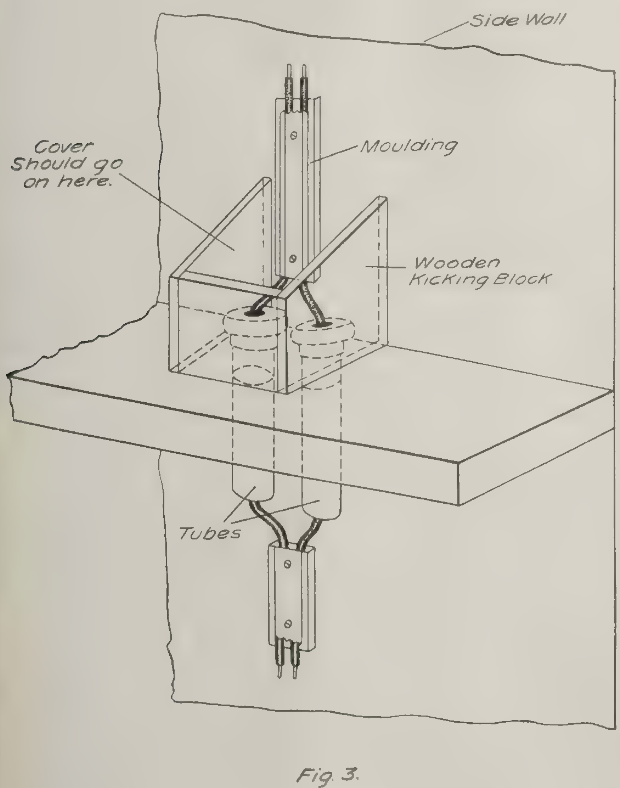


FIG. 2. A TOGGLE BOLT FOR SUPPORTING MOULDING.

other than the moulding must be provided above and through the floor. One method of disposing of the conductors in such a case, is indicated in Fig. 3, where a home-made "kick-plate" is shown. The "kick-plate" is merely a wooden box, which should be provided with a cover, although no cover is shown in the illustration. This box surrounds the heads of the porcelain tubes through which the conductors pass. The tubes must extend from above, entirely through and to below the floor. The "kick-plate" should be constructed of boards not less than ⅞-inch thick. Metal "kick-plates" manufactured especially for the purpose can be purchased, and it is probably cheaper to use these manufactured plates than a home-made one, where they can be purchased. In the event, however, that the manufactured article is not available, a home-made one, built as indicated, will give satisfactory service.

Another method of carrying conductors otherwise supported in moulding, through the floor, is shown in Fig. 4. In this arrangement the conductors are protected by a length of iron pipe, which extends entirely through the floor and 6 inches above and below it. The conductors, where they pass through such an iron pipe, must each be encased in a length of circular loom, extending in one continuous length from the moulding above the pipe to that below it. In the illustration quite a gap is shown between the end of the moulding and the pipe—the drawing being made in this way merely to indicate the presence of the circular loom. In practice the moulding can extend to and abut against the pipe. For No. 14 wire, encased in a standard circular loom, standard wrought iron pipe of a nominal diameter of about 1 inch would be found a satisfactory size.

In placing conductors in moulding prior to the fastening on of the capping, it is necessary to make some provision for holding the wires in the grooves. This is particularly true when the moulding run lies along a ceiling. The usual method of accomplishing this is, after the wires have been laid in the moulding, to drive tacks or brads into the base, as indicated in Fig. 5. The tacks are placed about every four or five feet, and are withdrawn as the capping is fastened in its recess. A great deal of time can be saved by using some form of patented moulding, like that, for instance, indicated in Fig. 5, this moulding having cuts along the sides of the wire grooves. These cuts form small tongues of wood, which extend out along the edge of the top of the groove, and will, after the wire is forced into the groove, hold it in position. Although the patented mouldings arranged with some wire holding feature are a trifle more expensive, in first cost, than the ordinary plain groove moulding, in the long run they are quite as cheap, if not cheaper, and are much more convenient. The reason for this is that the wire can be placed in these patented mouldings and the capping fastened on in much less time than is necessary with mouldings of the ordinary sorts.



3. A MOULDING KICK-PLATE.

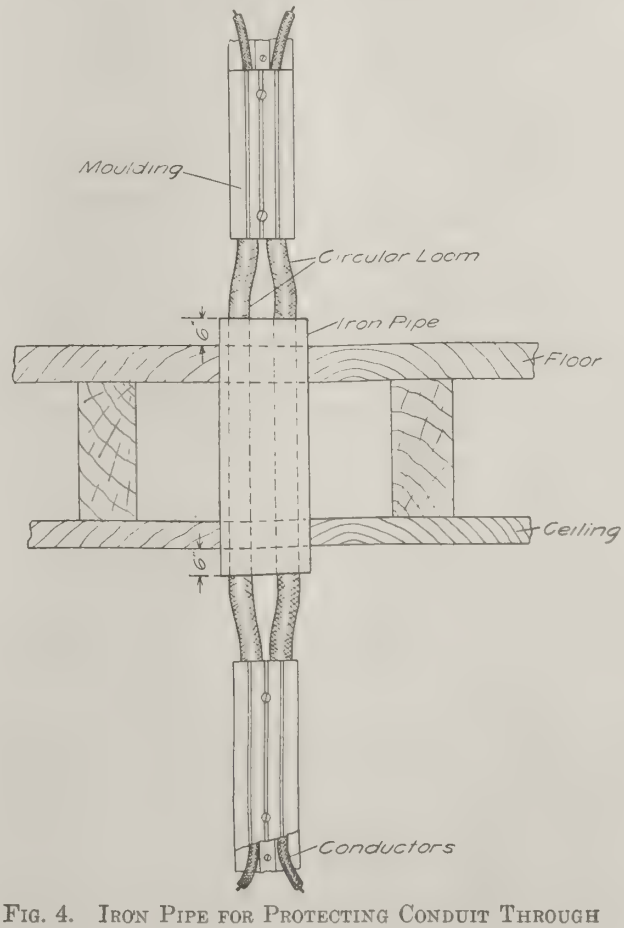


FIG. 4. IRON PIPE FOR PROTECTING CONDUIT THROUGH FLOORS.

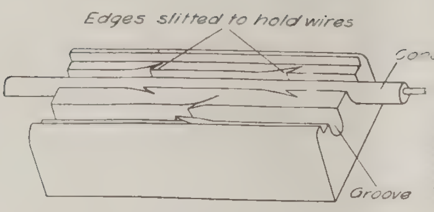


Fig 5.

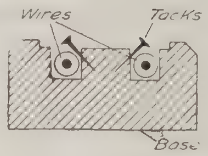


Fig.6

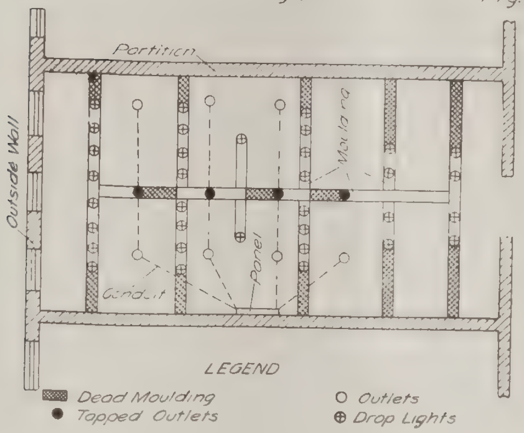


Fig 7.

FIG. 5. MOULDING THAT HOLDS CONDUCTORS IN PLACE. FIG. 6. A TEMPORARY BRAD HOLDING CONDUCTOR. FIG. 7. MOULDING WIRING ON FIREPROOF CEILING.

One application where wooden moulding is frequently and conveniently used, is where it is necessary to extend a lighting system on a ceiling which has outlets already installed at certain points. Fig. 7 gives an example of such an installation. The black circles indicate existing outlets, and the circles having crosses in them indicate the point at which drop lights must be installed. The illustration shows plainly how each of these drop lights are served from one of the existing outlets through conductors carried in the moulding. The shaded portion of the moulding in the figure, is what is termed "dead moulding;" that is, it has no conductors in it and is placed merely to give the work on the ceiling a symmetrical appearance.

In extending a lighting system such as that indicated in Fig. 7, it is necessary for the wiremen to consider the capacity of the branch conductors to each outlet. This is necessary so that the underwriters' allowance of 660 watts for each No. 14-wire branch will not be exceeded. It will be noted that of the eleven outlets that existed on the ceiling of Fig. 7, it was necessary to tap in at but four to serve the installation.

In Fig. 8 is shown another example of the installation of "dead moulding." In order to maintain a symmetrical appearance of the work on the ceiling, although but two outlets were installed, it was thought desirable in the case illustrated, to erect a symmetrical design in moulding, on the ceiling, inorder to have the appearance of the moulding installation in keeping with the other appointments of the room. It will also be noted that "dead moulding" was carried around the length and breadth of the room on the side wall, at the ceiling. This was necessary to render less conspicuous the run of moulding that had to be placed from the panel box along the upper corner of the room, to a point over the middle of the door.

In high class moulding installations, like that described in connection with Fig. 8, it is often desirable to use wooden moulding for fancy cappings. Two satisfactory

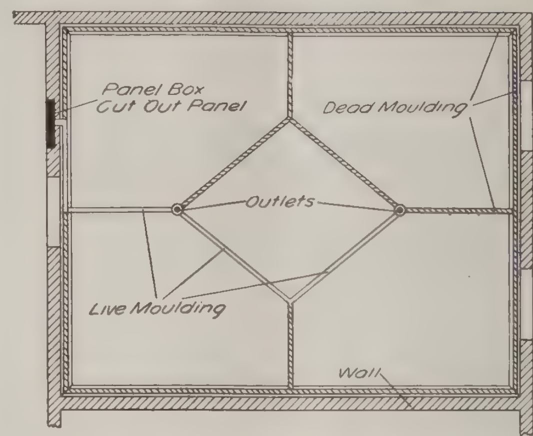


Fig 8

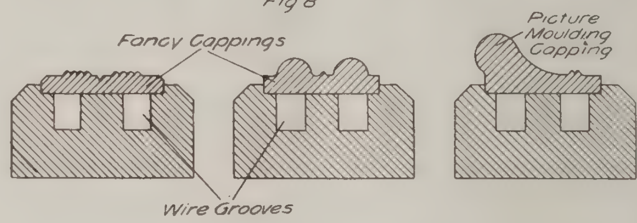


Fig 9

FIG. 8. DEAD MOULDING ON CEILING TO COMPLETE A DESIGN. FIG. 9. SPECIAL CAPPINGS FOR MOULDING.

designs are given in Fig. 9, and a picture moulding capping, such as that which was carried around the upper corner of the room of Fig. 8, is shown at the right-hand of the illustration. This picture moulding capping consists of base of the ordinary sort, but in the groove of it is fastened a moulding having at its upper edge an enlarged portion, over which metal picture hooks can engage.

Mouldings and cappings of hard wood, such as oak, cherry, or mahogany, can be purchased and are frequently used in fine work. Mouldings made of pine, oak, or any of the more common hard woods, cost in a general way, about twice as much as the bass wood or white pine moulding that is ordinarily furnished.

One of the most convenient applications of wooden moulding, is its use in combination with flexible tubing (circular loom) or flexible steel armored cable, for finished building wiring. In Fig. 10 is shown an illustration of

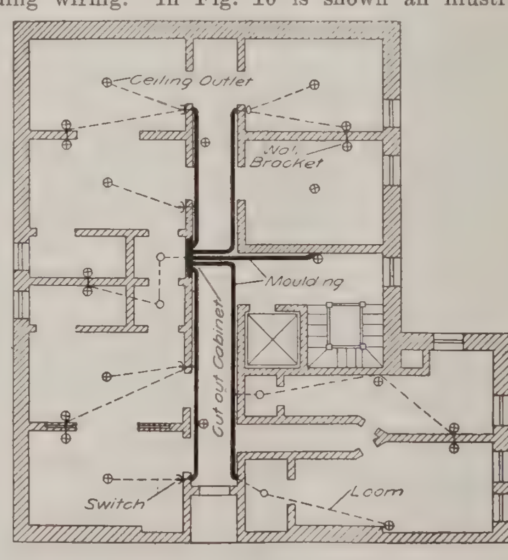


FIG. 10. APPLICATION OF MOULDING AND CIRCULAR LOOM IN WIRING A RESIDENCE.

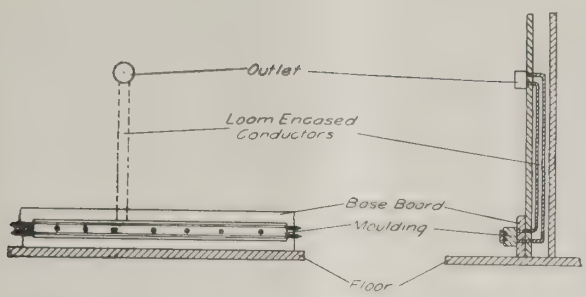


Fig 11

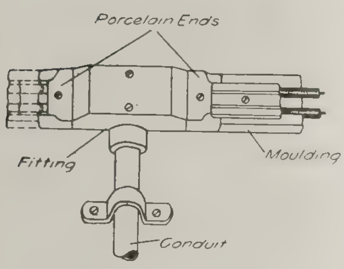


Fig. 12

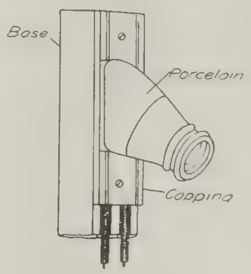


Fig 13$_{III}$

Fig. 11. Moulding on Base Board and Tap to Outlet. Fig. 12. Fitting for Junction of Conduit Line With a Moulding Run. Fig. 13. Moulding Receptacle.

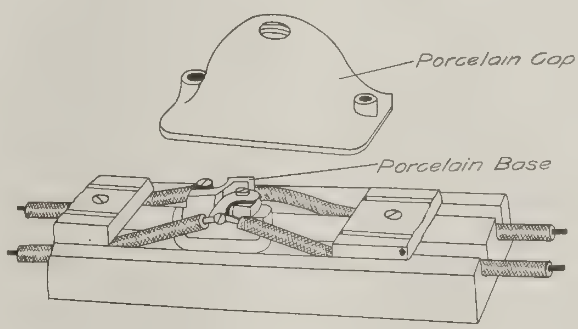
such an application of moulding. In the hall (Fig. 10) the conductors are carried in moulding supported on the ceiling, and the runs to the outlets are made with flexible steel armored conductors, which are fished from the hall to the outlets in the rooms. If circular loom is used in connection with the moulding, it is not necessary to provide steel or iron outlet boxes in which to splice the conductors carried in the loom to those carried in the moulding. Where flexible steel conduit or steel armored conductors are used, it is necessary to provide a steel or iron box at the point where the steel armored conductors join the moulding conductors. The splice between the two must be made in one of these metal boxes. Usually the construction of a finished building is such that it is inconvenient to fish continuous conductors in the ceiling above the hall and into the rooms; hence a combination arrangement like that indicated in Fig. 10 is often desirable. The moulding in the hall looks quite well enough, while in the rooms all of the wiring is concealed. It is very easy to fish the conductors from the hall to the rooms if the ceilings are furred.

Another application of moulding wiring in a finished building, is that indicated in Fig. 11, where conductors are carried around a base-board in moulding, and fished from the base-board to side wall outlets. In Fig. 11 the conductors within the walls are shown encased in circular loom, hence there is no necessity for metal splice boxes at the point where the loom conductors join the moulding conductors.

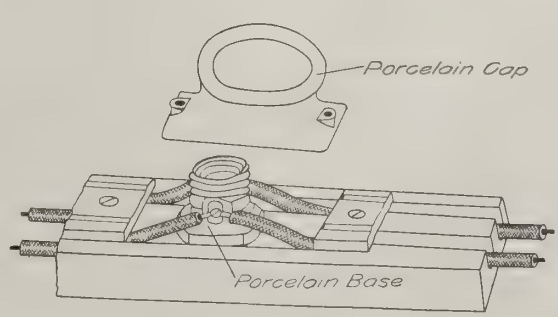
As suggested in a preceding paragraph, some sort of a metal splice box is necessary where conductors from conduit join those carried in moulding. A very convenient moulding, conduit junction box is shown in Fig. 12. One of the virtues of the appliance shown is that it is very compact, as it occupies much less space than the ordinary pressed steel, conduit outlet or splice box. Another advantage of the fitting shown in Fig. 12 is that the moulding can be sawed off square, as can the capping. Each of these can be fitted to the porcelain ends of the junction box without its being necessary to do any unusual cutting on the moulding.

Convenient forms of moulding rosettes and receptacles are shown in Fig. 13-a-b-c. It will be noted that it is not necessary to cut the base in order to install these fittings. This feature is not true of all the moulding fittings on the market, and as the elimination of unnecessary cutting saves considerable time, the purchaser should be careful to select moulding receptacles and rosettes of types similar to those indicated. It will also be noted that the capping is cut off square and that it abuts directly against the porcelain cap of the rosette or receptacle. The rosette fitting, Fig. 13-a, is used where a drop cord is connected to moulding encased conductors. The cord extends through the hole in the cap and is connected to the conductors by binding posts carried on the porcelain base. The fitting of Fig. 13-b is similar, except that it shows a receptacle rather than a rosette. The inclined recptacle of Fig. 13-c can be used effectively in show window and show case lighting. It is compact and provides a position of the incandescent lamp, that is frequently necessary in the lighting applications indicated.

Sub-bases must be used to support switches in moulding work. They may be made of hardwood, or they may be omitted if the construction of the switch is such that it is approved for mounting directly on the moulding. Switches of a construction approved for moulding wiring without the use of sub-bases are rather special, hence are not carried in stock by supply dealers as frequently as are the standard snap switches. Standard snap switches supported on suitable bases are most frequently used. Fig. 14 shows some of these bases. In Fig. 14-I is shown the details and the application of a wooden switch block for moulding wiring, that any wireman can construct for himself. The base is merely a square block of wood, with two grooves cut in it, and two holes bored from each end into the grooves, to provide for the admission of the conductors. It is possible to so make the block that the longitudinal



Rosette Fitting
Fig 13a



Receptacle Fitting
Fig. 13b

Fig. 13. A and B. Practical Moulding Rosettes and Receptacles.

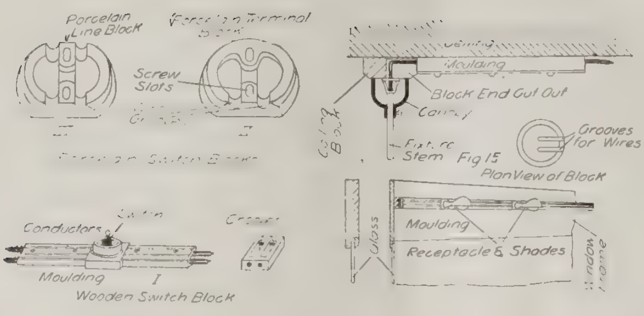


FIG. 14. BLOCKS FOR SUPPORTING SWITCHES IN MOULDING INSTALLATIONS. FIG. 15. METHOD OF SUPPORTING A FIXTURE IN MOULDING. FIG. 16. MOULDING FOR SHOW WINDOW WIRING.

grooves extend its entire length, eliminating the necessity for the holes, but this construction does not provide a sightly installation, because the switch will not cover the grooves at the ends, hence the conductors will be exposed at these points. At II and III, Fig. 14, porcelain switch blocks for moulding work are shown. These are regularly manufactured and are much cheaper, in the long run, than home-made wooden blocks. The wooden block is described, however, because conditions are such occasionally that porcelain ones cannot be obtained. The porcelain box shown at III is used at intermediate points in a moulding run and that shown at II is used at the end of a run.

Where fixtures are served by conductors carried in moulding, the fixtures must be supported on a suitable wooden block, as shown in detail and in section in Fig. 15. The block not only provides a substantial support for the fixture, but it also constitutes a backing for the canopy. The conductors from the moulding can be carried through holes bored or grooves cut in the block, rendering it unnecessary to cut the canopy for the admission of the conductors. A crow-foot should, as shown in Fig. 15, be used to support the fixture stem. The crow-foot is fastened to the block with wood screws.

One application for window lighting is also suggested in a preceding paragraph. Another application is given in Fig. 16, where the moulding is carried along the top portion of the window frame. Suitable window lighting reflectors can be used in such an installation, in connection with moulding receptacles. If the reflectors are selected properly, and the incandescent lamps are of the proper candle power, and spaced effectively, an extremely good window lighting installation can be installed at very low cost. It is frequently desirable in installations of this sort to "make up" the moulding complete with the receptacles, in the shop. This can often readily be done by making measurements of the window that is to be lighted. After the lengths of mouldings have once been assembled and taken to the job, they can be installed with a relatively small labor cost.

Inspection and Tests of Electrical Machinery

(*Contributed Exclusively to* ELECTRICAL ENGINEERING).

BY HUGH T. WREAKS AND R. L. SHEARER OF T. E. I. BUREAU.

Section 2. Tests on Rotary Converters.

THE tests usually made on rotary converters are no load and full load phase characteristics, pulsation test, no load and full load ratio, saturation, core loss, D. C. and A. C. starting tests and heat run (full load and overload). Taking the ratio of the A. C. volts to the D. C. volts is important. The rotary may be driven from the A. C. or the D. C. end. It is the usual practice to use two A. C. voltmeters and two D. C. voltmeters on this test so as to check the accuracy of the instruments. The ratio is taken at no load and full load. During the test the D. C. voltage is held constant and the A. C. voltage read between rings 1-3 on a 2-phase, and 1-4 on a 6-phase machine. The standard shunt wound rotary has nearly a constant ratio of A. C. to D. C volts, and any fluctuation in the A. C. supply shows direcuy on the A. C. voltage delivered.

PHASE CHARACTERISTICS.

The most satisfactory way to run a no-load phase characteristic is to use two rotaries, the one under test run as a rotary by the other run inverted with a D. C. loss supply. Holding the speed constant by varying the speed of the inverted machine, the D. C. volts being held constant by the volts of the loss supply. With the field excitation of the rotary reduced to the lowest limit, read the A. C. amperes and volts and D. C. amperes and volts field. The speed and D. C. volts are held constant throughout the test. Increase the field current of the rotary by small steps, reading as above. The A. C. amperes input will decrease until the minimum input point is reached, they will then increase. The field strength should be increased until they have about half the value of full load current of the converter. Full load phase characteristic is taken in the same manner as the no-load phase characteristic. The D. C. volts are held constant at normal rating and the amperes output constant at full load value. The strength of the field is varied through as nearly as possible the same range as used for no load.

Readings taken: A. C. volts, A. C. amperes, D. C. volts (held constant), D. C. amperes output (held constant), D. C. volts field, D. C. amperes field. Speed held constant.

D. C. AND A. C. STARTING TEST.

In the starting test from the A. C. end the converter at starting is similar to a transformer and the induced voltage in the field may be very high. In all cases, therefore, the field connections must be opened in at least two places to keep the induced voltage within safe limits. A potential transformer and voltmeter should be connected across one or two field spools and a reading taken of the induced voltage in the field. Starting test should be made from several positions of the armature with respect to the field. A scale should be laid off into equal parts, a point of reference being marked on the field spool opposite to which the marked position of the armature is placed for the successive starts. Having point No. 1 opposite the reference point, the A. C. switches should be closed and a moderate field put on the alternator (from which the rotary gets its power) sending about one-half normal load current through the rotary. Read volts and amperes in the various phases. It is impracticable to read all phases at once during start. Put ammeter into that phase which showed the highest current, and the voltmeter across the phase which indicates the highest voltage so as to get the maximum readings at the instant of starting. Increase the field of alternator until armature begins to revolve, then volts and amperes input and induced voltage on the field should be read. The voltage should then be held constant until the rotary reaches synchronism, the time required to reach this point from the start being noted. Readings should be taken on all phases of volts and amperes after the rotary has reached synchronism. It should then be shut down, the armature brought to position No. 2, and the test repeated.

Starting test from D. C. end. The rotary should be separately excited with a field current corresponding to that for no load at minimum input, unless it is desired to use full field. The voltage across the armature should be brought up gradually by increasing the field on the generator delivering the power until the armature begins to revolve. The voltage should then be steadily increased at a rate which will bring the converter to normal speed, approximately in a definite time, and when this time is found, test should be repeated once or twice.

The core loss on rotary converters is similar to that on D. C. machines.

SATURATION ON ROTARY CONVERTERS.

Careful readings should be taken of the D. C. voltage as well as the alternating current voltage between all phases with the field strength giving normal voltage. The phase voltage must be closely balanced. Generator or motor saturation can be made on a rotary converter. (This test as well as core loss test was taken up in a previous article).

PULSATION TEST.

This test is sometimes taken on converters. The rotary converter is very sensitive to change in line conditions, excessive line drop or speed change of the generating unit. Line drop will start a rotary pulsating. Once started, the pulsation generally increases rapidly until the rotary falls out of step or flashes over. Tests for pulsation consist of putting a resistance per phase between rotary and generating alternator. The drop through this resistance corresponds to line drop. The machine running in sycnhronism, self-excited and with field adjusted to give minimum input under rated conditions, observe the D. C. voltage of the machine. Any slight pulsation will show by the instruments at once. With the field current reduced to about one-half minimum input value, watch for pulsation. Next, adjust field to the minimum input value and again watch for pulsation. If no pulsation develops with the high line drop under these conditions, the machine is O. K.

NORMAL AND OVERLOAD HEAT RUN.

Before starting normal heat run, the shunt field should be divided into at least four sections to protect the field when starting from the A. C. end, otherwise a high voltage is induced in the field at starting. Provide for reading amperes and volts armature A. C. amperes and volts armature, amperes and volts field D. C. and speed of driving alternator. To start rotary close the A. C. line switch and field of the driving alternator, increase the field strength of alternator and keep close watch on A. C. line current. After starting, as soon as the A. C. current drops to the minimum value, showing the rotary is in synchronism, and the A. C. volts are normal, close the field switch, *i. e.,* used to split up the field. If then, after closing the field switch, the brushes spark, the residual magnetism left in the poles by the induced voltage at starting is of the wrong polarity. To remedy this, reverse residual polarity by opening the alternator field circuit, then close this circuit and bring rotary back to synchronism, doing this several times, if necessary, until the field builds up in the right direction. Before putting on normal load heat run, read the currents in each phase to see that they are not unbalanced. If the current does not vary over one per cent, no load and full load phase characteristics should be taken. After setting the brushes on D. C., and for best commutation, the normal heat run is put on rotary. During this heat run, hold full load D. C. amperes and volts constant with minimum input field current. The load is kept on until temperatures are constant. At end of run temperatures must be taken on all parts of rotary, and resistance measurements of armature on A. C. end and field taken.

On an overload heat run, after determining the heat run required for minimum input the overload phase characteristic, hold this current and the D. C. volts and amperes as on normal heat run. This run is usually kept on for two hours and then rotary shut down and temperatures taken on all parts of machine and resistance of armature A. C. end and field. Before putting on the overload heat run, rotary should be run for some time to heat up.

These tests, as outlined, cover the salient points and indicate what may be accomplished in the way of inspection and tests to see that a rotary converter's characteristics are obtained as specified.

German Electro-Technical Industry.

According to a report issued by the German Union of Electro-Technical Manufacturers, the year 1912 was a good one for the industry, the marked increase in the adoption of electricity for lighting and power purposes reflecting itself in increased turnover by most members of the union. Profits, however, chiefly owing to the advance in metal prices, were not always satisfactory. The union includes almost all the German electrical companies outside the A. E. G. and Siemens Schuckert groups. Makers of motors were well employed, but unfortunately it was only possible to obtain better prices for those of upward of 5 horsepower. The cable branch of the industry had little reason to complain, for owing to the efforts of the Cable Cartel prices were brought to profitable levels. Foreign competition was very keen. Prices of insulated wire, which were very unsatisfactory in 1911, were improved, producers coming to a price agreement. Toward the close of 1912 a price cartel was formed with regard to insulating tubing, the manufacture of which had become quite unprofitable. There was a slight improvement in the arc-lamp trade owing to the introduction of new and improved types, but the incandescent lamp trade left much to be desired. The German tax on lighting apparatus is seriously handicapping both the home and foreign trade. Owing to the customs practice in the United States and Canada of including the German lighting tax as part of the basic price on which to impose their own ad valorem import duty, it is now proving quite impossible to export German electric lamps to these markets.

Tests to Determine Economy of Combustion

Contributed Exclusively to ELECTRICAL ENGINEERING.

BY E. H. TENNEY, M. E.

Section 2. Furnace Losses and Functions of the Boiler.

ALL of the functions of combustion are intimately related to the amount of air supplied. Where large amounts of coal are to be burned a large amount of air must be supplied, hence high-grade coals usually require higher drafts. For each different kind of coal there is some particular difference in air pressure between the under side of the grate and the upper side of the bed of coals which will give the best general results with the fire. The curves in Fig. 4 illustrate this to some extent.

The working out of the conditions above noted must be accomplished by experiment and are probably most satisfactorily determined by repeated tests on the flue gases under each set of conditions. For this purpose the (CO_2) instruments noted above may be of great service, especially when used in connection with recording draft gauges, Fig. 5, recording pyrometers, Fig. 6, and capacity flow meters, Figs. 7 and 8.

In following out the investigation one series of observations should be made by feeding a given size and grade of coal to the furnace at a certain rate, noting all of the conditions, including horsepower output and quality and temperature of flue gases. Another series of observation should then be made after making a change in the quality or size of the fuel. The (CO_2) content of the flue gases in connection with the capacity output of the boiler furnish a sure guide as to which of the kinds or sizes of coal are being consumed under conditions of highest economy. Again, coal qualities and sizes may be maintained constant and changes be made in the thickness of the bed of coal and in the rate of feeding, and again the capacity output, and the (CO_2) along with temperatures and drafts will indicate most economical combustion. In cases where an insufficient supply of air is being admitted to the furnace the (CO_2) will tend to remain high, but the lowering in furnace temperature and boiler output along with a sudden rise in the furnace draft will be positive indication of the inefficient condition existing in the furnace.

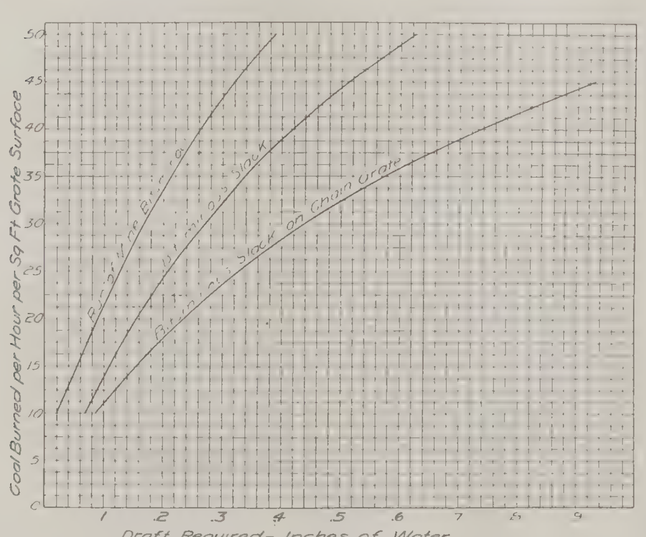


FIG. 4. FURNACE DRAFT REQUIRED FOR BURNING DIFFERENT GRADES OF BITUMINOUS COAL.

With a few instruments such as those mentioned above the engineer is able to size up the conditions of highest operating economy without resorting to a long series of evaporative tests. The steam flow-meter, the indicating and recording type of which were mentioned above, has recently been perfected by the General Electric Company and is an instrument which is of great value to the engineer in his boiler room investigations. This shows the horsepower output of the boiler at all times and indicates how effectively the heating surface of the boiler is absorbing the heat which is being produced in the furnace. With the aid of this testing equipment it is only necessary that the coal which is burned during a given interval of time shall be weighed and a subsequent test made of its calorific value and proximate analysis, in order to obtain a complete record of the economy and operating efficiency of the boiler and furnace for each set of conditions under which it is desired to run.

One of the features which from an operating standpoint detracts from the value of a complete boiler test in which the coal, water and ash are carefully weighed and where great care is used in firing, is the fact that the test is not being conducted under ordinary conditions of operation and that the fireman and everyone connected with the

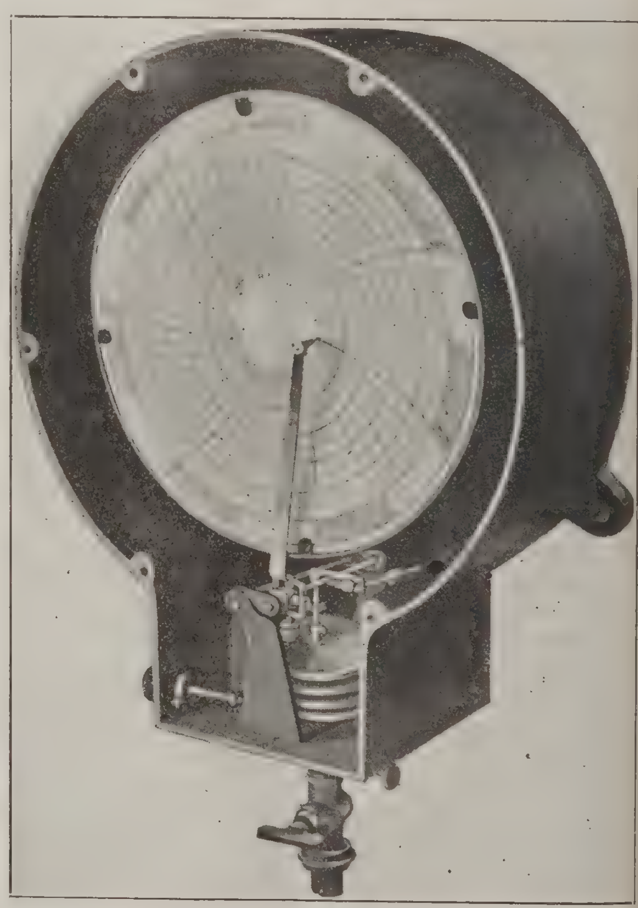


FIG. 5. A RECORDING DRAFT GAUGE.

equipment is using more than ordinary care. With a good set of recording instruments the engineer is able to conduct a test under the actual conditions of ordinary operation, possibly without the knowledge of the fireman, the instruments giving him an accurate record of all conditions as they have been developed during the day's run. On the basis of observations made during such conditions, methods of operation may be worked out which will give greatest furnace economy and boiler efficiency for each hour of the day.

FURNACE LOSSES.

In addition to the considerations of air supply and favorable combustion, tests for furnace economy should be made. These include an investigation of those losses which decrease economy and a determination of the necessary adjustments of furnace conditions which will bring those

FIG. 6. A RECORDING PYROMETER.

losses to their lowest terms. The losses which take place in a furnace may be investigated at three points: 1—In the heat carried away in the flue gases. 2—In the coal which has not burned, but has gone into the ash pit. 3—In radiation—Heat not dissipated from these causes may be considered as being taken up by the boiler.

(1) The amount of heat carried away by the flue gases may be determined by multiplying the weight of the flue gases by the difference in temperature between the air entering the furnace and the gases leaving. The weight of the flue gases is the weight of the fuel, less the ash and unburned coal, plus the weight of air supplied. For one pound of fuel, using Kent's formula, the weight of the flue gases will be $W = 3.032\ [N/(CO_2 + CO)] \times C + (1 - A)$. Where A is the propotrional part by weight, of ash in the fuel. C the proportional part, by weight, of carbon in the fuel, thus the British thermal units carried away by the flue gases per pound of coal will be: $B.\ t.\ u = .24 \times W\ (T - t)$. Where .24 is the specific heat of the flue gas. T = the temperature of the flue gas. t = the temperature of air supplied to the furnace. The flue temperatures may be readily determined by the use of indicating or recording pyrometers.

Where excessively high flue gas temperatures are found with good (CO_2) and every indication of good combustion, an examination of the boiler baffles for leaks may show the cause of the trouble. Such "short circuits" tend to in-

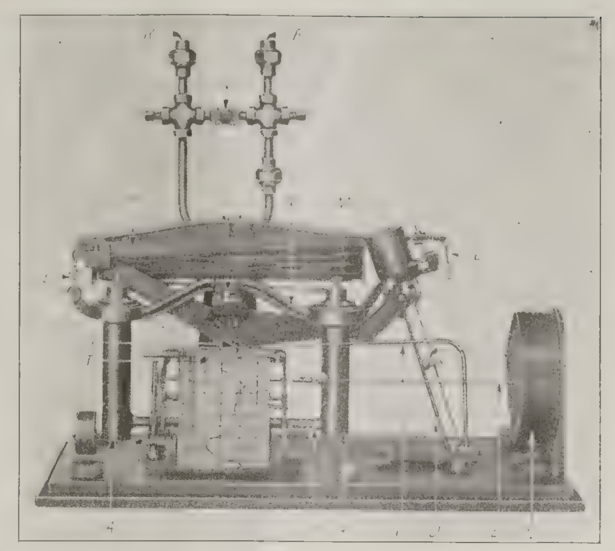


FIG. 7. RECORDING STEAM FLOW METER WITH AUTOMATIC PRESSURE COMPENSATING DEVICE.

crease the flue temperatures greatly and reduce the furnace economy.

(2) The amount of unburned fuel in the ash is determined by obtaining a representative sample of the ash extending over a certain interval of time and testing for its heating value. A close approximation of the heat units lost in this manner may be gotten from an approximate analysis of the sample which shows the percentage of combustible matter which it contains. The heat units lost in the ash will bear nearly the same relation to the heat units supplied in the coal as the combustible portion of the ash bears to the original coal. For example, if the ash from a coal whose proximate analysis shows 18% ash and 11,000 B. t. u. is found to contain 20% combustible, this would represent 3.6% of the combustible matter of the coal. The heat lost would then be represented roughly by 3.6% of 11,000 or 396 B. t. u. per pound of coal burned. This loss if excessive calls for more care in the regulation of fires, inasmuch as the trouble can usually be traced to the carrying of fires too "long." The quality of the ash from an efficiently operated power station will vary according to the quality of the coal burned. Bituminous coals of 18% ash will usually be found to leave a residue which contains from 16% to 18% of combustible.

(3) The radiation loss is seldom measured and usually composes a large part of the item called "unaccounted for" which enters into the complete heat balance of a boiler. The amount of radiation depends upon the surface exposed and the kind of insulating material used in the boiler setting. It also depends upon the temperature and efficiency of the fires, the higher furnace temperatures causing a greater loss.

FUNCTION OF THE BOILER.

The function of the boiler is to absorb the heat which has been liberated from the fuel in the furnace. The amount of heat which a boiler can absorb in a unit of time depends upon three things:

First, the difference in temperature between the water within the boiler and the hot gases impinging upon the heating surfaces without. Second, upon the quantity of those gases. Third, upon the ability of the material which separates the water from the hot gases to conduct the heat from the one to the other.

A boiler operating under 175 pounds steam pressure will contain water at a temperature of 377 degrees Fahenheit, obviously only that portion of the heat generated in the furnace which is above 377 degrees is available for absorption in the boiler, provided the heating surfaces are in the most favorable condition for the transmission of the heat. In other words, in a furnace which develops a temperature of 2,500 degrees Fahr. from an air temperature of 60 degrees Fahr. (377 — 60) or 317 B. t. u., or 12.68% of the heat developed cannot get intothe water of the boiler. The investigation of these conditions of maximum heat transmission must be made at three points; namely, as to the efficient contact of gases and heating surfaces; as to the presence or absence of substances which are heat insulators both within and without the tubes; and as to the proper circulation of water in the boiler.

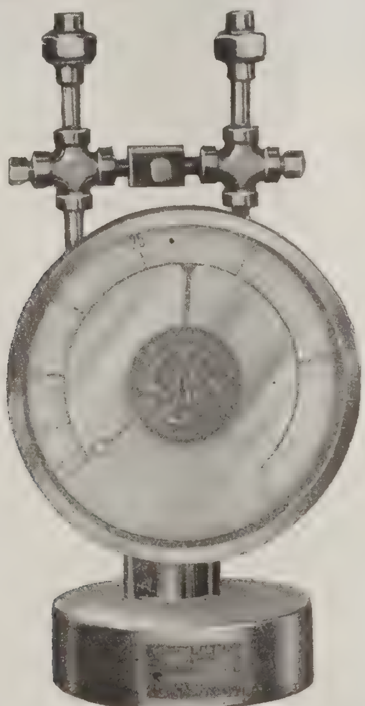


FIG. 8. INDICATING STEAM FLOW METER.

Tests for determining the efficiency of the contact of hot gases and heating surfaces are accomplished by temperature and draft readings throughout the boiler passes. A series of temperature readings may be taken by means of a pyrometer at consecutive points along the path of the hot gases, and any irregularity noted in the gradual drop in temperature through the passes will indicate the presence of leaks in the baffling. These leaks act as short circuits preventing a portion of the gases from proper contact with the heating surfaces, the heat escaping to the stack. In this manner points at which eddies and dead corners occur in the passes (especially in the case of horizontally baffled boilers) may be detected and very often, by slight changes in the position of the baffles, remedied with a definite increase in the efficiency of the heating surface at these points. Similarly an investigation of the force of the draft at various positions throughout the setting is very definite indication of the condition of the setting through which the hot gases are passing.

The avoidance of heat insulating materials both on the wet and the dry sides of the heating surface is the most important consideration in connection with the efficiency of the boiler as a heat absorbing medium. On the wet side of the heating surface scale must be prevented from forming. If some scale is unavoidable, the soft carbonate scales are preferable, as their porosity permits the water to penetrate through to the metal surfaces, thereby preventing them from heating up to the same extent as in the case with the metal beneath the hard sulphate scales. Aside from the decided loss in efficiency from the presence of scale in boiler tubes, a real danger exists in the temperature to which the metal of the tubes may be raised. Two tests of a series by Stomeyer and Baron in discussing this subject in "Engineering," (Dec. 25, 1903) were upon boiler tubes with and without scale and were as follows:

	Flame Swept Tubes.	
	With no scale	*With 1/8" scale*
Temperature of Flame....	2421° F	2484° F.
Temperature of Metal.....	396° F	630° F.
Percentageof total heat transmitted to water....	19.8	17.5

The temperature of the metal being increased 234 degrees and the evaporative power of the tubes being reduced 11.61 per cent due to the scale.

A similar laboratory test conducted by the writer upon a clean, empty 4 inch boiler tube and upon the same tube coated its inner surface with a thin film of graphite paint showed a decrease in the transmission of heat through the tube of 9.0 per cent due to the graphite paint. An increase of 24.5 per cent in the temperature of the metal was necessary in order to give the same temperature at the center of the tube as that obtained at the center of the clean tube. Investigations of boiler efficiency may well include a careful inspection of the inner surfaces of the boiler from time to time.

On the dry side of the heating surface, investigation should determine the efficiency of the flue blowing apparatus which is supposed to keep the soot and fly-ash removed from the top of the tubes. These substances are very effective in lowering the heat absorbing ability of a boiler. Equally effective as a heat insulator is an accumulation of slag upon the bottom of the tubes nearest the fire.

An interesting method of testing for circulation of water in a boiler has been devised and used in connection with tests made by the United States Geological Survey in their boiler investigations during the World's Fair in St. Louis (Bulletin No. 325). This consists in a small copper shaft carried through a gland in a hand hole plate, across the water leg and into the boiler tube. On the inner end of the shaft a small propeller is mounted which is caused to revolve by the water as it circulates in the tube. Each revolution of the indicator makes an electric contact on a small glass drum mounted on the shaft and this is made to energize the receiver of a telephone instrument. By counting the revolutions of this instrument under a great variety of boiler operating conditions they have established the interesting fact that the circulation of water in a boiler does not increase in proportion to an increase in capacity. Consequently at the higher capacities the temperature of the heating surfaces is higher because of being covered to a greater extent with steam bubbles. The effective heating surface is thus diminished and the available heat for the boiler (and consequently the over-all efficiency) is less.

From the above it is evident that the importance of good circulation is great especially in boilers which are to be operated steadily above their rating and where the disengagement of the steam from the water surrounding it must be rapid.

The Lighting of the Panama-Pacific Exposition in 1915.

The advance information that has been given out in regard to the lighting of the Panama-Pacific Exposition in 1915 seems to indicate that something unusual, not to say revolutionary, in exposition lighting is planned. One of the foremost illuminating engineers in this country, Mr. W. D. A. Ryan, has charge of the work, whose reputation in regard to all fields of lighting, especially spectacular effects and general illumination such as he accomplished at the New York Hudson-Fulton Celebration, is assurance that the plans now announced only indicate in a meager way what is to be actually realizeu through the proposed schemes of lighting. The fact that the main characteristics of the illumination will be secured through direct and indirect means, lends decided interest. There will be no outlined lighting of buildings with incandescent lamps, yet through the direct and indirect principles, the architecture of the important buildings will stand out at night in detail equal to that of daytime.

W. D. A. Ryan, Illuminating Engineer, Panama-Pacific Exposition.

In a recent issue of the *Sunset Magazine,* Mr. Ryan comments upon the lighting of the exposition as follows: "Deep in the lagoons and carefully placed water-spaces, will appear the perfect and complete reflections of the briliant walls and towers of the exposition, not striped with lines of light on areas of shadow, but glowing in all the radiant colors and contrasting surfaces which architect and sculptors and colorists have created for them. And high upon battlements and turrets, the flags of all nations that have met together in this great festival will not be lost against the night sky, but will be brought out in full value. There will be electrical fountains, but no water will flash in them. Instead, smoke and steam, much superior media for such effects, will be sent into the air and turned to glory by the rays from a mighty scintillator.

"It is planned to have a huge locomotive mounted on a steel turn table which will develop power sufficient to send it eighty miles an hour. From this machine, columns of smoke and steam will be sent against the sky and brilliantly illuminated, and contrasting delicately with these geysers of color, providing experiments now being made prove successful, thousands of giant soap bubbles will be sent soaring into the sky with rays of light upon them to give them the iridescence of insects' wings.

"In the courts the mural paintings will be lighted by concealed lamps set into pillars, a special tubular lamp having been perfected for the fluted columns. Where the lighting of the buildings is direct, a dense globe will be used and the intrisic brilliancy of the lamp reduced to the point where it may be looked at directly without injury to the eye. This is a very important thing in exposition lighting, for the exposition visitor is there to keep his eyes open and any exposed brilliant source is sure to lead to headaches and consequent irritability.

"Jewels made of glass of a special cutting for different distances and effects are to be used wherever they add to the beauty of an architectural line or surface of a sculptored form. This faceted glass, pure white or blackened with color to imitate any precious stone, will be mounted upon delicate springs so that the least vibration from wind or machinery or even tramping of feet may set them flashing. As an example of the use to which these jewels may be put, we may take the role of seraphic figures which is to surmount the colonade about the main court, the Court of Sun and Stars. These figures will be fourteen feet high and the head of each will be crowned with a star measuring four feet across. These stars will be studded thickly with jewels. In such a heroic group as that which will crown

Layout of Panama-Pacific Exposition in 1915.

the West entrance of the main court, a group symbolizing the East and containing an elephant bearing an Indian prince in all the splendor of the Durbar, these jewels added to the color of the sculpture will supply magnificence.

"A great scintillator will be mounted on the main axis of the exposition, about five or six hundred yards out in the water. It will be placed on a barge anchored in the bay and sixty trained men will be required to operate the lights. It will go through an evolution of color throwing gorgeous auroras into the sky. A spread of these colors will be visible all over the bay and on clear nights will be visible in the sky for forty or fifty miles. The illustration shown here gives an idea of the layout of the exposition and the scintillator mentioned."

Convention of Electrical Development Society.

As announced in the June issue of *Electrical Engineering,* the first annual convention of the Electrical Development Society was held at the Hotel Sherman, Chicago, on June 2, the first day of the N. E. L. A. convention. From the report of the secretary it was learned that the society now has 181 members. It was also learned that $110,000 has been pledged for the support of the work of the society, also that of the $20,476 advanced by the directors of the society, $8,665 has been spent in organizing the work.

At this meeting by-laws were adopted whereby electrical manufacturing companies can become members and their membership not indicate directly their annual revenue. An amendment also provided for the presence of at least seven members of the board of directors to constitute a quorum.

At the close of the convention, the following executive officers were re-elected: President, Henry L. Doherty, New York City; first vice-president, W. H. Johnson, Philadelphia; second vice-president, W. E. Robertson, of Buffalo; third vice-president, A. W. Burchard, of New York; fourth vice-president, Ernest Freeman, of Chicago; fifth vice-president, J. Robert Crouse, of Cleveland; general manager, J. W. Wakeman, of New York, and secretary and treasurer, Phillip S. Dodd, New York.

Annual Convention of Illuminating Engineering Society.

At a meeting of the Convention Committee of the Illuminating Engineering Society held in Pittsburg, Friday, May 16th, it was decided to hold the next annual convention in that city during the week of September 22. The convention committee consists of C. A. Littlefield, New York Edison Company, chairman; P. S. Millar, Electrical Testing Laboratories, president of the Society; H. S. Evans, Macbeth Evans Glass Company, Pittsburg, Pa.; W. A. Donkin, contract manager of the Duquesne Light Company, Pittsburgh, Pa.; D. McFarlan Moore, General Electric Company, Harrison, N. J.; M. C. Rypinski, Westinghouse Electric & Mfg. Co., New York; C. J. Mundo, General Electric Company, Pittsburgh, Pa.; J. C. McQuiston, Westinghouse Electric & Mfg. Co., Pittsburgh, Pa.; W. R. Serrill, United Gas Improvement Company, Philadelphia, Pa.; S. B. Stewart, Philadelphia Company, Pittsburgh, Pa.; T. J. Pace, Westinghouse Electric & Mfg. Company, Pittsburgh, Pa.; and Prof. H. S. Hower, Carnegie Technical Schools, Chairman of the Local Section of the Society.

W. A. Donkin, of the Duquesne Light Company, was selected as chairman of the local committee on arrangements which will have charge of the convention. J. C. McQuiston, of the Westinghouse Electric & Mfg. Company, was appointed chairman of the Publicity Committee and will make all arrangements for advertising the convention. It is expected that several hundred engineers from all parts of the country interested in lighting in its various forms will be present, and the program, details of which have not as yet been compiled, will consist, in addition to the technical sessions, of a reception and dance, several excursion trips and visits to the various industries in Pittsburgh.

Convention of Ohio Electric Light Association.

The nineteenth annual convention of the Ohio Electric Light Association will be held at the Breakers Hotel, Cedar Point, Ohio, on July 15, 16, 17 and 18.

The first session will consist of the address of the president; report of the officers; and an address and demonstration on "Cooking by Unity Load Factor Ranges," by Matthias Turner, of the Cleveland Electric Illuminating Co., of Cleveland, Ohio. The second session on Wednesday, July 16, will be known as "Commercial Day." The papers will be: "Retention of Business of Dissatisfied Customers," by Thos. F. Kelly, of the Dayton Power and Light Co., Dayton Ohio; "New Busniess," by J. E. North, of the Springfield Light, Heat and Power Co., of Springfield, Ohio; "New Applications of Electricity as an Adjunct to New Business," by Prof. F. C. Caldwell, of Ohio State University, Columbus, Ohio; and "Means of Developing and Diversifying the Present Load," by H. E. Armstrong, of Tri-State Railway and Electric Co., of East Liverpool, Ohio. Third session, on July 17, address by S. G. McMeen, president of Columbus Railway and Light Co., of Columbus, Ohio, on the subject, "The Human Equation." "Report of the Meter Committee," by A. H. Bryant, of Cleveland Electric Illuminating Co., of Cleveland, Ohio. "Report of Long Distance Transmission Committee," by M. H. Wagner, of The Dayton Power and Light Co., of Dayton, Ohio. Fourth session, on July 18, address by Jas. V. Oxtoby, counsel for the Edison Illuminating Co., of Detroit, Mich., on the subject of "Franchises." "Illumination as a Commercial Plant," by A. M. Seegear, of Toledo Railways and Light Company, Toledo, Ohio. 3

Hearts and Electricity.

Hearts are strange things. Ever see one? Dark red. About acorn shaped. Flabby? Yes—that's a dead one. Live hearts don't look like that. Some folks wear them on their sleeves, some folks say. Other folks grieve them out, it's understood.

But—real hearts rule the world. Blood pulsates in and out of them. Thus the heart energizes the human system by passing blood through the lungs and arteries and veins—this builds men and women. Men and women manage the world and rule the world.

Human hearts make human brains. Human brains know how to handle power. Electricity is the heart of power. Electricity is power. Power in work helps men and women live longer because it helps strengthen their hearts.—*The Silk Cord.*

New Business Methods and Results

Representing Interests of Central Station, Electrical Jobbers, Dealers and Contractors.

Notes on N. E. L. A. Convention Papers and Reports.

The principal topic of interest during the past month among central station men was the N. E. L. A. Convention, hence our comments this month will be limited to convention news. These news do not pretend to be in any sense a review of the convention, as this is found elsewhere in this issue, but simply a few significant extracts from the reports, principally those of a commercial nature, with comments thereon.

RATE RESEARCH.

The question of scientific rate analysis, while not by any means exhausted, is at least becoming more settled. The principles involved are now generally understood, and future progress would seem to lie along the lines of simplifying the rate schedules and adapting them to the different classes of business. The labors of the committee this year seem to have been largely expended on making a critical study of the large number of existing schedules, studying them not only from the standpoint of accuracy but from their value as business getters, and taking note of their relative flexibility, simplicity and general attractiveness. We have pointed out before in this department those features which we deem commercially desirable in a rate schedule, and it is satisfying to observe that the results of research along these lines are bearing out our opinions.

Probably the most important thing in the whole rate question is the fact that although there is yet much diversity in detail and even a good many scattered places where antiquated, complex or inadequte schedules are still in force, there is a distinct movement among the larger companies toward uniformity, not especially as a result of any concerted action, for there has been none, but rather showing the crystallization of opinion brought about largely, no doubt, by the varied discussions, constantly appearing in the technical press, reports of research committees, public service commission rulings and the like. The most valuable action taken by the present committee seems not to lie in the expression of their opinion, though we value this, but in the accurate record which they have given us of standard schedules. For the first time in the history of the association, we can refer with some degree of confidence to what is coming to be recognized as standard practice along the lines of rate making. While many factors have contributed to this, no doubt a large share is due to the work of the various state commissions, not directly but indirectly, in that their rulings have compelled central stations to make a scientific study of the rate problem.

Nearly all companies provide a general basic rate applicable to all customers and offer a choice of other rates such as block power and lighting rates, "demand" rates, "Hopkinson" or "fixed charge" rates, and the controlled flat rate. All of these rates are especially suitable for certain classes of service. The committee entirely disapproves of the so-called step rate.

The committee further believes that a great many rate schedules are entirely too complicated and that the simple demand charge combined with the Kw.hr. charge, either or both of which may be divided into blocks if necessary, will accurately meet the needs of a great many kinds of business under widely varying conditions, rendering it possible for a company to get any net rate it may desire. The weakness of any system of demand rates which leaves the demands to the estimation of the company was pointed out. This does not essentially differ from allowing the company to estimate the rate itself. The committee appreciates the difficulties in measuring the demands and also the difficulty of inspecting in case the demand is based on floor area, or on a number of so-called "active" or "inactive" rooms. These are serious difficulties and are largely responsible in fixing the demand. However, it is very important, in order to be entirely free from any charge of discrimination, to express these rules so explicitly that they can be applied clearly and definitely to all cases.

Considering the situation as a whole, the following may now be considered as standard practice: The application of the Hopkinson rate to big business; the encouragement of residence business by a two-step rate or by a controlled flat rate, or both; the right to charge a minimum has been established. Lamp renewals are now definitely based on the Gem lamp.

The following matters are now under discussion: The difficulty of putting tungsten lamps on a renewal basis; the proper rate and form of contract to use for break-down service; the proper method of arriving at the demand of a small consumer; how to establish standard practice in the matter of line extensions.

ELECTRICAL MERCHANDISING.

This subject, already treated at considerable length in these columns, was interestingly reported on by the proper committee. One of the main thoughts seemed to be that the old-time methods are inadequate, and that central stations must adopt modern merchandising methods. We are glad to note the definite stand taken by the committee against selling appliances at cut rates, and they advise maintaining retail prices and in all other ways possible encouraging the active handling of appliances by local contractors. The report also contains much valuable matter on appliance campaigns, show window arrangements and other methods for increasing this branch of the business and gives some recommendations in regard to necessary accounting.

LAMP RENEWALS.

Practice in this regard seems to be undergoing a good deal of change. An increasing number of companies are substituting the Gem lamps for the carbon filament. Several have discontinued the lamp renewals but these are more than counterbalanced by the number inaugurating the practice, while still others who do not renew lamps have reduced the price. The matter of renewal of tungsten lamps either entirely or in part, is being cautiously approached by a few companies, yet the trend of the movement appears to be in this direction, and there is little doubt but that as soon as a few central stations can report the satisfactory operation of such a plan, others will be ready to take it up.

It seems advisable at the present price and with the present construction of lamps to require some payment, if only nomnial, to serve as a check upon gross carelessness, or in some other way to limit the number of lamps given out. Perhaps it might be possible to allow renewals in proportion to the current consumed by a customer. For instance, if it were decided to allow renewals to the extent of one cent per Kw.-hr. and the monthly bill amounted to $2.50, a small column on the ledger might be used for the credit of 25 cents on a customer's lamp account, and when renewal was needed the cost of the lamp charged against this small account, provided all the credit had not been previously used up. Since electric irons, cooking utensils and the like would run up a good deal of lamp credit, which would not be needed with normal life of lamps, it would be best to make the allowance liberal enough to cover all ordinary cases, barring carelessness, and then annually wipe off the unused lamp credits.

The committee strongly recommends that all central stations put forth every effort to induce customers to use the tungsten lamp.

REFRIGERATION AND ICE MAKING.

The committee report on this subject gave valuable information. The principal advantage of motor driven refrigeration over use of ice were named as: Lower temperature; no dirt, muss or slime; drier, since moisture is not precipitated as water but as frost; the temperature is better regulated; it is applicable to show windows and show cases for display of peishable goods.

The two general systems in use for producing refrigeration, the compression and absorbtion types, were described and compared. A description was also given of the Audriffen machine which uses sulphur dioxid hermitically sealed, so as to protect the parts of the machine against the action of the sulphurous acid produced.

COMMITTEE ON PROGRESS.

We give here a few extracts from Mr. Martin's excellent paper. "One great net result," he says, "of all the progress of rigorous investigation and all the control and regulation by Public Service Commission, has been to establish broadly the good faith of the companies, the efficiency of their management, the reasonableness of their rates, and their general stability as investments because, based upon service to the public, needed with little variation whether times are good or bad; and increasing in volume of business as population grows."

The Central Illinois Public Service Company, a holding company serving 87 communities found 49 separate generator plants supplying the field. Nearly all of these were shut down in short order, and now the same territory is served with eight and ultimately by four plants. This will result in an enormous saving in generation, distribution and management, and the best part of it is that the public will get a large share of the benefit.

Dr. Steinmetz predicts the creation of great trunk lines operated at 150,000 to 200,000 volts, and serving the customers 100 miles from the generation station with a loss of only 10 per cent or less.

The National Civic Federation has proposed a standard bill for the establishment of public service commissions in states not already having passed such legislation.

The Board of Gas and Electric commissioners of Massachusetts, have refused a municipal plant permission to sell current for commercial lighting at 12 cents per Kw.-hr., because an analysis shows that it costs 16.43 cents to produce it, significantly adding that the sale of a commodity to private consumers at less than the cost of production compels the other tax payers to bear part of the loss.

The recent floods and cyclones that have devastated large portions of the Central West and have damaged badly many central station systems, depriving the companies of customers and income, have gone to show that the ordinary low rates of depreciation and dividend allowed by regulating bodies are not adequate for proper reserves, and do not compensate for the risks of the business.

Every citizen of the United States and every family within our borders, if not on our circuits is a prospective customer. They probably will never all use current, but the point is that we should give them all the opportunity.

The Wisconsin Commission holds that the title of the owner of a utility business to the entire savings produced by the substitution of a cheaper power has not been clearly demonstrated, and that such a process would preclude the public from enjoying any share in economic methods of service, and would seem to place upon the users of utility service the burdens of maximum cost of operation.

The Electric Sign Specialist.

For the last couple of months we have been considering the field of the specialist in central station commercial work, and have tried to show the underlying principles governing the employment of special talent. In the case of power and lighting, of course, the matter of technical education enters largely, and since as we pointed out, technical training and salesmanship are usually developed at the expense of each other, the best results are usually only accomplished by employing first class commercial men, assisted by others possessing requisite engineering knowledge.

In the case of signs, however, the question is somewhat different since there are few, if any, technical or engineering features connected with securing this class of business. There is, however, the necessity for the employment of expert talent in order to secure the greatest results from this class of business, and this is due to the fact that a sign is not for the purpose of illumination primarily, but for the purpose of advertising, and it requires, therefore, a knowledge of advertising principles to sell it. No matter how good the solicitor may be along general lines, if he does not understand the art of advertising, he will not be able to secure the sign business that should be had, for it requires just as much special training to talk electric advertising as it does any other kind of advertising.

We have spoken several times in these columns of the necessity for persistent day by day and house to house solicitation, placing little if any reliance upon "whirl-wind campaigns" as permanent business getters. It is true that they arouse interest, but we have maintained that the results will be almost entirely lost unless followed up by persistent house to house work. With signs, however, the conditions are different, and in our opinion, large numbers of signs can be connected most easily by a well planned campaign. There is a sort of contagious influence about sign advertising as well as a friendly rivalry among merchants, and by first arousing interest and then following it up with a rush, results can be secured as the wave of enthusiasm is rolling high, that would be difficult to get under normal conditions. This fact is abundantly demonstrated by the sign campaigns which have been held recently in various cities, notably in

Galveston, Texas, as a result of a combination campaign conducted by the Brush Electric Company and the sign people. In this case considerable effort was put forth prior to the campaign itself, and the prospects worked up, when at the proper time the concerted effort was put forth with the results named.

Returning to the question of the sign specialist, we give it as our opinion that in towns of 40,000 and upwards there should be a man on the field who, while doing other lines of work, should give at least a part of his time to systematically taking care of the sign business. In towns of 100,000 and upwards it is probable that one experienced employee can be profitably engaged entirely on sign business, at least for a good part of the year, while in cities of 250,000 and upward it would probably be profitable to organize a sign department with two or more men employed continually on this work. In addition to this, there would be a need for extra men at times of special campaigns.

As already stated in connection with power and illumination, there is also a distinct advantage in having a specialist in the sign line. Apart from the influence gained through any superior knowledge he may have on the subject, there is a tendency on the part of customers to be more easily influenced by one who poses as an expert along any line than by the common everyday solicitor, no matter how good he may be. Furthermore, in the matter of closing a deal, often the special man can do better than the regular solicitor could do alone.

As regards the method of handling the sign business, we recognize, of course, the fact that there is no scientific reason for charging for the current used for signs on a different basis than that employed for any purpose, since it requires a very simple analysis to show the amount of fixed and variable charge that is necessary. Hence if signs are put on a meter, as is sometimes the case, the conditions as far as we see do not call for any special treatment. However, due to the fact that the hours during which the sign is required to burn can be quite definitely arranged, the the growing tendency on the part of central stations is to handle as much of this business as possible on a flat rate basis, including in the monthly charge the amount necessary to cover the expense of patrolling, cleaning, and in most cases, the renewal of lamps.

With the introduction of the tungsten lamp there was a considerable discussion among central station men as to how they could reap part of the benefit due to their superior efficiency. We predicted that in the case of general lighting that this could not be done, as the customer investing in a more efficient light source, would naturally claim all of the benefit to be derived therefrom. It is a fact, however, that lighting companies can install signs using the 5-watt tungsten sign lamp on a flat rate basis, including renewals and get a higher rate for the current furnished than they could if the customer had a sign using the old carbon lamp. For instance, we find that one company in a large city furnishes sign lighting at 12 cents per lamp per month for signs under 100 lamps, from 100 to 200 lamps, 11 cents, and over 200 lamps, 10 cents. The signs are burned from dusk to midnight or on an average of 165 hours per month. At this rate, a gross revenue of from 12 cents to 14½ per Kw.-hr. is secured, and since the lamp renewals may be figured at from 3 to 4 cents per Kw.-hr., the net revenue is from 8 to 11 cents per Kw.-hr. There is a further slight reduction, for the expense of patrolling and cleaning, yet still leaving a very fair return for the current used.

As regards the investment required, it has been found quite a stimulus to this class of business to help the customer bear the investment cost by assuming the obligation and allowing him to repay it in installments. In order that the local contractor may get his share of the benefit derived from the sign work, it is much preferable, we think, to allow him to make the installation. This plan has been tried successfully in many places and where persistently carried out has resulted in the addition of a good many signs to the company's circuits. Quite a number of smaller tradesmen can be induced to use electric signs by purchasing and carrying stock at reasonable figures a number of signs reading HATS, SHOES, BAKER, CANDY, LUNCH, HOTEL and the like, and puting them out on the basis already described.

A. G. Rakestraw.

COMMENTS FROM READERS.

C. C. Ousley, Asst. to President Kentucky Electric Company, Louisville, Ky., Describes Most Interesting Window Display Presenting Ball Game.

Electric lamps in a thrilling contest for baseball supremacy has proved a decidedly novel lamp and fan window display in the windows of our handsome new building near the heart of the retail business district. Judging from the size of the crowds which have been attracted by the exhibit, a heavy percentage of Louisville's population must be enrolled among the baseball fans.

The window is laid out to represent a baseball diamond with a team of Mazda lamps defeating a nine composed of metallized filaments,—Gems. No detail has been overlooked in the construction of the display. The actual playing of the last half of the ninth inning is carried out with the Gems at the bat. Descriptive placards relate the results of the game up to this point which show that Gems have been so sadly walloped that the Mazdas are forced to concede them the retirement of seven men instead of three before they will consent to play the last half inning of the game.

The players are represented by "men" ingeniously made out of duplex wire. Sixty watt Mazdas are used as heads in one instance and sixty watt Gems in the other. The Mazda team is provided with blue caps while the competitors wear red. The umpire, a frosted lamp, is the only "man" who remains lighted during the game. The plays are effected by the use of a thirteenpoint flasher which is concealed beneath the platform used as a diamond.

In the course of the game brilliant field work is done by the Mazdas and all men on the team are brought into action one or more times during the half inning. One of the most ingenious stunts is the "fanning" of one Gem player. The grand stand is constructed the full length of the diamond and on this was displayed about a score of electric fans of various types. These fans were all attached to the flasher and made to show their enthusiasm by revolved for a short period when the most brilliant plays were made. On the retirement of the last man about half of the fans get into action, waving paper handkerchiefs to demonstrate their delight. Local flavor is injected into the display by giving the Mazda players the names of members of the Louisville Baseball team, each Mazda being named after a corresponding player on the local club. The

Gems are referred to as the "Has-Been" team. At the same time the electric fans have been named. Many prominent local citizens who never fail to appear at the ball park when the Louisville team is at home are found, shown by means of small placards attached to the electric fans in the crowd of rooters for the Mazdas.

FAN EDITION "KY-EL-CO" EXTRA FAN EDITION

VOLUME OF COLD AIR | HOT TIME IN JUNE, 1913. | NUMBER OF BREEZES

MAZDAS WIN 30 TO 10.

Tungsten Lamps Prove Their Claim to Supremacy In the Incandescent Lighting Field.

GEMS BECOME "HAS-BEENS."

Mazdas Give Three Times the Candles That Gems Do For Same Consumption Of Electricity.

The Fans Give Vent To Much Breezy Chatter.

A grand stand full of "fans" is seeing the last half of the ninth inning between the Mazdas and Gems at "Ky-El-Co" park. They are cheering like March winds as the Tungsten bunch mows down the metallized filaments.

The "Red Caps" were so unmercifully slaughtered while the "Blue Caps" were at bat that they declined to play their half of the last inning unless the Mazdas would consent to seven men instead of three being put out before the game ended. This the "Much-Light-For-Little-Money" fellows readily agreed to, and the fans wafted a few additional zephyrs.

Following is the last half of the ninth inning by plays with Gems at the bat.

(a) The pitcher hands a slow one to the batter and he rips it to left fielder Stansbury who cops it, first man on bench inheriting the stick. ONE MAN OUT

(b) The twirler passes three fast ones over the plate catcher Clemons pulling 'em in in quick succession as the batter allows himself to be retired on three "strikes" and the second benchman comes up. "Booster" Norton starts a "cyclone" in the front row TWO MEN OUT

(c) Lowdermilk to save his arm and to give Clemons a rest and trusting to the outfield to land every fly, passes the Cardinal chap a young bird and he gives it new wings for a soar to right field, Burch opening his mitt to cradle the chirper. The third benchman shows animation. THREE GEMS OUT

(d) The wiry figure on the slab delivers another package by parcels post and the hickory pops it over third Niehoff takes it under cover and the fourth "Red Cap" on the bench yawns and gets in action, while "Bob" Brown and Harry Bingham make merry over Niehoff's good catch FOUR MEN OUT

Mr. Fan Blows Himself Right

(e) Our "blue capped" curve artist hands the 16 candle batter an up-shoot and he splits the diamond with a grounder, which is too hot for Hulswitt at second, but he recovers it in time to rush the sphere to Weinberg at first and "Mr Umps" calls for batter 5 from the bench. FIVE GEMS OUT

(f) Pitcher Lowdermilk drives the cow (hide) toward home and the sixth man from the "Red Cap" team hooks it on his bat for a browse into center field, where Osborne welcomes it with open arms and closed hands, and the next man on the mourner's bench gets "lit up" while Barry Norman, Chas. Thixton and the Mayor's secretary pull off a triple lung expansion act up near the boxes that pushes the rebel yell clear into the Gulf of Mexico SIXTH MAN OUT.

(g) The pitcher feels full to overflowing at the luck of the blue-headpieces and spills a drop on the seventh Gem, who lifts it feebly to short stop Beumiller It's all over but the shouting which is gloriously done in the fan row by "Chairman" Tierney, "Chief" Lindsey, "Chief" Lehan, Gill Boyle, "Doc" Rees, Garnett Zorn, Jack Shiveley and Lewis Johnson

SEVENTH AND LAST MAN OUT AND NOT ONE REACHED FIRST

MR. MAZDA outshines any Diamond, whether Base Ball or Gem.

THE FINAL SCORE

	1	2	3	4	5	6	7	8	9	R	H	E
MAZDAS,	4	2	1	4	3	2	5	6	3	30	19	0
GEMS,	3	1	0	2	2	1	1	0	0	10	6	23

TOO LATE TO CLASSIFY.

LOST—An opportunity to keep cool by not having an electric fan.

[illegible]

[illegible]

FREE COPIES of this EXTRA inside at the FAN COUNTER and the LAMP COUNTER.

KENTUCKY ELECTRIC CO.
INCORPORATED
LIGHT—HEAT—POWER,
And all they Operate
4th Street South of Chestnut

FIG. 1. MINIATURE NEWSPAPER ADVERTISING WINDOW DISPLAY.

The Kentucky Electric Company has issued a "KY-EL-CO Extra" on the game shown here in Fig. 1. It is in the form of a miniature newspaper page gotten up as a sporting edition and describing in detail the play which can be witnessed in the window. The little sheet contains advertising for the company and is illustrated with cuts of fans and lamps. These are distributed by the company at the fan and lamp counters in its display rooms.

Display of Southern California Edison Company, Pasadena, Cal.

In the April issue of *Edison Current Topics*, a small publication issued monthly by the Southern California Edison Company, a most interesting article appeared on the subject of Demonstration by District Agent E. H. Mulligan. Through his courtesy we present here an illustration of the company's Pasadena display room, a model in every particular. It is located in the Hotel Maryland and a lady attendant has charge during business hours for demonstrating the devices.

In commenting on the results of demonstration in his field, Mr. Mulligan says:

In 1911 we added to our load nearly twenty-six thousand household appliances; in 1912 practically the same number, till every consumer of electricity on our lines was using an average of more than one appliance. For the three years since 1909, demonstration of the lightening of the housekeeper's burdens by the use of these electric appliances

FIG. 1. PASADENA DISPLAY ROOM, SOUTHERN CALIFORNIA EDISON COMPANY.

alone, by the fifty thousand users of them before 1909 brought more than sixty-three thousand additional appliances into use. In other words, "We have seen, we now believe."

It has, then, assuredly been *fortiter in re* with us in the matter of demonstration and we have met the Missourians on their own ground, as it were, and they are ours. Demonstration, as we have seen thus far, can be measured in dollars and cents and the actual results obtained are shown in our operating reports.

Never before in this world of ours, since sale and barter began, has the demonstration of courteous treatment in our business relations been so clearly defined as an asset as in this present day and age. Here we have not had our engineers to theorize for us, we must continue to work out our own salvation lest we bring reproach on our company, and here must perfection in demonstration be sought for, taught and imbibed till this goal also is reached and we again achieve. The "square deal," that slogan of the twentieth century, can mean no greater thing than the demonstration of our willingness to serve in all courtesy, fairness and honesty; not for policy, not because we *must*, but because the light has reached us and we too believe.

Finally, demonstration for us is achievement, for as we achieve we progress. Then what more inspiring watchwords can we take for the year before us, for 1913, than Courtesy and Progress, Courtesy in all of our dealings?

Mr. Frank Hammond, Jr., Contract Agent Birmingham Railway, Light & Power Company, Birmingham, Ala., Outlines a Sale of Electric Irons.

We have just completed a fairly successful campaign on the sale of electric irons, that we may put under the head, "Let the Fair Sex Do the Work." Our plan was to write a letter to the president of the various church societies along our line, stating that we had a proposition by which we felt that through a little effort on their part we could increase their treasury to some extent during the coming months. The subject of this proposition was left blank for the purpose of exciting the feminine curiosity in order that we might receive in the office a telephone call or a letter seeking the intention of the proposal, at which time I requested the privilege of calling upon the society at its regular meeting and explaining in person our intention. This was that we sell our irons at $2.75 each, allowing a credit of 50 cents payable in cash for the sale of each iron. We feel that although we have received no record sales from the effort, that we have placed before several hundred ladies a good talk on electric heating devices in the home. We have already sold a number of irons and further results look very favorable.

R. B. Mateer, Sales Manager Great Western Power Company, Suggests More Consistent Boosting of the Electric Range by Commercial Managers.

A few years ago the small electric appliance was placed on the market by manufacturers interested in promoting the use of current-consuming devices. Cooperation between manufacturers and central station managers has resulted in many thousands of these small appliances being placed in the hands of public utility consumers, and today the appliances are so popular on account of their convenience and economy of operation that many light and power companies claim a better load factor and greatly increased revenue.

Those appliances first meeting with public favor were the electric iron, the toaster, and the percolator, which have long since ceased to be considered as luxuries. Now the vacuum cleaner, sewing machine motor, the electric washer, and hot plate are advocated as means of increasing the use of electric service. Why not boost the electric range? It is no longer an appliance passing through the experimental stage, but has proved a decided convenience where used in the home. Certainly it is not on account of the operating cost that such an appliance is not in general use for it has been demonstrated that the range can compete with gas and other fuels. Is it then, the attitude of those managers of combination companies fearing the range to be a competitor of gas-consuming appliances, or is the general use of the electric range prohibited by reason of the apparent high first cost?

Like every patented article, a higher price is asked for the range adapted for electric service than for the old style coal range or one adapted for gaseous fuels. Yet, as the popularity of the coal range and gas range increased, resulting in greater demand for such appliances, the cost of manufacture decreased. So might the price of the electric range be decreased as the central station and the public appreciate the value of electric cooking. It is reasonable to suppose that the price of the range will decrease in a manner similar to that of the tungsten lamp which now costs but little in excess of the old style 50 watt carbon lamp. Why should the central station, therefore, maintain an attitude of indifference to the electric range instead of joining hands with the manufacturers, encouraging a popular demand for the appliance and resulting in the establishment of a price within reach of the average consumer? As it required active solicitation on the part of the public utility, combined with attractive advertising, to introduce the iron for domestic purposes, it would seem reasonable that an equal amount of money spent in a publicity campaign would result in the establishing of the electric range in the home as an appliance possessing convenience and removing such current-consuming device from the ranks of apparent luxury. Considering the desire on the part of every lighting company to increase its load factor, especially in the summer months, through the sale of current to amusement parks, isolated plants, and for irrigation purposes, should not some effort be made to encourage the use of the electric range which can be classed not only as profitable summer business, but of value throughout the year.

In casting around for methods of straightening out the load curve, some attention must be given to the domestic consumer and encourage the use of such appliances, especially the range, as will utilize transformer capacity during the daylight hours, and promote all-year-round business. Boost everything electrical, not only those appliances which are at the present time meeting with popular favor, but purchase a range yourself, try it out in your own home, and then administer to the customer large doses of the tonic which you have found beneficial. You can then speak from experience and not from hearsay evidence.

Mr. E. D. Craig, President the Savannah Electric Garage & Tire Company, Outlines Electric Vehicle Situation in Savannah, Ga.

When we opened up the electric garage in Savannah, business was in a chaotic condition. We found owners of pleasure vehicles who were afraid to drive their cars to Thunderbolt, a distance of about five miles, fearing they would run out of juice. This condition was mainly caused by incompetent handling on the part of both the owners and so-called garages. The electric owners were considered a joke by the garage men, no attention being given them whatever. Instances have been brought to our attention where owners were compelled to buy new batteries after six months' service. We have cured all of these troubles by paying attention to the small details, treating the customers nicely, giving them first-class service in every way and charging a nominal price for same. A number of the real old cars have been taken in exchange and broken up by us to get them off the streets, the balance of the old cars that were worth it were overhauled and are still in service. Twenty new cars have been sold and the electric vehicle situation is in healthy shape at the present writing. All of the cars are giving service and satisfaction and the owners have changed from knockers to boosters, which will prove to be beneficial to both ourselves and the central station.

FIG. 1. INTERIOR SAVANNAH'S ELECTRIC GARAGE.

We teach all the members of a family to drive their car so that cars are in service every day. No charges are made by us for teaching to drive electric vehicles. We are completely equipped to thoroughly overhaul and rebuild cars, including the batteries, tires, car work and painting, and have four floors 60 x 90 feet devoted exclusively to electric vehicles.

There are now three commercial cars in successful operation in Savannah; one of them a Waverly, which is seven years old, still doing excellent work; the second one a Waverly light delivery wagon, which has run in twenty-one months over 20,000 miles, and makes three complete trips in the city each working day, and four trips on Saturdays. This car has never missed a trip and delivers packages on all of the sand streets in the city of Savannah. The one thousand pound Baker truck owned by the Savannah Electric Company has only been in service a couple of months and is giving excellent satisfaction.

There are a great number of interested prospects for electric commercial cars in Savannah, among them dry goods and department stores, laundries, hardware and supply houses, furniture and builders' supply houses, express companies, transfer companies, breweries, etc., and we confidently expect to place a number of electric trucks in the city the next few months. When this is done you will see Savannah leap to the front in the electric vehicle field.

Questions and Answers from Readers

Readers are invited to make liberal use of this department for discussing questions, obtaining information, opinions or experiences from other readers. Discussions and criticisms on answers to questions are solicited. However, editors are not responsible for correctness of statements of opinion or fact in discussions. All published answers and discussions are paid for.

SIZE OF 3-PHASE MOTOR STARTER.

Editor Electrical Engineering:

(383) Please request some reader to outline the necessary requirement in order to select the proper size of starter for a 3-phase motor. That is, what data as to motor and circuit is required? W. E. D.

OPERATION OF WATER WHEEL AND MOTOR ON SAME SHAFT.

Editor Electrical Engineering:

(384) I would like some information in regard to running a motor and a water wheel connected to the same shaft. The wheel and motor now operate separate sections of the shaft, the main shaft being uncoupled. The wheel pulls its load with the gate about half open. Could this shaft be coupled and the gate opened wide allowing the water wheel to do all the work it could with the motor to take care of the remaining or overload on the wheel? Would the speed be regular and would there be a saving of current in this operation with gate open wide? Should the load go off suddenly would the motor hold the wheel to normal speed? The motor is alternating current operating at 2,200 volts. J. P. L.

CONSTANT FOR A. C. METERS.

Editor Electrical Engineering:

(385) Please advise how to find the constant of an A. C. watthour meter. The meter I desire to find the constant for is a 200-volt instrument, used on a 100-volt circuit. The ratio of the series transformers is 20 to 5 and of the shunt transformers 6,000 to 100 volts. S. C.

SYNCHRONOUS MOTOR-GENERATOR SET VS. INDUCTION MOTOR SET.

Editor Electrical Engineering:

(386) The company with which I am connected is negotiating with a coal mine to supply electric service. The conditions are as follows: Length of transmission line, 3 miles; voltage, 2,300; 60 cycles; 3-phase; load approximate, 60 Kw. consisting of 40 horsepower mining locomotive, 25 horsepower mining machine, and 15 horsepower in fan and additional motors. The load factor of the mining locomotive and machine cannot be taken higher than 30 per cent, but the 15 horsepower motors will run 8 hours a day continuously. The mine is now using a storage battery locomotive capable of hauling 7 or 8 cars (3,500 pounds total weight). For the above equipment, I would like to know the relative merits of the motor-generator set and synchronous motor-generator set, the generator being direct connected and a D. C. machine of 250 volts. How do the two sets compare in price? The ability to make a power factor correction on the system as a whole seems the only point in favor of the synchronous motor. If there are other advantages, I would like to learn them. F. G. F.

NATURAL AND CRITICAL FREQUENCY OF A TRANSMISSION LINE.

Editor Electrical Engineering:

(387) Kindly explain in your columns the difference if any between natural and critical frequency of a transmission line. The writer is of the opinion that the critical frequency would be the operating frequency required to produce resonance in a given system or in other words if the operating frequency were made the same as the natural frequency of the line, such would be the critical frequency. Aside from there being an excessive voltage produced, I am not quite clear as to whether or not this would cause an excessive current to flow in the line regardless of the connected load. I am of the opinion that it would, as it seems that with this condition, the voltage of the alternator would only be required to overcome the ohmic resistance of the line. Any information further will be appreciated. C. A. H.

USE OF TIME LIMIT RELAYS.

Editor Electrical Engineering:

(388) Will some reader please discuss the advantages and disadvantages of using time limit relays in connection with automatic circuit-breakers on polyphase high tension transmission circuits? P. N. P.

WHY DOES LOAD SUDDENLY INCREASE?

Editor Electrical Engineering:

(389) The ammeter on the switchboard of our 3-phase 2,300-volt primary, 110-volt secondary system ordinarily

shows about 20 amperes. Once in a while the pointer jumps up to 60 amperes and sometimes to 80, then right back to 20 amperes again, but sometimes stalling a 150-horsepower engine. This happens when there is positively no motor load. What conditions might cause this ammeter action?

K. E. P.

Transformers for Induction Motors. Ans. Ques. No. 347.

Editor Electrical Engineering:

As a general rule, it may be considered that the proper size of transformer to install for an induction motor is a combination having a kw capacity equal to the hp. rating of the motor. This rule holds for motors from 10 to 50 Hp. For motors below 10 Hp about 10 per cent additional capacity should be added. Where three-phase motors are operated from two transformers the capacity of each transformer should be 150 per cent of the capacity arrived at when applying the above rule, for three transformers. That is, when using two transformers the capacity of the two must be equal to the capacity of three for the same load on the motors.

A table of transformer capacities for various sizes of motors is found on page 296 of Foster's Handbook. Mr. Bowker also gives a table in his excellent article, page 70 of the February issue. In this table sizes of transformers are given for three-phase circuits using two and three transformers and for a two-phase circuit using two transformers.

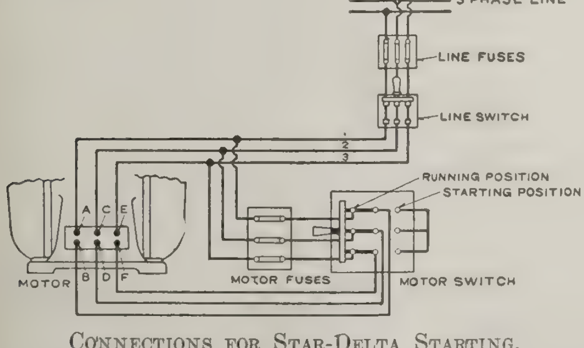
H. F. Boyle. (N. Y.)

Star-Delta Starting Scheme. Ans. Ques. No. 351.

Editor Electrical Engineering:

Where a three-phase induction motor is not required to start under load, the star-delta method of connection for starting can be used and is in most cases permitted by the Underwriters. The only objection that the Underwriters can have to the scheme is covered when the wiring and fuses to the motor satisfy rule 8-b of the code, and the requirements as to capacity of switches.

The Wagner Electric and Mfg. Company makes a motor especially adapted to this method of starting. Six leads are brought out from the stator as shown in Fig. 1, when the star-delta wiring can be arranged as there shown without a starter.



CONNECTIONS FOR STAR-DELTA STARTING.

Under this arrangement when a motor is to be placed upon a three-phase circuit of 220 volts and is to operate a device not requiring at starting more than 60 per cent of normal full load torque, the starter may be omitted, and a triple pole double switch used in its place, connecting the motor in star (or an equivalent of 60 per cent voltage) at starting, and in delta for normal operation. Under such conditions the starting current will be approximately 1½ times normal current.

The scheme of omitting and using in place thereof a double-throw switch is not practicable for two phase motors, due to the low-starting torque obtained and the rush of current when full voltage is applied. This current will be much greater in two phase than in three-phase. The size of switches recommended for this scheme of starting with Wagner motors, is 30 amperes for ½ to 7½ Hp., 100 amperes for 25 to 35 Hp, and 200 amperes for 40 to 50 Hp.

By this scheme the voltage per phase at starting is $1 \div \sqrt{3}$ or 58 per cent of the line voltage. The starting torque is proportional to the square of the starting voltage which would give the starting torque about 33 per cent that for full line voltage.

This scheme was briefly discussed by Mr. Phillips and Mr. Dennison and the voltage relations discussed by them on pages 97 and 99 of the February issue.

H. B. Davis, (Mo.)

Star-Delta Starting Scheme. Ans. Ques. No. 351.

Editor Electrical Engineering:

There are two objections commonly taken to the use of the star-delta wiring arrangement. First, in the case of some motor installations the starting torque required can not be obtained from the commercial or average induction motor. Such cases are often found in connection with wood-working machinery. Second, in the case where a 3-P-DT switch is used the installation is not foolproof. It is sometimes further contended that, since six wires are required from the switch to the motor, the cost of installing is more expensive. The underwriters object to the use of the 3P-DT switch on account of the constantly live and exposed contacts. This method of starting an induction motor can be used on sizes up to 30-horsepower provided the starting characteristics of the motor are sufficiently good. As a point of fact, there is on the market a specially designed "Star-delta" switch which is of the controller type, not in the form of a knife switch. This switch is oil immersed and for all classes of work with exceptions as pointed out above, this switch is far superior to the "auto-starter," since it does away with all unnecessary coils, thus reducing materially the cost of maintenance.

Wm. Mangum. (N. Y.)

Kva. and Kw Ratings. Ans. Ques. 365.

Editor Electrical Engineering:

The Kva rating of a transformer is independent of the power factor of the circuit on which it may be operated, while its Kw capacity, if its Kva rating is not to be exceeded, does depend upon the power factor.

When current and voltage are not in phase, the former has a reactive component which, while it does no useful work, gives a larger resultant current. The heating effect on line and all connected apparatus is proportional to the square of this resultant current. The power factor, therefore, limits the useful load that a given transformer will carry without exceeding its Kva rating. The Kw capacity is equal to the Kva rating only when operated at unity power factor. It is therefore evident that manufacturers naturally have had to choose some basis for rating, which would be independent of "power factor," hence the kilovolt-ampere and volt-ampere ratings.

G. S. Wills (Ariz.)

New Apparatus and Appliances

Oscar C. Turner Organizes and Heads Turner Electric Supply Company.

The Turner Electric Supply Company has recently been organized to succeed the Southern-Wesco Supply Company of Birmingham, Ala. The officers of the new company are: Oscar C. Turner, president; James J. Fitzsimmons, vice-president; Wm. M. Bowles, secretary; and J. D. Turner, treasurer.

Mr. Oscar C. Turner has headed the Southern-Wesco supply Company as president for the past four years, with Roger V. Scudder as vice-president. The death of Mr. Scudder some weeks ago caused the new organization whereby the Turner brothers secure entire control of the company. This makes one of the largest electrical houses in the south now strictly a Birmingham concern. While the company at present acts only as jobbers and wholesalers in electrical and automobile supplies and accessories, Mr. Turner has stated that in the course of time as the business expands, it is the intention to erect in Birmingham a large electrical apparatus manufacturing plant.

Mr. Oscar C. Turner has been prominently connected with Southern electrical activity and well known in electrical supply circles for the past twenty-three years. He started in business with the Georgia Electric Light Co., of Atlanta, his home town, after graduating from college in 1905. At that time Mr. H. E. Edgar was manager of the above company and G. W. Brine, cashier, the company then operating about 2,500 incandescent lamps on their circuits with very few fans and no arc lamps. Mr. Turner's duties

JOHN D. TURNER, TREASURER OF TURNER ELECTRIC SUPPLY COMPANY.

at that time included visits to customers and prospective customers to advise concerning the safety in the use of lamps and electrical wiring for same. He was later made purchasing agent and finally secured the wiring business handled by the company and established in business under the name of Turner Brothers, W. W. Turner being associated with him. He conducted in Atlanta an electrical contracting and supply business until 1896 when he sold out and went with the Atlanta Street Railway Company, then controlled by Joel Hurt, having charge of the contract and construction department of this company until it was merged with a competing company. Mr. Turner then became connected with the Western Electric Co. as traveling representative and after two years was made manager of the apparatus department of the Cincinnati office, which position he held for two and a half years, leaving to become vice-president and general manager of the Southern Elec-

OSCAR C. TURNER, PRESIDENT OF TURNER ELECTRIC SUPPLY COMPANY.

trical Co., electrical jobbers, at Nashville. He remained in this position for four years when he was appointed general manager of the Warren Electrical Specialty Co., manufacturers of Peerless lamps at Warren, O. After two years in this position he resigned to purchase an interest in the Birmingham branch of the Wesco Supply Co., this company then doing a small supply business in Birmingham. He re-organized the branch in 1909, calling it the Southern-Wesco Supply Co. At that time there were only four members of the office force while today thirty-three are employed and the states of Georgia, Florida, Mississippi, Alabama, North and South Carolina and Tennessee covered by representatives.

Mr. Turner has been prominently connected with civic and political affairs of both Birmingham and his state, being president of the Underwood club during the recent political campaign. He is first vice-president of the Chamber of Commerce of Birmingham, a member of the Elk's Club, the Country Club, Birmingham Motor & Country Club, and director of the State Fair. He was an important figure in the recent membership campaign of the Birmingham Chamber of Commerce when in five days 1249 members were secured. He also originated and carried out the Potlatch Celebration in April of 1913, showing up the successful growth and businesses of Birmingham.

Mr. John D. Turner, now associated with Mr. Oscar C. Turner and a part owner of the Turner Electric Supply Co., has for a number of years been connected with the textile industry. He was with the Exposition Cotton Mills for a number of years in Atlanta, later in the cotton business in North Carolina, and a representative of Stephen M. Weld in Atlanta. He moved to Birmingham in 1911 to become associated with Mr. Turner in the Southern Wesco Supply Co., taking charge of the financial end.

The organization of the Turner Electric Supply Co. is interesting on account of the fact that the stockholders, other than the principal owners, are employees of the company, among whom are F. P. Jeter, C. W. Burney, A. H. Shirley, W. H. Low, and Fred Schuing. The company is well established and handles one of the largest jobbing and electrical supply businesses in the South.

New Weston Instruments.

The Weston Electrical Instrument Company, of Newark, N. J., has recently placed on the market a new line of miniature direct current instruments, constructed on the permanent magnet movable coil principle. This line includes voltmeters, ammeters, volt-ammeters, special battery testing voltmeters and milli-ammeters. Single, double and triple range volt-ammeters are also offered in various combinations. The standard finish is dull black with nickel trimmings. The weight of these instruments is less than

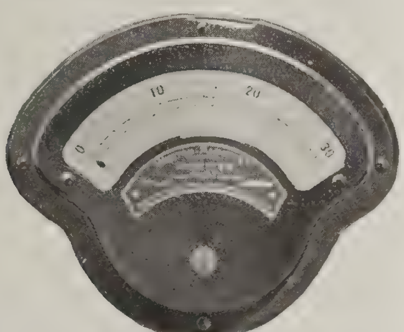


FIG. 1. WESTON SWITCHBOARD VOLTMETER OR AMMETER.

one pound each, being so compact that they may be easily carried in a coat pocket. The portable forms have knife edge points, and the switchboard type has a pear-shaped or "spear-head" pointer, to permit being read at a distance. The scale is 2.75 inches in length and the entire instrument in portable form has outside dimensions of only 4.4 by 4.6 inches.

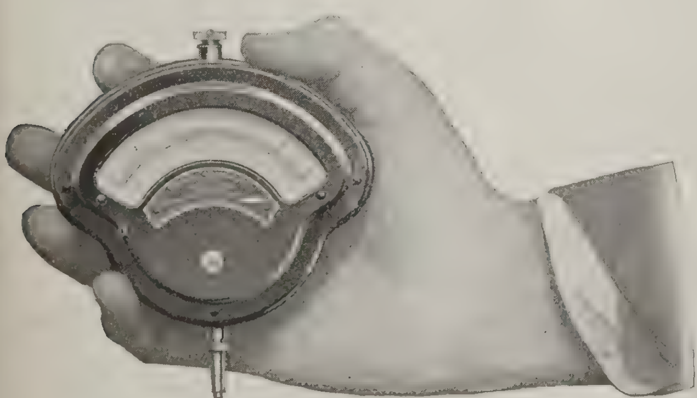


FIG. 2. WESTON BATTERY-TESTING VOLTMETER.

With the triple range volt-ammeter, any current from 30 amperes to 0.05 ampere may be determined and any voltage from 150 volts to 0.02 volts may be directly measured. Fig. 1 is an illustration of a miniature switchboard meter. The movements in these instruments are practically identical with those in the portable form. Made only in single range with back connections.

Fig. 2 represents a battery testing voltmeter, one-half actual size. A steel point may be fastened to one terminal and a flexible cord with another point attached to the other terminal. These are furnished with the instrument and permit the rapid measurement of the individual cells of a battery. The scale is regularly calibrated with zero in center. On automobile dash boards, on gasoline launch switchboards and elsewhere, when space is an important consideration, and one instrument must be used for the determination of current and e. m.f. the Weston volt-ammeter. Fig. 3, is specially useful. Normally, it indicates the charging or discharging current, but when pressure is applied to a contact button it registers volts, without breaking the current circuit

FIG. 3. AUTOMOBILE VOLT-AMMETER.

Exhibits at N. E. L. A. Convention.

The following firms had exhibits and occupied booths at the recent N. E. L. A. convention reported elsewhere in this issue:

Adams-Bagnall Electric Company, Cleveland, Ohio—Flame Arc Lamps

American District Steam Company, North Tonawanda, N. Y.—Models of steam-heating fittings.

American Ironing Machine Company, Chicago, Ill.—Electric ironing machines.

Bell Electric Motor Company, Garwood, N. J.—Alternating cur-

Benjamin Electric Manufacturing Company, Chicago, Ill.—Industrial fixtures and lighting specialties.

Century Electric Company, St. Louis, Mo.—Single-phase motors.

Chicago Fuse Manufacturing Company, Chicago, Ill.—Enclosed fuses and conduit fittings.

Conlon-Simplex Machine Company, Chicago, Ill.—Electric washing machines.

Co-operative Advertising Service for Central Stations, Chicago, Ill.—Advertising specimens.

Cooper Hewitt Electric Company, New York—Mercury-vapor lamps.

Duncan Electric Manufacturing Company, Lafayette, Ind.—Meters and transformers.

Duplex Metals Company, Chester, Pa.—Copper-clad wire.

Economical Electric Lamp Works of General Electric Company, New York, N. Y.—Turn-down electric lamps.

Economy Fuse & Manufacturing Company, Chicago, Ill.—Fuses.

Edison Storage Battery Company, Orange, N. J.—Storage batteries.

Electric Appliance Company, Chicago, Ill.—Regulating and protective apparatus.

Electric Service Supplies Company, Philadelphia, Pa.—Protive devices and line specialties.

Electric Storage Battery Company, Philadelphia, Pa.—Storage batteries.

Electric Vehicle Association of America, New York, N. Y.—Cooperative periodical.

Electrical Review & Western Electrician, Chicago, Ill.—Electrical periodical.

Electrical World, New York, N. Y.—Electrical periodical.

Eureka Vacuum Cleaner Company, Detroit, Mich.—Vacuum cleaners.

Federal Sign System, Electric, Chicago, Ill.—Signs, meters, protective devices and transformers.

General Electric Company, Schenectady, N. Y.—Electrical machinery, apparatus and instruments.

General Vehicle Company, Long Island City, N. Y.—Electric devices.

G. & W. Electric Specialty Company, Chicago, Ill.—Lnie and high tension devices.

Hotpoint Electric Heating Company, Ontario, Cal.—Heating devices.

Hubbard & Company, Pittsburgh, Pa.—Line material.

Hughes Electric Heating Company, Chicago, Ill.—Electric ranges, stoves and radiators.

Hurley Machine Company, Chicago, Ill.—Washing machines and vacuum cleaners.

Innovation Electric Company, New York—Suction cleaners.

H. W. Johns-Manville Company, New York, N. Y.—Protective devices, conduit, refrigeration and insulation.

Life-Saving Devices Company, Chicago, Ill.—Resuscitation apparatus.

W. N. Matthews & Bro., St. Louis, Mo.—Fuse switches and line material.

Metropolitan Engineering Company, New York, N. Y.—Meter protective devices.

Minerallac Electric Company, Chicago, Ill.—Maximum-demand devices.

Moloney Electric Company, St. Louis, Mo.—Transformers.

National Quality Lamp Division of General Electric Company, Cleveland, Ohio—Incandescent lamps.

National X-Ray Reflector Company, Chicago, Ill.—Indirect lighting and direct lighting reflectors.

Oshkosh Manufacturing Company, Oshkosh, Wis.—Construction tools.

Otis Elevator Company, New York, N. Y. —Elevators.

Phileadelphia Electric & Manufacturing Company, Philadelphia, Pa.—Lighting standards.

Pittsburgh Transformer Company, Pittsburgh, Pa.—Transformers.

Popular Electricity Magazine, Chicago, Ill.—Electrical periodical.

Sangamo Electric Company, Springfield, Ill.—Instruments and meters.

John A. Roebling's Sons Company, New York, N. Y.—Wires, cables and fittings.

Simplex Electric Heating Company, Cambridge, Mass.—Heating devices.

Southern Exchange Company, New York, N. Y.—Poles and crossarms.

Standard Underground Cable Company, Pittsburgh, Pa.—Wires, cables and accessories.

Thompson Electric Company, Cleveland, Ohio—Cut-out hangers.

Transportation Committee, N. E. L. A.

Tungstolier Works of General Electric Company, Conneaut, Ohio—Fixtures.

Valentine-Clark Company, Minneapolis, Minn.—Butt-treated poles.

Wagner Electric Manufacturing Company, St. Louis, Mo.—Electrical apparatus and instruments.

Western Electric Company, New York, N. Y.—Appliances, line and supply material, telephone apparatus, instruments and appliances.

Western Water Supplies Company, Kansas City, Mo.—Electric sterilizers and coolers.

Westinghouse Electric & Manufacturing Company, Pittsburgh, Pa.—Electrical machinery, apparatus, instruments and appliances.

Westinghouse Lamp Company, Bloomfield, N. J.—Incandescent lamps.

Westinghouse Machine Company, Pittsburgh, Pa. — Primemover apparatus.

Weston Electrical Instrument Company, Newark, N. J.—Instruments.

Wilkinson Company, Chicago, Ill.—Portable lamps.

Electrical Construction News

This department is maintained for the contractor, dealer, manufacturer and consulting engineer.

ALABAMA.

BIRMINGHAM.—The Birmingham Railway, Light & Power Co. is to install a 22,000-volt transmission line to Lewisburg, Kimberley, and Sibleyville. This line will serve coal mines and manufacturing plants. It is futrher understood that additional generating equipment will be installed in the power plant at 18th and Paul Ave.

ROANOKE.—The city of Roanoke is to erect a power transmission line. Two 150-horse power boilers and one 300-horse power engine and one 12-Kw. exciter are to be installed, also pumps, switchboards, transformers and the necessary line maerialt for the transmission system. This will include lightning arresters, tub transformers and arc lamps. W. S. Green is superintendent.

FLORIDA.

JACKSONVILLE.—The Southern Utilities Co., of Jacksonville, is to install additional equipment in the plant of the Ariston Ice and Electric Co. at Fort Myers, where one 300-Kw. turbo generator set and four panel switchboard will be installed and one 150-Kw. direct connected tandem compound engine and four panel switchboard at Arcadia Ice & Electric Co. of Arcadia; one 150-Kw. compound direct connected unit at the Tarpon Springs Ice & Electric Co. at Tarpon Springs. J. G. White Engineering Co. of 43 Exchange St., New York City, are operating managers. The local general manager is H. G. Adams, of Jacksonville.

MISSISSIPPI.

JACKSON.—The Capitol Light & Power Co. have recently rebuilt its plant and will extend its distribution system. Collins Johnson is secretary and treasurer.

PONOTOC.—The Ponotoc Electric Light & Power Co. is to install a water works system. L. E. Price is manager.

WIGGINS.—The Wiggins Electric Light Co. is to purchase a 150-Kw. 60 cycle, 2,800-volt generator with exciter and switchboard. A. W. Reid is treasurer and manager.

NORTH CAROLINA.

BURLINGTON.—The Piedmont Railway & Electric Co. is to construct a hydro-electric plant between Burlington and Graham and will develop 3,000 horse power for transmission to operate lighting and raiways systems at Burlington, Graham, Haw River, Mebane, Swepsonville, Elon College and other cities.

HIGH POINT.—It is understood that High Point is to purchase power for operating its system from the North Carolina Public Service Co. and will construct a transmission line to connect with the latter company.

OKLAHOMA.

HENNESSEY.—The Hennessey Electric Light, Power and Ice Co. has recently built a plant containing a 55-Kw., 2,300-volt, 3-phase generator connected to an 80-horse power oil engine. It is expected that within the next six months a street lighting system will be installed consisting of 30 250-watt tungsten lamps. The company is operated by T. A. Chatswell Company, T. A. Chatswell, general manager.

OKEMAH.—The Northern Texas Traction Co. is planning to erect a terminal building in Dallas. The building will be used for a sub-station to distribute energy for local street and railway systems and for lighting and power business.

SOUTH CAROLINA.

CHARLESTON.—The Isle of Palms Traction Co. of Charleston is to erect two sub-stations and purchase equipment including instruments, switchboards, etc. W. W. Fuller is general superintendent and chief engineer.

TEXAS.

AUSTIN.—The Colorado River Power Co., which has under construction a dam across the Colorado river near Balinger, for

ELECTRICAL ENGINEERING

PUBLISHED MONTHLY

Vol. 45. AUGUST, 1913 No. 8

PUBLICATION OFFICE
DALTON, GA.

EDITORIAL and ADVERTISING DEPARTMENTS
GRANT BUILDING ATLANTA, GA.

SUBSCRIPTION RATES

Domestic ..... $1.00 For Two Years
Canada ..... $1.00 Per Year
Foreign ..... $1.50 Per Year

Complaints of failure to receive ELECTRICAL ENGINEERING regularly or of any errors of any nature, should be promptly made to the Atlanta office.

Advertising copy or change orders for standing advertisements must reach the Atlanta office by the 5th of the month preceding the month of publication.

Entered at Dalton, Ga., Postoffice as Second-class Matter.

CONTENTS.

Macon, (Ga.) Convention of Southeastern Section, N. E. L. A.

During the present month, August 14 to 16, the central stations of the states of North and South Carolina, Georgia, Florida and Alabama are to add another link to the chain of events making up the history of southern electrical development, through the assembling in convention for the first time as a body organized under a definite standard and determined together to work out the problems of future expansion and service. In the words of President Deal, the nature of southern developments, through consolidation of properties and miles of inter-connected transmission lines, is such that a "community interest" has been created affecting every one of the southeastern states so that now southern managements can no longer hold that their problems and conditions are materially different from those of other sections in this district and can best be solved alone. The problems of one station are the problems of the others, varying slightly in one direction or the other according to the stage of development and diversity of the loads. In the main, the commercial interests are the same and the slight differences and peculiarities of one load form useful information for another station that may be nearly to or at a point that some station has already passed through. Again our stations need to discuss the connection of those loads that at present seem least profitable, yet attractive through characteristics tending toward improvement of load factor. And so it is through this "community interest" that the experience of one station, whether it be large or small adds to the experience of another with results that cannot help but be beneficial to all. It is in this way that a standardization of service can be hoped for and the public given a basis for the comparison and analysis of the problems which at times seem to them intrigues of injustice, yet which can after all be analysized as the problems of any other corporate business when given a consideration on a similar earning and service basis. In this regard we predict the greatest usefulness of this association work the value of which only the future can tell.

From the standpoint of southern central station progress, which has been so rapid and marked, the formation of the Southeastern Section of the National Electric Light Association, is a most important step. It is so generally recognized and by those who have had years of experience in the organization, operation and management of public utility properties. It bears out the further development of the national organization and undoubtedly in the near future will be only one of a large number of territorial divisions of this association, of which at present there are only three. The purpose of the Southeastern Section is in the main simply a further application of the purpose of the national body to a particular section as already explained in these columns and generally known. It is therefore important to the future growth and successful development of all our southern stations as financial propositions and as public utilities, that affiliation be at once established or at least the merits of such affiliation investigated. The Macon convention will be a good time to do this—the matter will be thoroughly discussed—you have had several invitations—it is up to you to come.

In regard to the convention, President Deal has the following to say: "The program and plans are practically completed. It is gratifying to note the interest that is being manifested by the members, for everything points to the convention being the largest and most successful gathering of electrical men that has ever taken place in the South. From one to ten representatives are expected from each central station company, and a large delegation will be on hand to represent the manufacturers. The papers to be presented deal with live subjects, effecting the successful management and operation of the central station companies doing business within the states making up the Southeastern Section.

"Electrical developments have been so rapid and extensive in the South during the past few years as to make it absolutely necessary that those engaged in the electrical industry in the states covered by the Southeastern Section form themselves into a 'closer-at-hand' organization than is true of the National Electric Light Association, in order to properly advance the best interests of the entire industry. There is no other business, profession or trade worth speaking of, but that has its state or section organization for the purpose of maintaining maximum progress, and no argument should be necessary to make it plain that the central station business demands closer association, more harmony of action, and general co-operation than any other present day business. This is of unusual importance where consolidations, water power developments, and extensive transmission systems have been so great as to create a strong 'community interest' extending over neighboring states such as have been created during the last few years in the Carolinas, Georgia, Florida and Alabama.

"There is no way of dealing fairly and effectively with this 'community interest' except through intelligent and active association work, hence the formation of the Southeastern Section of the N. E. L. A., and the great interest the convention is attracting. Central station companies which decline to take time by the forelock, and at least get together with their neighbors occasionally for the purpose of exchanging experiences and ideas are not properly lending their influence to the good cause of the central station industry, and will sooner or later find themselves embarassed through lack of activity or interest in matters essential to the general good o fthe business. A consideration of these facts makes it the duty of every company to send at least one representative to the convention, and as the program is such that all who attend should be greatly benefitted, each company should send as many employees as they possibly can. The coming convention promises to mark an epoch in 'community interest' activity of the central station industry of the South, and we mean that it shall."

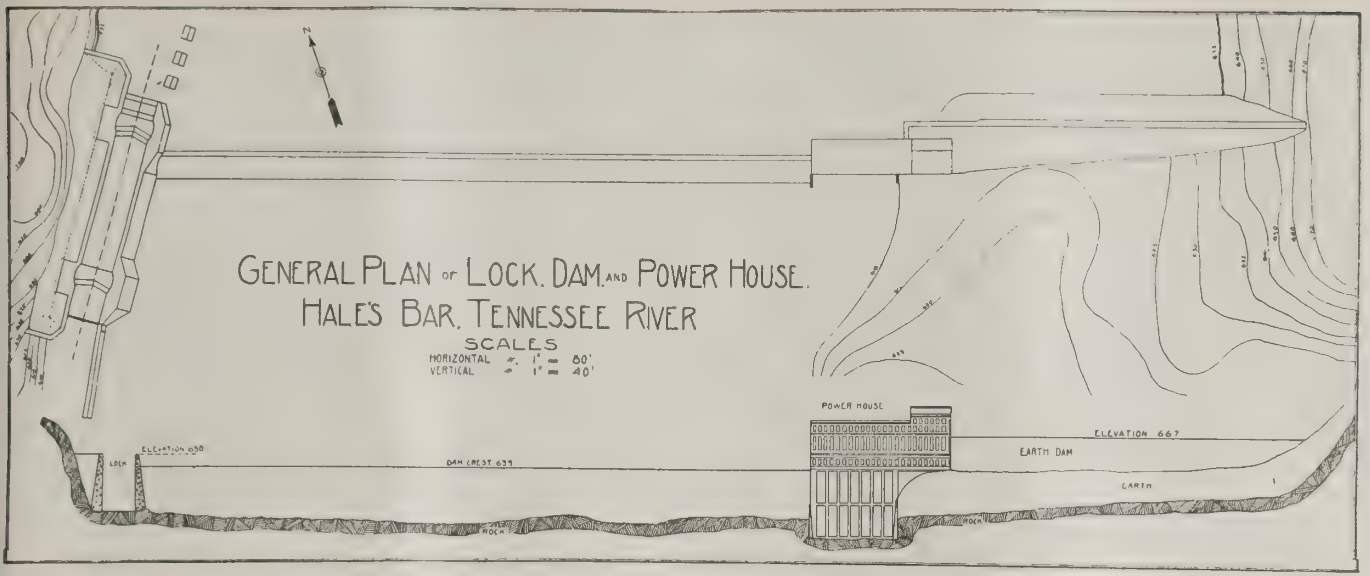
The convention program and other details of transportation, hotel accommodations, etc., are found elsewhere in this issue.

Consolidation.

The discussion at the recent N. E. L. A. convention of the advantages gained through the combination of lighting, power and railway loads, touched upon a topic closely associated with the tendency of the times in central station development. It was shown that a notably good load-factor, power-factor and an improved diversity-factor results from such combination, enabling the use of larger generating equipment with its increased efficiency. It seems to be now plain that the true solution of the central station problem of low rates and fair return on investment in our large and growing cities, is one generating plant or one inter-connected system furnishing energy for traction, light, power and all other purposes, thus providing economies that can never be achieved by competition or duplication and at the same time making regulation by the representatives of the people more easy than with several competing concerns.

Many of our progressive cities have during the past decade or so been bitten by the competition microbe and the citizens have acquired such a distorted idea of actual operating conditions that they have either honestly believed or have been induced to believe by selfish minded politicians, that the way to secure lower prices for current was to advance the cause of competition, either private or municipal. Largely for this reason in those cities where the spirit has been strongest, several companies have sprung up, in some cases with a trifling reduction in rates to the customer, but with a greatly reduced return to the investor. It has caused duplication of plants, duplication of distribution lines, duplication of office facilities and those to take care of the details, besides the carrying in stations of useless and non-productive machinery. In practically every case the conditions in the long run have shown that in a restricted field such as the central station field, competition is in no way practical.

As the consolidations take place in the different sections of the country, it is earnestly hoped that the results and conditions may be made known in detail and placed at the disposal and for the careful perusal of those interested, in an investigation of the actual conditions for their own good. Such an investigation will certainly injure in no way any company and will greatly benefit the industry, in that it is certain to show that consolidation and monopoly, if you so choose to call it, furnish the only solution to the utility price question and that this question can never be answered by competition. For in spite of all the laws that may denounce such combines, in spite of the popularity-seeking outcry of politicians and the adverse sentiment of sincere citizens, the common sense way to cheapen the utility service is to make full use of expensive but indispensable machinery. This cannot be done by duplication, neither can it be done by using generating machinery part of the time for a single service and other machinery another part of the time for another service. If you believe it can be done in this way study the conditions in Savannah, Ga., Montgomery, Ala., and New Orleans, La., and compare same with conditions in Atlanta, Ga., Birmingham, Ala., Nashville, Tenn., and the conditions that brought about the present situation in Louisville Kentucky. Keep on combining—reduce your rates as economy of production permits and eventually the development of the business will serve as its own protector.



Plan of Lock, Dam and Power House of Hales Bar Development.

Hale's Bar Development of The Chattanooga and Tennessee River Power Co.

Written for Electrical Engineering.
BY B. T. BURT, RESIDENT ENGINEER, CHATTANOOGA AND TENNESSEE RIVER POWER COMPANY.

THE hydro-electric plant of the Chattanooga and Tennessee River Power Company at Hales Bar, is one of the largest water power developments yet undertaken in Tennessee. The development includes a lock and dam about 40 feet high across the Tennessee River at a point known as Hale's Bar, where at ordinary stages, the river is 1,500 feet wide This development is of especial interest since it inaugurated a new policy in government dealings with inland waterways. It is the first case where a private company was permitted to construct a dam across a large navigable river, and where river improvement and power development was combined. The development on the Mississippi river at Keokuk, Iowa, and those in Alabama are other and later examples.

On April 26, 1904, Congress passed an act authorizing the Secretary of War to grant permission to the city of Chattanooga to build a lock and dam at a location known as Scott's Point. This act provided that if the city should fail to notify the secretary of war of its intention to construct such a lock and dam within four months, then the Secretary of War should be empowered to offer the franchise to private citizens of Chattanooga. The city did not take up the franchise and it was accepted by C. E. James and the late J. C. Guild, of Chattanooga, who later interested A. N. Brady, of New York City.

These parties organized the Chattanooga and Tennessee River Power Company, and entered into a contract with the United States Government for the construction and maintenance of the work. Investigations were at once made which led to the conclusion that Scott's Point was not a favorable site for the power development nor for improving navigation, on account of the fact that the location of a dam at this point would not give sufficient improvement to the river nor sufficient water power due to the backing up of the tail water at the higher stages of flow. Authorization was finally obtained for the locating of the dam at Hale's Bar, 33 miles below Chattanooga, where solid rock was available for the dam foundation and the flood plane widened out to such an extent that a rapid rise of the tail water would not be so disastrous to power development. At this point the head on the turbines is about 39 feet at

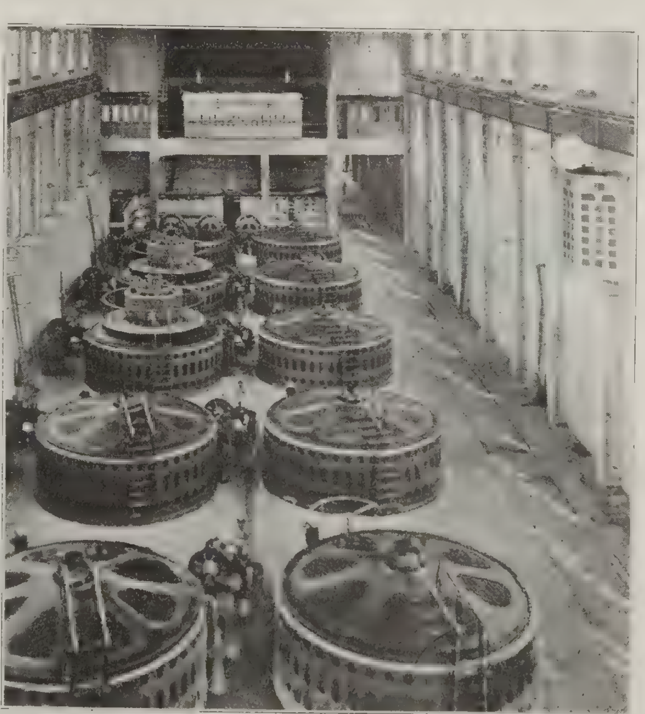


Fig. 1. Generator Room Showing Exciters and Switchboards in the Rear.

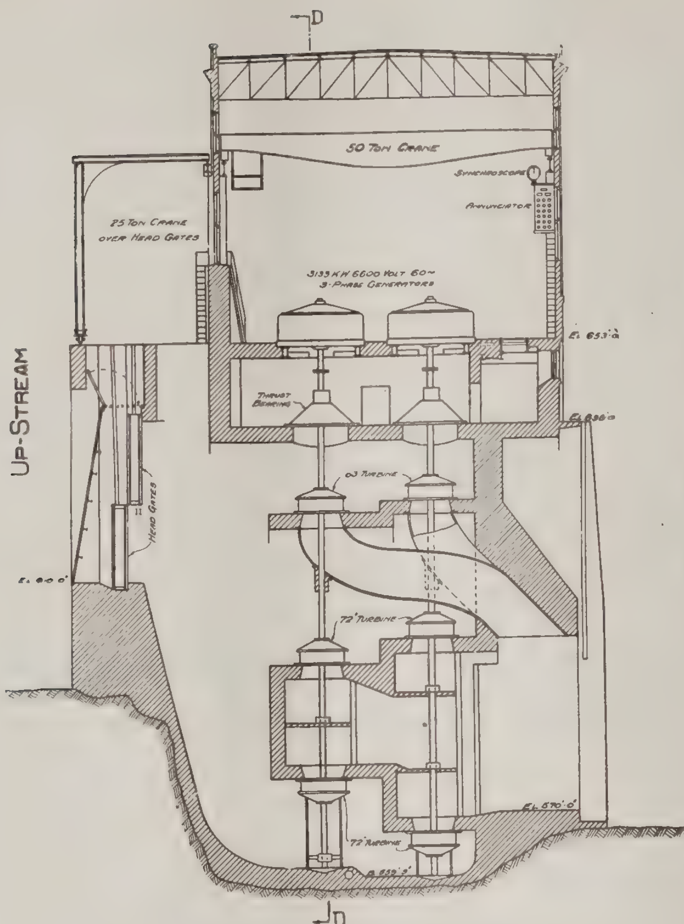


FIG. 2. SECTION THROUGH TURBINE WHEELS AT HALES BAR STATION.

low water, while at a 40-foot stage of the river, the backing up of the tail water reduces this head to about 19 feet.

The excavation of the river bed through drilling showed apparently solid rock under a blanket of sand and gravel. However, when the drilling of the dam and power house started in October of 1905, unexpected difficulties arose which have created much interest and discussion among engineering circles. When cofferdams were constructed on the water side, it was found that great quantities of water

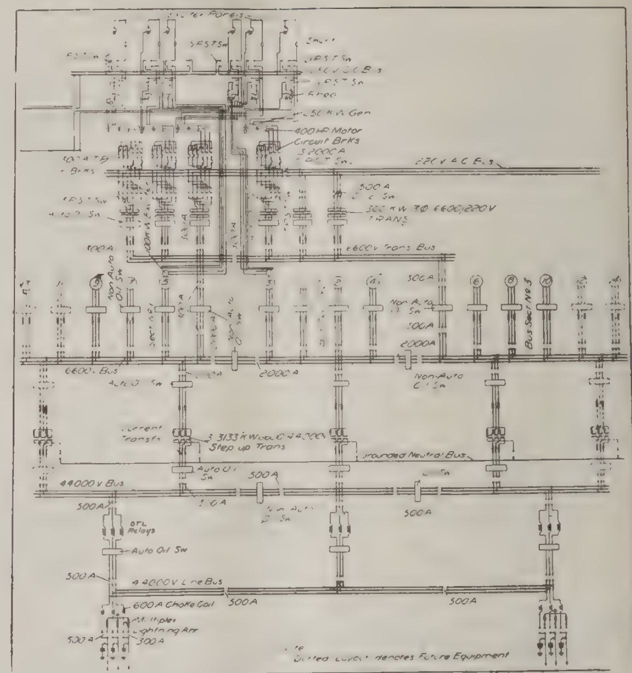


DIAGRAM OF CIRCUITS AT HALES BAR STATION.

spurted from fissures in the bed rock. Before concrete could be laid, these fissures had to be closed. This was accomplished by drilling 6-inch holes to a depth varying from 30 to 50 feet. Pipes were then sealed into the upper ends of the holes and cement forced under pressure into them until they would take no more, thus grouting the fissures and sealing them. This process was a slow and difficult one and had to be carried out for the foundation of power house and dam alike. When building the dam and a section cofferdamed, water in some cases gushed up through the bottom to such an extent that 20,000,000 gallons of water was discharged from the fissures per day. In stopping these subterranean waterways, something over 200,000 sacks of cement were used.

THE LOCK AND DAM.

The lock which is situated on the west or right bank of the river is built against a rock bluff, and has a clear width of 60 feet, and is approximately 310 feet long inside. The

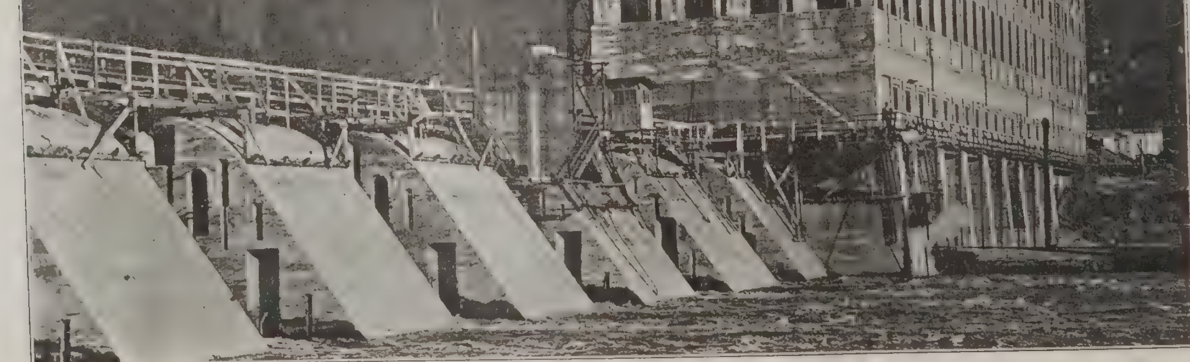
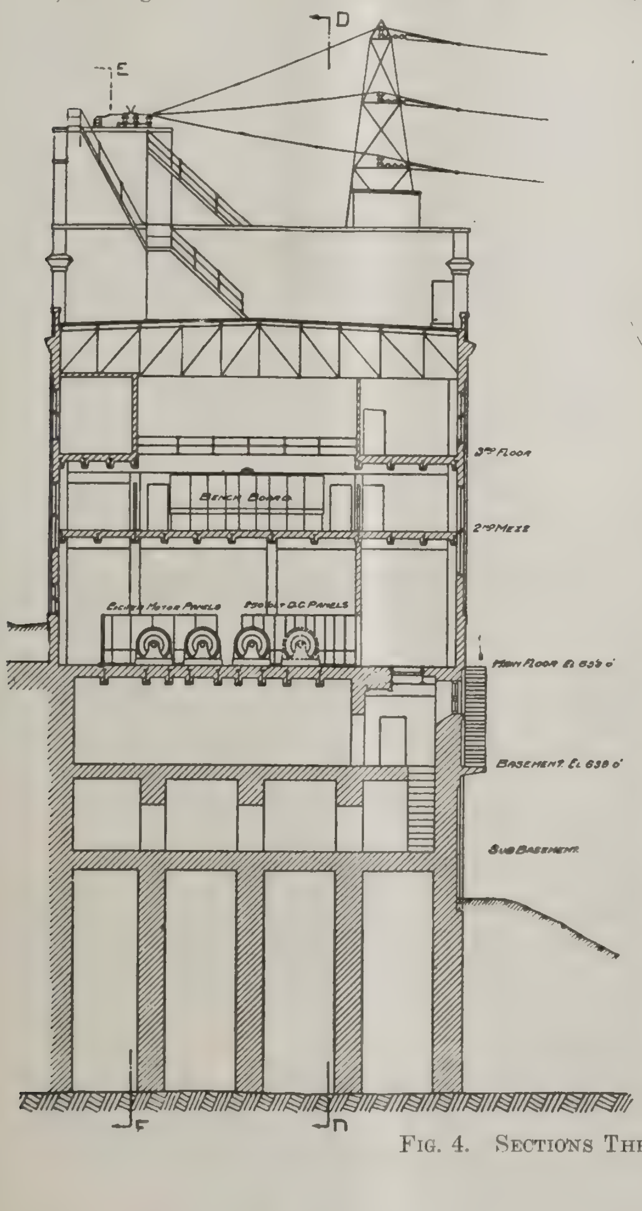


FIG. 3. VIEW OF DAM AND POWER HOUSE FROM DOWN STREAM SIDE.

gates are of the mitering type horizontally framed, built of steel and operated by electricity. These gates are somewhat remarkable for the head which they have to support, the difference in elevation between the two pools being about 40 feet; each lift of the lower gates will be 34 feet long, 59 feet high and will weigh 129 tons. The upper gate was built by the Baltimore Bridge Company, and the lower gate by the Penn Bridge Company, of Beaver Falls, Pa. The lock chamber is filled by two culverts 11 feet by 6 feet, operated by stoney sluice gates fitted for electric operation. The dam itself is 1,200 feet long and extends from the lock on the west side of the river to the power house and transformer house on the east side. The crest of the dam will be of an elevation of 636 feet, a flash board apparatus bringing the elevation of the crest up to 639 feet being provided. There is a passage way through the dam in which the electric conduits are carried from one side of the river to the other. In the power house a sluiceway is provided to supply water to the lower pool, at times when none is passing over the dam or through the power house.

The power station is 66 feet wide by 353 feet long, and in two sections, consisting of an operating building one-story high, 220 feet long, and a switch and transformer house three stories high and 133 feet long. This operating building consists of seven bays, each containing two turbine units, making a total of fourteen. Each unit consists of three S. Morgan Smith turbines mounted on a vertical shaft with a generator at its upper end. Each generator has a capacity of 3,133 kilowatts, making a total capacity of 43,862kilowatts for the station. Under ordinary stages of the river only two of the turbines will be used for each unit, the third being held in reserve and used when there is a large quantity of water flowing, but giving a reduced head due to back water in the tail race. The two lower turbine wheels are 72 inches in diameter, and the upper wheel 65 inches in diameter. The turbines run at 112½ revolutions per minute. Each unit is capable of delivering 5,250 horsepower with a head of 35 feet.

The operating building rests practically on the east end of the dam and is carried down to solid rock. The switch and transformer house is supported by round concrete piers carried down to solid rock. The piers were placed by means of light sheet steel caissons sunk through the earth to solid rock, the earth being excavated as the caissons were sunk; the steel caissons were filled with concrete, the concrete piers being proportioned so as to stand the entire load without any assistance from the light steel shell.



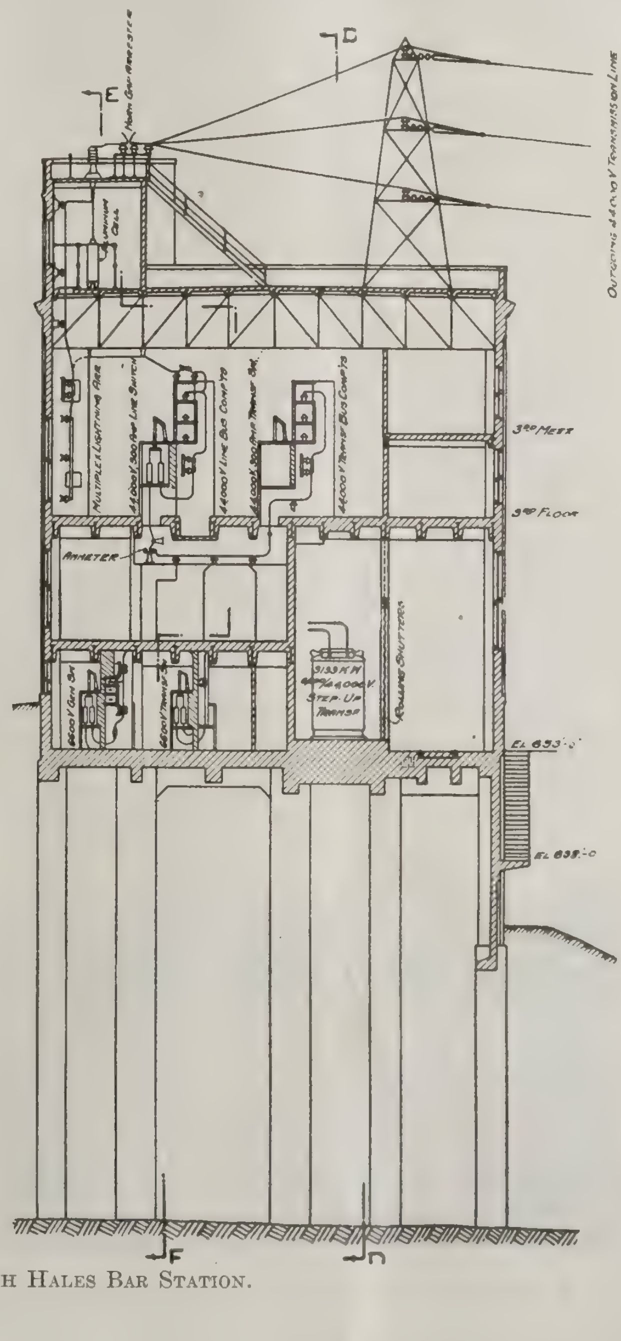


Fig. 4. Sections Through Hales Bar Station.

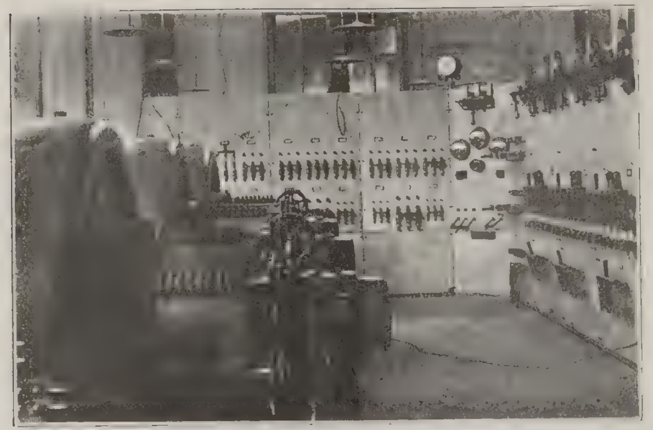


Fig. 5. Exciters and Light and Power Panels for Lock and Dam at Left—Motor Generator Panels at Right.

The operating building and the switch and transformer house are steel frame structures with concrete walls. The main floor of the transformer house is composed of reinforced concrete, and the upper floors and the roof of the transformer house and the roof of the operating building are built of flat concrete arches set between steel beams. An electric traveling crane of 30 tons capacity is provided to handle the generators and turbines in the operating room, and a gantry crane is placed on the up-stream side of the operating building to handle the head gates.

The generating station is laid out to accommodate fourteen a.c. generators, six exciters, one exciter switchboard, one a.c. lighting and power board, one a.c. control board, fourteen a.c. generator field rheostats, one storage battery, six step-down transformers, fifteen step-up transformers, twenty-nine 6,600-volt H3 oil circuit breakers and buses, ten 45,000-volt H3 oil circuit breakers and buses, three sets of multiplex lightning arresters and choke coils, and three sets of electrolytic lightning arresters and horn arresters.

The 14 alternating current generators are located on the main floor of the operating room, arranged in two rows, seven in each row. Each generator is of 3,133 kilowatt capacity, three-phase, 60 cycles, 6,600 volts, 112.5 revolutions a minute, and is mounted on a vertical shaft, which is driven by three water wheels. At present there have been installed only ten generators, two of which have a 100 kilowatt exciter, mounted on the shaft. On the main floor of the operating room, near the switchboard, are located the other four exciters, each consisting of a 250 kilowatt, 250-volt, 720 revolutions per minute direct current generator, driven by a 375-horsepower, 220-volt, 720 revolutions per minute, three-phase induction motor, both the generator and motor being mounted upon a common base and coupled together.

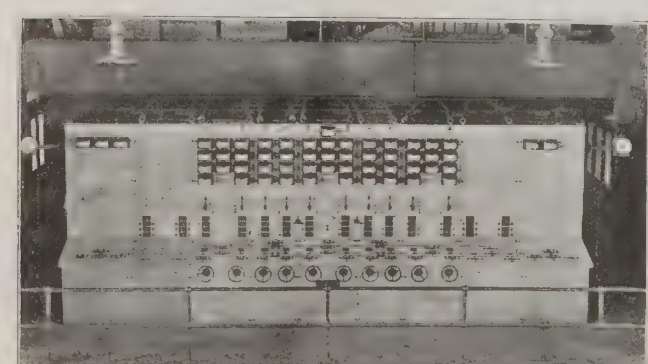


Fig. 6. Bench Board in Power Station.

Fig. 7. Compartments for 44,000-Volt Bus in Transformer House—6,600-Volt Oil Switches in Rear.

On the same floor, close to the motor exciters, is located the exciter switchboard, and the alternating current light and power board.

At the extreme eastern end of the main floor of the operating room are located six step-down transformers, each of 300 kilowatt capacity, three-phase, 60 cycles, 6,600/230 volts, oil cooled. These step-down transformers are located in back of the alternating current light and power board, but are separated from it by a fireproof enclosure. At present only five step-down transformers have been installed, three of which will furnish alternating current to the exciter-motors and two will furnish current for station lighting and power. Above the exciter board and the

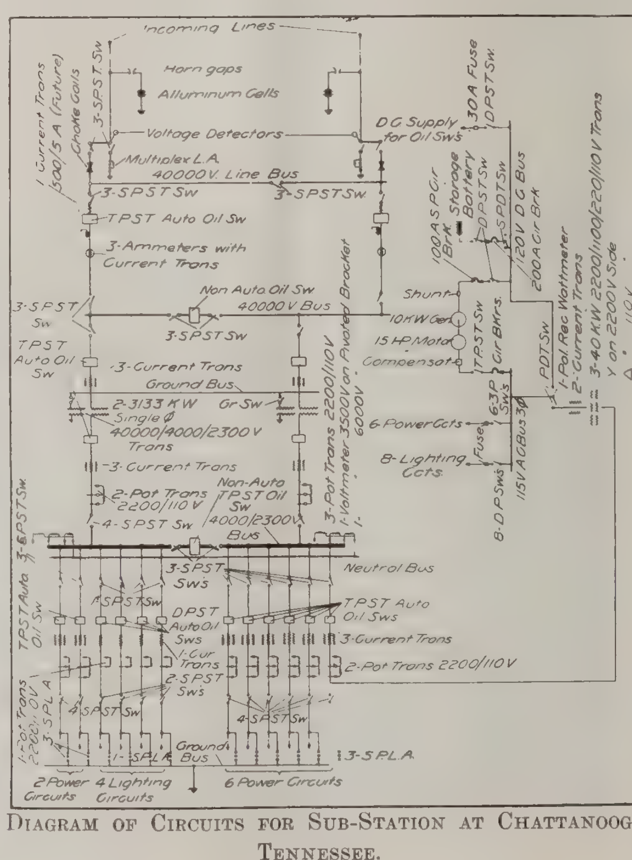


Diagram of Circuits for Sub-Station at Chattanooga, Tennessee.

step-down transformers is a gallery on which is located the main alternating current 6,600 and 44,000-volt control switchboard, from which are also operated the alternating current generator field rheostats, located in the rear of the board.

From each of the alternating current generators, three single-conductor cables are run in bituminized fiber conduits, laid in concrete, to the generator oil circuit-breakers and generator buses, which are located in the north part of the first floor of the transformer house, divided from the operating house by a 12-inch thick concrete wall. The 15 step-up transformers are grouped in five sets, three transformers to each set, each transformer being 3,133 kw. capacity, high tension side 25,400/44,000, low tension 6,600 volts, 60 cycles, single-phase, water-cooled. At present only three sets have been installed.

The 44,000-volt current from the step-up transformers is transmitted through oil circuit breakers to the 45,000-volt buses, which are located partly on the second and partly on the third floor in the transformer house. On this floor are also located the 44,000-volt multiplex lightning arresters. From the 45,000-volt buses, the current is sent through two oil circuit-breakers and choke coils up to the roof, where connections are made with the two transmission lines, carried on a steel tower built on the roof. The ends of each line are connected to horn arresters, which are located on top of a narrow house or enclosure built on the roof. From the horn arresters connections are run through "roof entrance" type insulators to the electrolytic arresters, four to one line, which are located in the above enclosure. There is a provision made for a third (emergency) transmission line, which will not be installed at the present time.

All the H3 oil circuit breakers and buses, both 6,600 and 44,000 volts, are installed in compartments built of reinforced concrete. All the main 6,600-volt connections are cables with 2/32 inch best rubber, 8/32 inch varnished cambric and two waxed braids. All 44,000-volt connections are bare copper tubing of 1 5/16 inch outside diameter. The connections between the horn and the electrolytic arresters are bare copper tubing of 15/16 inch outside diameter.

THE TRANSMISSION LINE.

The transmission lines leave the generating station on top of the roof at almost a right angle to the long side of the building, are carried to the sub-station on 175 steel towers, exclusive of the two steel towers, one on top of the generating station and a similar tower on top of the sub-station.

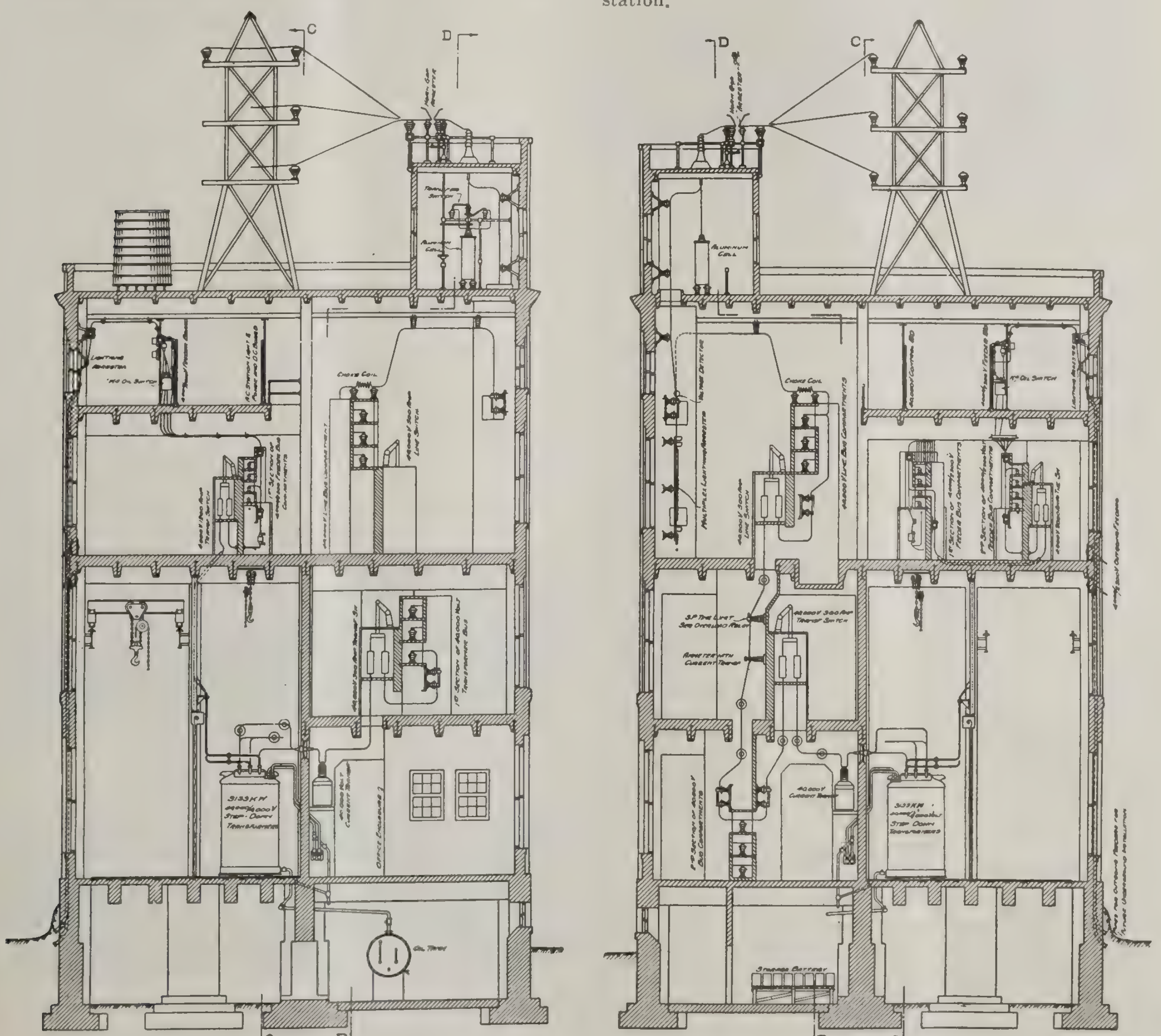


FIG. 8. SECTIONS THROUGH CHATTANOOGA SUB-STATION.

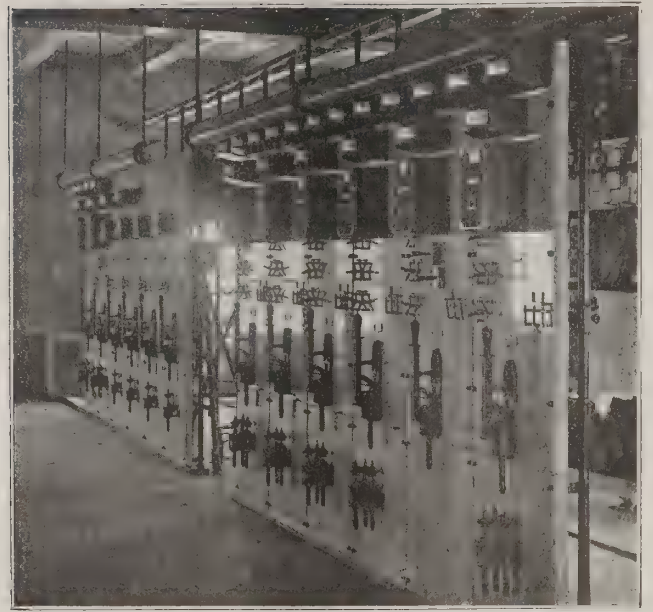


Fig. 9. Single-Phase and 3-Phase Feeder Panels in Sub-Station.

The pins which support the large line insulators are of malleable iron, and are designed to withstand a horizontal strain of 6,000 pounds. The strain insulators are furnished by the Ohio Brass Co., and the line insulators by New Lexington Co., and R. Thomas Sons Co. The transmission line follows, the greater part of its route, the tracks of the N. C. and St. Louis Railroad Company, crossing them in six places. After going in an easterly direction about two-thirds of its total length, it turns sharply north and continues in that direction until it reaches a point on the river near Moccasin Bend, where it turns northeast, crossing the Tennessee River and Moccasin Bend, and crossing the Tennessee River for the second time, enters the city of Chattanooga at the foot of Henry street. From the foot of Henry street the transmission line follows the eastearly course parallel with Henry street over the company's private right of way, until it reaches the sub-station at the northwest corner of Henry and Carter streets.

There are two transmission lines carried on steel towers, each tower carrying two lines, and each line consisting of three No. 000 bare copper cables, which are used on the whole distance of 17½ miles, with the exception of the two crossings over the Tennessee River, where 350.000-cir. mil bare copper cable is used. On the top of the transmission towers a steel cable clamped to the steel structures with cast iron clamps is carried throughout the whole distance from the generating station to the sub-station, with the exception of the two crossings over the Tennessee River. This steel cable is used as a ground wire. The steel towers vary in height; 35-foot, 40-foot, 45-foot and 60-foot towers being used for ordinary spans and 150 foot and 170-foot towers being used for the river crossings. Between the foot of Henry street and the sub-station the transmission line crosses the N. C. & St. Louis Railroad Company tracks, and at each side of this crossing is erected a 60-foot tower on concrete base, 5 feet high above the ground.

All the towers are erected on concrete foundations. On account of the mountainous character of the country, it was not possible to have the towers located at equal distances, and, therefore, the spans vary between 200 and 700 feet, and in one instance the span being as short as 150 feet. The spans over the Tennessee River are 1,400 feet and 1,500 feet, respectively. In several places it was necessary to erect angle towers, and on such the lines were dead ended.

THE SUB-STATION (TRANSFORMER STATION).

The sub-station is a three-story and basement building 69 feet 10 inches long, 55 feet 4 inches wide, and 81 feet 1 inch high from the ground, the basement being 15 feet deep, and is located at the northwest corner of Henry and Carter streets, Chattanooga, Tenn. The sub-station is laid out to accommodate two sets of electrolytic lightning arresters and horn arresters, two sets of multiple lightning arresters and choke coils, five 40,000-volt H3 oil circuit-breakers and buses, three 4,000-volt H3 oil circuit-breakers and buses, one 40,000-volt control board, two 4000/2300-volt control boards, ten 2,300-volt outgoing lighting feeders, fourteen 4,000-volt outgoing power feeders, one station a.c. light and power board, one motor generator set, three 2300/115-volt oil-cooled step-down transformers for station light and power, one storage battery, and nine 40,000/4,000-volt main step-down transformers. With the exception of the storage battery all apparatus is of the same type as that in the generating station.

The principal arrangement of the apparatus is similar to that in the generating station. On top of the roof of the sub-station is a steel tower on which are supported the two transmission lines, which enter the building through an enclosure built on the roof, and through large openings in the roof enter the southern part of the third floor, where the 40,000-volt oil circuit-breakers and buses are located. On this floor, near the southern wall, are also installed the multiplex lightning arresters. The ends of each line are connected to horn arresters, which are located on top of the enclosure, built on the roof. From the horn arresters connections are run through "roof entrance" type insulators to the electrolytic arresters, four to each line, which are located

Fig. 10. Transmission Line Crossing Tennessee River at Chattanooga on 150-Foot Towers—Span 1486 Feet of 350,000 Cir. Mil. Cable.

Fig. 11. River Crossing Tower at Chattanooga.

in the above enclosure.

From the buses, on the third floor, copper connections lead down to the southern part of the second floor, where two 40,000-volt transformer oil circuit-breakers are located, and from which cables are run in fiber conduits to two banks of large step-down transformers, located in the middle part of the first (main) floor. There are three large compartments built, each to accommodate three 3,133 kw. water-cooled, single-phase, 60-cycle, 40,000/4,000-volt transformers. At the present time only two sets of transformers, two in a set, are installed. From the step-down transformers the 4,000-volt current is carried through large cables in fiber conduits, built in concrete walls, up to the northern part of the third floor, where the 4,000-volt transformer oil circuit-breakers and buses are located. From these buses leads are run upward to K4 automatic switches, which are mounted in the rear of the 4,000/2,300-volt board, located on a gallery called the third mezzanine floor. From this board circuits are run through choke coils out of the building, connections being made with multiplex lightning arresters, before leaving the building. As above mentioned, provision is made for ten lighting and fourteen power circuits, but at present only four lighting and eight power circuits are installed.

On the third mezzanine are located the main alternating current control board, from which are controlled all 40,000-volt and 4,000-volt H3 oil circuit-breakers, one motor generator set, station light and power board, and three step-down transformers. The motor generator set consists of a 10-kw. 120-volt direct current generator, direct connected to a 15-horsepower, 115-volt, three-phase induction motor. This motor generator will furnish the direct current for operating the oil circuit-breakers, but will be also used for charging the storage battery, which is located in the basement. Each of the three step-down transformers is 40-kw. single-phase, 2,300/115 volts, oil-cooled. Both the motor generator and the storage battery and also the three station light and power transformers are controlled from the station light and power board.

At present all outgoing 4,000 and 2,300-volt leads will leave the building on the level with the third floor and will be supported on wooden poles erected on the sidewalks. Provision is made for carrying the outgoing feeders in underground ducts, and for this purpose fiber conduits are built in the northern building wall and leave the same a short distance below the grade, being at present provided with fiber caps.

Fig. 12. Strain Insulators and Platform on River Crossing Towers.

As in the generating station, all the H3 oil circuit-breakers and buses are enclosed in concrete compartments. All the 40,000-volt connections are bare copper tubing of 1 5/16 inch outside diameter, and all connections between the horn and the electrolytic arresters are bare copper tubing of 15/16 inch diameter. All the 4,000-volt connections are cables of 3/32 inch best rubber, 4/32 inch varnished cambric insulation and two waxed braids.

The hydralic and mechanical work of the development was in charge of John Bogart as chief engineer and Thomas E. Murray as consulting engineer of the Chattanooga and Tennessee River Power Company.

With the exception of the storage battery all the station apparatus was furnished and installed by the General Electric Company. The contractors for the hydraulic machinery was the S. Morgan Smith Company, of York, Pa.

For a large part of the material appearing in this article, credit is given Mr. T. E. Murray, consulting engineer for the company, the illustrations showing sections of the plant being taken from a published work by him.

The man with a permanent position, a clear conscience, a good appetite and regular pay, is wealthy, not rich. Every big man who has his heart, his head and his hands weighted down with responsibility, envies the ernest working class. Riches only add responsibility, multiply care and increase trouble. The real wealth that has no wings is found by the willing worker.

Alternating Current Engineering

(*Contributed Exclusively to* Electrical Engineering).

BY WILLIAM R. BOWKER.

Section 16. Electrical Construction Features of Generators and Motors—Circuits and Winding Arrangements.

THE principle of generating alternating currents was briefly discussed in the first sections of this series of articles. It is now essential that some additional information on this subject of a more practical character be given, especially in reference to winding principles of two and three-phase circuits.

In the generation of alternating currents, two component parts or members are absolutely essential, the field magnet and the armature. These are analogous to the "stator" and "rotor" of an induction motor, with the difference that in a motor the stator is always fixed or stationary, and the rotor the rotating or movable member. In the case of an alternator, the armature may revolve and the field magnet be fixed or vice versa, for many alternators, especially those of high voltage, are designed and constructed so that the field magnets revolve.

A single-phase alternator of a simple form is shown in Fig. 93, and consists of several coils assembled at equal angular positions upon an iron core to form the armature. The field magnet circuit with outwardly projecting pole pieces, are wound with wire and supplied with a direct current which flows in such a direction as to induce alternate North and South polarity pole pieces. In Fig. 93 is shown revolving field magnets, which when rotating generate a current of electricity in the armature winding, and on the principle of electro-magnetic induction. The current in any and all of the coils will in turn be reversed each time the rotating pole changes from a North to a South or vice versa as it passes immediately underneath the coil. The number of alternations or reversals will depend upon the speed of rotation of the field magnets, that is number of revolutions per second, and the number of pairs of poles; the one factor multiplied by the other gives the number of cycles per second which is the periodicity or frequency of the generator.

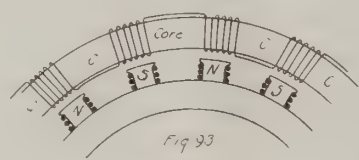
The current generated from a machine as described is a single-phase alternating current and can be collected for external supply purposes by connecting the two ends of the armature winding to two collector rings on which press brushes. It must be clearly understood that in the generation of alternating currents, the field magnets have to be separately excited by means of a direct current, so as to obtain a North and South polarity of the magnets, thus necessitating either a separate exciter or other external source of supply.

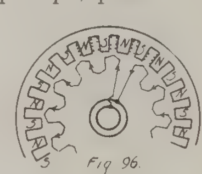
If in Fig. 93 the field magnet cores were of a larger diameter than the armature, the pole pieces projecting inward instead of outward, the electrical results would be the same and this latter arrangement be a machine in which the field magnets are fixed and the armature revolves. Whether the field magnet revolves or is stationary, is determined by practical considerations to fulfill certain requirements, in which the question of voltage and insulation are important and deciding factors.

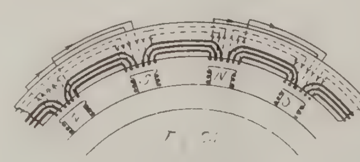
In Fig. 93 the coils are assembled upon what is known as a smooth core armature, but this structure is somewhat lacking in stability. For several other reasons, mechanical and electrical, the toothed or slotted armature core is almost wholly used in the construction of modern machines, the one great advantage being that it affords a magnetic circuit of high efficiency. Fig. 93 is known as a "ring wound" smooth core armature and Fig. 94 a "drum wound" smooth core armature, the full and dotted lines with the arrow heads represent back end connections of armature windings.

In Fig. 95 is shown a very simple form of single-phase winding, known as the "single coil per pole" winding; this being an alternator with a fixed field and revolving armature, the core not being shown but instead the scheme of winding. Fig. 96 is a single-phase winding using armature bars instead of coils and is well suited for heavy current generation.

The adoption of the toothed armature led to the general use of what is called "distributive winding" which means that the armature core has a great number of slots and the armature windings are distributed or assembled so as to cover practically the whole of the armature core excepting the space occupied by the core tooth. An armature winding such as is shown in Fig. 93 is called a "concentrated winding," it being concentrated in one place so as to correspond with the location of the field magnet pole piece. Referring again to Fig. 93, it will be seen that there is a considerable space between the adjacent coils C on the armature core, and no reason why a second set of coils similar in all respects to the first ones but separate from them, could not be assembled there. In practice this is done and the machine then becomes a two-phase generator, one set of coils coming into action a quarter period later than the other set. If there were three separate and distinct sets of coils, so spaced that each came regularly into action with the magnetic field one third of a period behind the coil preceeding, the machine becomes a "three-phase" generator. The simple construction is shown in Fig. 97, which is constructed with a toothed armature and distributive winding of three sets of coils of two coils per pole per phase. This







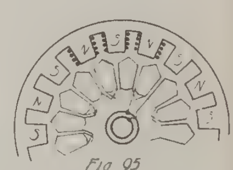
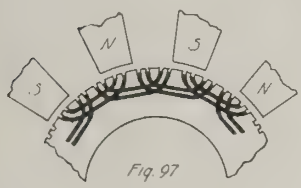


Fig. 93. Simple Form of Single-Phase Alternator. Fig. 94. Same With Drum Wound Smooth Core Armature. Fig. 95. Same With Single Coil Per Pole Winding. Fig. 96. Same With Armature Bars Instead of Coils.

three-phase winding may be connected either in delta or star as demanded by the voltage and current requirements.

In Fig. 98 an outline diagram is given of the necessary components of a single-phase alternating current gnerator, and is known as a four-pole, ring wound armature with a concentrated winding. If now a second set of coils similar to the first set were distributed between the first set and connected to a second pair of slip rings and brushes, the coils would come into action, such that their maximum Emf.



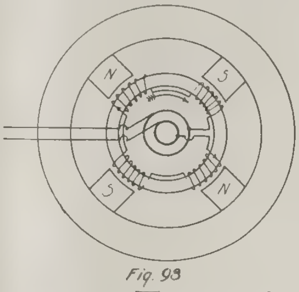
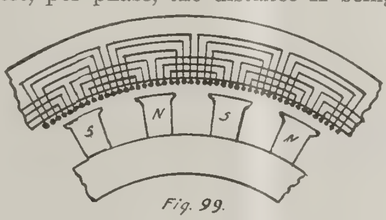


Fig. 97. A Three-Phase Distributive Winding. Fig. 98. A Four Pole Ring Wound Armature With Concentrated Winding.

occurred when the first set was at a minimum or vero Emf. This would result in a phase difference of 90 degrees, the currents being in quadrature, and deliver a "di-phase" or "two-phase" current. Fig. 99 is an outline diagram of a two-phase machine with three slots, per pole, per phase, and Fig. 100 a three-phase machine with two slots, per pole, per phase.

Obviously then the only difference between a single-phase, two-phase and three-phase generator from the constructive standpoint of the winding circuits, is in the disposition or grouping o fthe separate sets of windings, two for two-phase and three for three-phase in relation to the magnetic field poles or coils. The principle involved in the grouping of the windings in relation to the field magnet poles may possibly appear more distinct by showing them in a line, with the armature core and field magnet pole circumferences straightened out as shown in Figs. 101, 102, and 103. Fig. 101 represents a three-phase winding with three slots, per pole, per phase, the distance A being technically



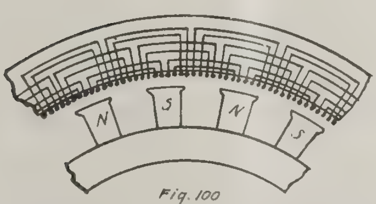
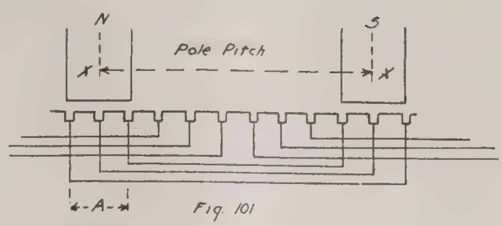
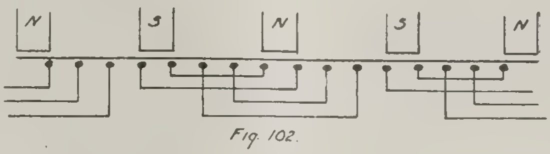


Fig. 99. Diagram of Winding for Two-Phase Generator. Fig. 100. Same for a Three-Phase Generator.

known as the width of winding; and the distance (X X) between the center lines of two adjacent magnets being called the "pole pitch." Fig. 102 is a two slots, per pole, per phase, two-phase winding, and Fig. 103 a two-phase, two slots per pole, per phase lap winding.

In Figs. 104 and 105 are shown the different forms of slots and punched holes used in modern alternators and





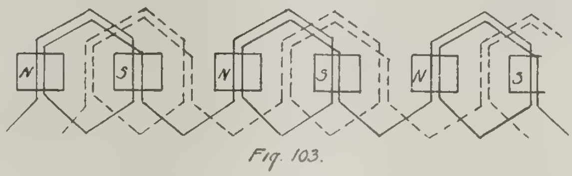
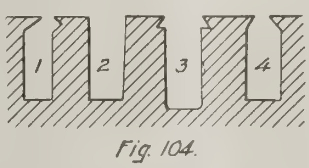


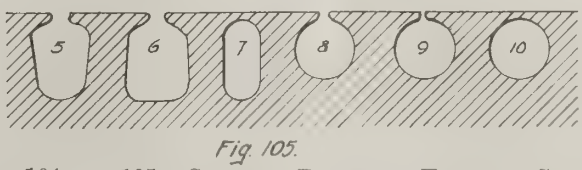
Fig. 101. Winding Arrangement With Reference to Field Poles for 3-Phase Machine. Fig. 102. Same for Two-Phase. Fig. 103. Same for Two-Phase With Lap Winding.

also the stator and rotor slots of induction motors. After the assembling of the conductors in the slots, the winding in slots (1), (3) and (4) are always tightly wedged by means of wood strips or other suitable insulating material, and slots of the forms shown at (5) and (6) are also usually tightened by a wedge. With the closed or partially closed slots or holes of the shapes (5) to (10), it is impracticable to wind with formed wound conductors, the conductors having to be threaded through under such circumstances. With a formed wound armature, stator or rotor, the core slots have to be approximate to or be similar to the forms or shapes (1) to (4).

The core plates used for armatures, stators and rotors are stamped by machinery out of thin sheets of iron, which when assembled constitute a laminated core, the slots or holes usually being punched in the core plates, but sometimes being milled out.

In Fig. 106 is illustrated the forms of the stator and rotor core slots of a 6 horsepower 2-phase, four-pole, short circuited, squirrel cage, bar wound, rotor made by Brown





Figs. 104 and 105. Showing Different Forms of Slots.

Boveri and Co., of Switzerland. The stator has 40 slots and the rotor 37 holes, it being always necessary to have a different number of stator and rotor slots to prevent "dead" points or positions at starting. The number of stator slots must always be a multiple of the number of phases and number of poles, as for instance in the above case, 40 is a multiple of 4 poles and also of 2 phases.

Two of the factors that determine the number of poles are the speed required and the frequency of the supply circuit, after which the number of slots or holes are so calculated that the internal periphery of the stator can be equally divided and spaced with them. Fig. 107 illustrates the shape of holes or slots generally used in modern induction motors; the left hand type being more suitable for the squirrel cage bar winding and the right hand shapes for the formed coil wound rotor. It will be noticed that there are more rotor slots than stator slots. The shape of the slots at the right hand of Fig. 107, and in the stator of Fig. 106, and slots 5 to 7 Fig. 105 provide for winding with more than one conductor in each slot. Large machines are designed and constructed with a number of conductors in one slot which admits of them being connected in parallel as shown in Fig. 108. The core slots both in the stator and rotor run parallel to the rotor shaft, and in these the insulated windings or conductors are embedded, the slots being either wholly or partically closed, as shown in the several illustrations.

Large alternating current generators are invariably built with stationary armature and revolving field magnets. This permits of easily and effectively insulating the armature conductors, dispenses with movable contacts and affords greater mechanical stability, the assembled prts being more securely supported and thereby not affected by vibration or centrifugal action. The revolving field magnet has fewer movable contacts, and provision has only to be made for the low potential direct excitation currents necessary to be delivered to it. In high potential generators the fixed armature construction is always adopted. Since in alternators, the no load terminal voltage is less the greater the number of coils in which the winding is divided, this construction of winding is greatly utilized, the terminal voltage, no load ratios being for single coil 1.0; double coil 0.707; triple coil, 0.667; four coil, 0.654.

In both single-phase and polyphase generators, the number and shape of the armature core slot has a considera ble effect upon the performance of the generator. In the unitooth armature core, (a unitooth being one slot, per pole, per phase), the regulation is bad, there being excessive armature reaction resulting in a deformed Emf wave curve, high self-induction, and requires a large exciting current at full load. The advantage of a unitooth design is that it effects economy of insulation in high voltage generators. In modern practice, however, the multi-tooth generator has become generally adopted, the polyphase generators having two or more slots per pole, per phase, which offers the following advantages: Decreases the self-induction of the winding, resulting in a low inductance; gives a more efficient regulation; the core surface is utilized to better advantage resulting in a more even heating of the conductors; a greatly decreased armature reaction giving a better Emf wave form, and with open slot winding it prevents the necessity of considerably increasing the field exciting current at full load.

For long distance transmission at high voltage, the multi-tooth armature construction is especially suitable. Open slot construction with distributive winding results in a very low inductance, a desirable electrical condition to be attained. When the armature conductors are threaded through and imbedded in holes punched beneath the periphery of the armature core, thus giving a continuous armature core surface, there is very little tendency for eddy currents to be generated in the field magnet pole pieces, thus obviating the necessity of laminating the field magnet pole pieces. This sometimes is a desirable requirement under the heading of constructive expense.

In induction motors the clearance or air gap between the stator and rotor must be very small approximating less than 1/32 of an inch, as this prevents excessive magnetic leakage. If there is much leakage, the torque is reduced and excessive starting currents are demanded. The smaller the air gap, the less the magnetizing current required, the higher the power factor and the greater the electrical efficiency in general.

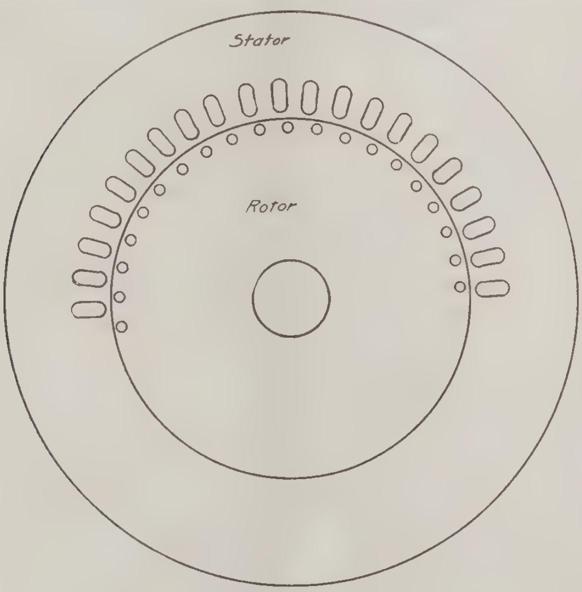


Fig. 106.

Fig. 107

FIG. 106. FORMS OF STATOR AND ROTOR SLOTS FOR BROWN AND BOVERI MOTOR. FIG. 107. SHAPES OF SLOTS MOST USED FOR INDUCTION MOTORS.

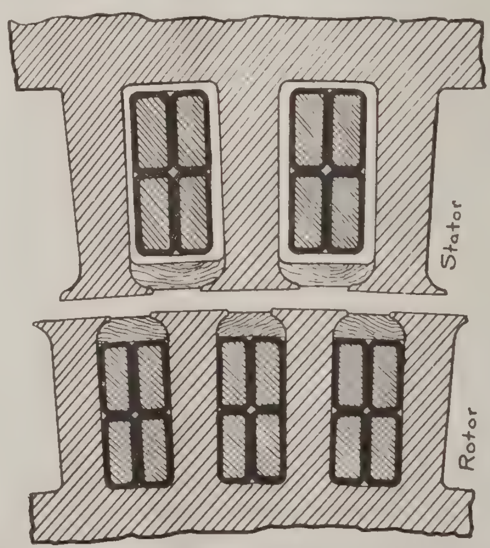


FIG. 108. SECTION OF WINDING SHOWING INSULATION AND WEDGING OF 4 CONDUCTORS IN PARALLEL.

Both the open and closed core slots possess certain practical and electrical advantages and disadvantages. The open slot facilitates readiness of winding and is easy and convenient to repair, being a less costly winding so far as the labor factor is concerned, and besides admits of a formed coil winding, and largely for that reason the motor stators and generator armatures are generally constructed with open slots. With closed holes or slots, the conductors have to be threaded through by hand, and they do not admit of a formed coil winding. They are also more difficult to repair, not being so easily removed as in the open slot construction. The closed slot while increasing the self-induction of the winding, decreases the reluctance of the magnetic circuit, which reduces the magnetizing current and increases the power factor.

For induction motors the squirrel cage type of rotor is extremely simple in construction, the straight bars or rods being threaded through the slots or holes, and the projecting ends short-circuited by a metallic ring at each end. The coil wound rotor is wound in a similar manner to a coil wound stator. In the stator winding the slots are so selected that they carry conductors in which flow currents in the same direction for each phase, and are then connected by end connections to conductors in slots carrying currents in the opposite direction. The coil wound rotor has a definite set of coil windings which correspond to the polar windings of the stator.

The number of slots in a stator core are calculated as follows: In a four-pole, three-phase machine with six slots per pole, per phase, the number of stator slots would be, $4 \times 6 \times 3 = 72$ slots. The slot depth would be approximately three times the width. The rotor slots must never be of the same number as the stator slots, otherwise there would be dead points, offering obstacles to starting under load, and the motor would not start and run smoothly against even very light loads.

The ratio generally found in practice is as follows:

Rotor	10	8	6	6	5	5	4	3
Stator	6	6	5	4	4	3	3	2

There are nearly always more rotor slots than stator slots. To avoid dead points, the number of slots per pole, per phase, in the rotor of the squirrel cage or single conductor per phase, per slot, type, must always be prime to the number of stator slots, and the number of stator slots usually range from 7 to 9 times the number of stator poles.

Machines are generally constructed with two or more conductors per slot, the windings usually being connected in parallel. The number of rotor slots must then be a multiple of both the number of pairs of poles and number of phases. Fig. 108 illustrates a section of the stator and rotor core teeth of a three-phase motor, and also shows a cross section of the winding, insulation and wedging of the conductors, of which there are four conductors per slot connected in parallel.

The next section of this series will take up the transmission of power.

The Design of Steam Power Plants

(*Contributed Exclusively to* Electrical Engineering).

BY EARL F. SCOTT, M. E., MEMBER A. S. M. E., MECHANICAL ENGINEER, ATLANTA, GA.

Section 4. Detail Specifications for Pipe Work of Steam Plant Under Discussion.

IN section 3 of this series of articles the writer discussed in a very general way pipe sizes and arrangements. In this section detail specifications covering the pipe work for the plant in question will be taken up.

Since it is impossible to make up an intelligent pipe layout until the machinery has been purchased, and also on account of the fact that the average manufacturer, from whom the machinery may be purchased, does not like to install a plant complete including the detail apparatus such as the pipe, valves and fittings, it will be in order to prepare a pipe specification separate and independent from the machinery specifications. If we follow this arrangement, it will be necessary as a preamble to the specification, to mention the location of plant facilities for doing the work, conveniences for handling the material, with cranes and also the fact that all machinery not mentioned in the pipe specification will be placed on foundations ready for the pipe contractor to make connections. This information may be found in section 1.

For convenience, however, we will repeat the condition under which the pipe and apparatus must work which are as follows: One hundred and fifty (150) pound pressure (gage) one hundred and fifty (150) degrees superheat. This is the condition for the live steam lines only, the other conditions will be mentioned under the different headings. With these conditions, we will have a temperature of 516° F. or 366° for the steam at 150 pounds pressure plus the 150° superheat.

On very high temperatures, particularly above 500°, it is necessary for steel valves and fittings to be used, as cast iron will not withstand these high temperatures for any length of time. It might be safer or rather call for less comment if the writer would say it is not safe to use cast iron fittings for these high temperatures, since it is a fact that iron deteriorates under such conditions. There are, however, plants in operation using cast iron fittings which have not shown signs of failure, but we do not know at what time they may fail and prove disastrous. With this knowledge before us, therefore, the writer believes the proper specification for this plant will be cast steel.

Valves. We will first discuss the valves for the steam lines. For high temperatures it is not enough to make valve bodies of cast steel, some type of trimming for the valves must be used so that the metals for the seats, etc., will have a similar expansion to the valve bodies. If these were not the same, or nearly so, with the high temperatures and excessive expansion, we would have loose joints and leaks. Also the ordinary bronze seat will warp at high temperatures. For these and possibly other reasons, we must specify that the valves be made of special metal for this service.

The valve specifications will therefore be as follows: The bodies, bonnets and yokes shall be cast steel, free from blow holes, sand holes or other flaws that would impair the strength. The trimmings, including the seat rings, seats and stems, shall be either nickel bronze or "monnel" metal (monnel metal is high in nickel), suitable for the above mentioned specification. All valves $2\frac{1}{2}$ inches and larger shall be flanged, 2-inch and smaller valves shall have bodies made of nickel bronze and similar trimmings. Valves above 6 inches shall have bypasses made a part of the valve. All flanges of valves shall be faced with 1/32 inch raised face, within the bolt holes, and all holes shall be drilled and spot faced. All valves $2\frac{1}{2}$ inches and larger shall be of the outside screw and yoke type, (rising stem). These requirements will apply to globe, gate and non-return valves.

It may be in order here since preparing the above specification to tell where the different types of valves should be used.

Non-Return Valves. On or near the outlet of each boiler, it is very necessary to place a non-return, hand-stop valve. This valve performs a dual purpose; first, it will close of its own accord in case an accident should occur to the boiler, such as blowing out of a tube, or in any way reducing the pressure in the boiler; and second, if one boiler fire should become sluggish and the steam pressure drop, this valve would close and prevent the rush of steam from the other boilers into the boiler of low pressure. To the trained engineer, this function is readily apparent.

We might have adopted for this plant a more expensive type of valve for this purpose than the plain non-return valve, which would have been the non-return emergency stop valve. This type of valve not only fulfills the functions mentioned in the non-return and hand-stop valve, but will close if an accident should happen to any part of the pipe system, thereby releasing the pressure. Or the whole plant may be closed down at will by opening a $\frac{1}{2}$-inch pilot valve which relieves the pressure sufficiently on the emergency valve to cause it to close instantly. These $\frac{1}{2}$-inch pilot valves may be placed in different places about a plant so that one may be reached easily in case an accident should happen anywhere in the plant.

With this explanation, the specification should read as follows with reference to these valves: There shall be placed on the steam outlet of each boiler a non-return and hand-stop valve, these valves to be made of the same materials as specified for gate valves.

Gate Valves. Location of gate valves: A gate valve should be used always in a steam line where the valve is either to be opened wide or closed off tight, and should never be used as a throttle valve. With this explanation we would require gate valves on all steam branches where same leave the main header.

Globe Valves. Globe valves should be used only where the valve is to be used with a throttling effect. With this in view, we would require globe valves at each machine (when not furnished with the machine). Globe valves shall have the same specification as required for gate valves.

Fittings (flanged). We will next consider the fittings for live steam lines. Fittings as well as valve bodies should be made of cast steel (see reason on valves). Therefore, the specification should read as follows: All fittings on live steam lines shall be of cast steel, free from flaws, sand or blow holes, or any other defects that would impair the strength. All fittings $2\frac{1}{2}$ inches and larger shall be flanged. Fittings shall be made from extra heavy dimension patterns with extra heavy diameter flanges. All flanges shall be faced true to the axis of fitting, and shall have 1/32 inch raised face on the inside of the bolt holes. All bolt holes shall be drilled to standard templet and spot faced on back.

Fittings (screwed). All fittings 2 inches and smaller shall be extra heavy patterns and cast steel, tapped true to axis, free from all flaws that would impair the strength or tightness. Metal to be in every respect equal to that of the large fittings.

Flanges (van stone). All flanges 4 inches and larger shall be suitable for the Van Stone joint, and shall be high hub rolled steel. Each flange shall be finished smooth on the parts where pipe bears on it, also on back, and shall have an easy curve where the pipe extends through and is lapped over. Bolt holes shall be drilled. Extra heavy standard templet.

Flanges (screwed). Flanges from $2\frac{1}{2}$ to 4 inches shall be extra heavy pattern, rolled steel, tapped true to axis for pipe to be screwed on.

Unions. At points most convenient for the removal of pipe, all lines 2-inch and smaller shall have extra heavy brass ground joint unions. Union bodies to conform to material specification for small fittings.

Flanged Joints. All joints 4 inches and larger shall be of the Van Stone type, with the metal properly lapped over for the different size joints. Each joint shall be faced true front and back so that a perfect contact is made with the face of flange, and the proper joint is made with the gasket. Joints below 4 inches shall be made by screwing the pipe through the flange, and flange and pipe faced off true with one setting in the machine.

Pipe. All pipe used for bends and straight runs in steam lines shall be "full weight" wrought steel lap welded pipe.

Bends. Bends shall be turned on a smooth, even radius and shall not show any lumps or unevenness on inside of curve. Radii shall be standard unless otherwise specified.

Gaskets. All live steam line gaskets shall be of compressed asbestos, commonly known as "Vanda," "Taural," "No. 900," "Klingeret," or any other similar material. Gaskets shall be 1/16 inch thick and shall be cut so as to fit inside of bolt circle.

Bolts. All bolts shall be the best grade machine bolts with square heads and cold pressed hexagonal nuts. Bolts shall be long enough so that a full thread shows when bolts are tightened up.

Pipe Supports. Under this heading it is hard to give anything definite further than to say that all pipe shall be properly supported to allow for free expansion and contraction, and prevent undue vibration. Where pipe runs along a wall, it shall be supported by wall brackets and adjustable stands and rolls, and at other points from roof or floors by adjustable rod hangers.

Steam Separators. While it may not appear consistent to use steam separators in connection with a plant where superheated steam is used, still it does not pay to take any chances of water being drawn over from the boilers or elsewhere. Where the steam has a continuous flow as with the steam turbine, we should use what is known as the small separator (not the receiver type). This type of separator will separate the water but does not retard the flow of steam. With this in view, the specification would be as follows:

Near the inlets on each turbine, including the exciter and condenser turbine, shall be placed a cast steel steam separator suitable to operate under the conditions of this specification. Flanges on separators to meet the requirements of the flanges on the valves and fittings.

Steam Traps. On the low points in the steam header and each separator, shall be placed a steam trap. Each trap shall be bypassed properly, and the discharge run to a common header and thence to the heater. In each branch from header to trap shall be placed a swing check valve. Fittings and valves in drains to traps shall be extra heavy, but need not be designed for superheated steam. The traps shall be a high grade of non-return steam trap with float, suitable for 200 pounds working pressure.

We have now covered each item used in the make-up of the steam line. Attention will now be directed to the exhaust between turbine and condenser, or to the vacuum lines.

Valves. The valves that will be used in this service will be entirely different from those mentioned for the steam lines and will require a separate specification. On the lines between turbine and condenser, which are larger than, say, 24 inches, it will be advisable to have valves operated by a motor or mechanical drive as it takes some time to close or open such a valve. The body of the valve should be cast iron with bronze trimmings. What is known as the double disc type of valve. Each valve should be arranged so it may be water sealed around the glands. This is very important, as this is the point where you may expect most if not all leaks.

The electric drive for such valves would consist of an induction motor connected through gears (spur gears), to the spindle of the valve. The motor to be suited for the plant current.

What has been said in the preceding paragraph may be considered descriptive and it may be in order to write a concise specification for these valves, as follows: All valves in lines between turbine and condensers shall be flanged, low pressure, double disc gates, cast iron body, bronze mounted, with outside screw and yoke. Each valve 24 inches and larger shall be electric driven. The motor shall be of the induction type, suitable for the plant current, and direct connected to the spindle of the valve by gears (spur gears being preferable). Each valve shall have the glands sealed by water.

Fittings. All fittings used in lines between turbines and condensers shall be flanged cast iron suitable for 28 inches vacuum.

Pipe. If the lines are short, as they are shown in Fig. 1 of Section 3, cast iron makes the best material for this type of pipe and necessarily would take the same specifications as the fittings.

Gaskets. All gaskets used in joints shall be the same as specified in the steam lines.

Drains. Whenever the gate valve should be cut off and the turbine is run non-condensing, necessarily there is a condensate that collects in the bottom of these large fittings. In order to get rid of this, it is an easy matter to place a drain at the low point about 2 inches in diameter. In this drain should be placed two check valves and a couple of "ells" on outside of checks to form a water pocket to prevent a possible leakage where there is a vacuum on the system. When the condenser is running, this water of condensation is swept over into the condenser with the high flow of steam. This arrangement of drainage is much cheaper than a vacuum trap and is just as satisfactory so long as the lift is not too high to prevent the steam from carrying this water over when in operation.

AUXILIARY AND ATMOSPHERIC EXHAUST LINES.

Relief Valves. On each turbine there should be placed an automatic relief valve, the purpose of this valve being to break the vacuum and relieve the turbine in case of accident to condenser. We will not discuss the conditions under which the valves would come into operation as this point is well known to every engineer, but we will discuss the type of these valves. In the preceding section, we showed how to select the proper size of these valves, so we will not touch on this point again. These valves should be made extremely tight, as the vacuum in the condenser would be affected from any leakage through them. In order to make them tight, they should be arranged to be water sealed. This can be done by having the seat arranged for a water seal and connection made to the service line in the building.

A specification for these valves should be as follows: On each atmospheric line shall be placed an automatic exhaust relief valve; the body of cast iron, bronze trimmings, the seat to be arranged to form a water seal. Each valve shall be arranged with hand lifting device on top or bottom as selected by the engineer.

Gate Valves. All gate valves on auxiliary lines shall be standard, iron body bronze mounted, inside screw gates, flanged for 5 inches and larger, with brass body for 2 inches and smaller.

Fittings. All fittings on exhaust lines shall be cast iron flanged 5 inches and larger.

Pipe. Pipe 10 inches and smaller shall be standard wrought steel pipe, larger sizes shall be galvanized spiral riveted pipe of standard thickness, with standard A. S. M. E. flanges.

Gaskets. All gaskets used in exhaust lines shall be the same as specified for steam lines.

Hangers. Pipe shall be supported from roof of floors by adjustable hangers.

WATER LINES, CONDENSER, INJECTORS, DISCHARGE AND PUMP SUCTION.

The sizes of these lines were discussed in the preceding section, so we will not touch on this point further. However, it is necessary to mention the kind of material required. All pipe should be cast iron with flanged joints; while this class of material is much more expensive than the regular bell and spigot pipe, yet we are justified in specifying such, as it will be disastrous to our plant if the suction line should leak air. This is especially true if there is a high lift on the condenser (specification for which is 12 ft.).

With this in view we would have a specification as follows: The injection line shall be flanged cast iron pipe, cast even thickness, free from blow holes and other flaws or cracks due to cooling. The pipe shall be dipped in tar when at a high temperature. Flanges shall be faced and drilled standard.

Valves and Fittings. The valves and fittings shall be the same as was specified for exhaust lines.

Gaskets. All gaskets shall be a good grade of cloth inserted rubber gasket, 1/16 inch thick.

BOILER FEED PUMP DISCHARGE.

Since the boiler feed discharge is not only under a very high pressure (boiler pressure plus friction) the discharge should be designed with the very best materials for it is the most vital part of a power plant.

Valves and Fittings. The valves and fittings shall be extra heavy, cast iron body, bronze mounted gate valves with rising spindles. Valves and fittings shall be flanged 3 inches and larger.

PIPE. All pipe and bends shall be extra heavy wrought steel pipe.

FLANGES. All flanges shall be extra heavy cast iron, faced and tapped true. Flanges shall be screwed on pipe and the pipe and flange faced off at one setting in machine.

GASKETS. All gaskets shall be the same as specified under "Live steam line" headings.

BOILER BLOW OFF.

Under this heading all material shall be as specified under boiler feed lines.

DRAINS. Under this heading would come small pipe not falling under any of the above headings. It is hard to give a full description of this material and usually it is better not to attempt to do so beyond stating that the contractor shall make such connections that may be required for this part of the work. Under this heading would be the water and oil drains for the turbines, bearing water for sealing the glands of the turbines, drains from cylinders of auxiliary machinery.

All cylinder drains should be run to a sump drain furnished in the building contract. Connections for the water lines for bearings would be from the service line brought into the building by the plumbing contractor.

The material to be used in these lines should be as follows:

VALVES. All valves used in drain lines shall be Lunkenheimer "Ferro Renewo" type.

FITTINGS. Fittings shall be cast iron standard or extra heavy as the pressure might require.

PIPE. The pipe shall be standard weight wrought steel pipe.

UNIONS. There shall be placed wherever necessary ground ball joint unions, same to have one brass joint against iron, with cast iron body suitable for the pressures that may be required on the lines.

PIPE COVERING.

The following lines will have to be covered with some sort of nonconducting material: Live steam lines, boiler feed lines, suction from heater to pump, auxiliary exhaust lines from machines to heater, and the heater.

A specification to cover these lines will be as follows:

LIVE STEAM LINES. All live steam lines, including valves, fittings, and flanges shall be covered with 85 per cent magnesia pipe covering and shall be applied as follows:

VALVES. The body of valve, including the bonnets, shall be covered with 85 per cent plastic covering, wired on and troweled smooth and canvas placed over same, the thickness of plastic shall be the same as is required for the corresponding different size pipes.

FITTINGS AND SEPARATORS. All pipe shall be covered with a double thickness of 85 per cent magnesia covering, each layer to be standard thickness required for that particular size pipe. Joints shall be broken in placing the covering on. Each layer shall have a canvas jacket properly plastered. Brass lacquered bands shall be placed 18 inches apart. At the flanges the covering shall be finished off with a chamfer so that bolts may be removed without breaking the covering.

FLANGES. All flanges shall be covered with sectional blocks and wired on securely and canvased smoothly. The blocks shall be arranged so that the covering may be removed in halves without further breaking same. A band shall be placed around each flange after it is plastered.

EXHAUSTS, BOILER FEED SUCTION AND DISCHARGE LINES.

The above lines shall be covered as follows:

VALVES AND FITTINGS. Shall be covered the same as called for under "live steam lines."

PIPE. Pipe lines shall be covered with one thickness of 85 per cent magnesia covering, canvas jacketed, and lacquered bands placed 18 inches apart.

HEATER. The feed water heater shall be covered 1 1-4 inches thick with 85 per cent magnesia plastic. One inch shall be applied with blocks or plastic whichever will be easier. This shall be wired on securely after which a 1-4 inch coat of plastic shall be applied and troweled smoothly and a canvas jacket placed over the whole.

PAINTING. All lines covered shall be given a coat of gray waterproof paint. The bands shall be removed before painting and replaced after paint is dry.

PAINTING AND CLEANING UP.

All exposed pipe, not covered, including valves and fittings, except brass valves, shall be given a coat of asphaltum paint, this includes support hangers, etc.

All debris made by the cantractors in installing pipe work shall be removed by the said contractor and the premises left clean.

BUILDING.

It is not the purpose of this article to attempt the design of the building for this plant, for as stated at the beginning of this series, this part of the work, if elaborately designed, should be left in the hands of a competent architect. However, it may be opportune to discuss some points regarding the structure.

We have already touched on the clearance that is desirable around the different machines, which within itself determines the size of the building. We have not, however, mentioned the large space that is desirable in front of the boilers for firing room. In addition to this, large space is required for drawing the tubes from the boilers during repairs. It is usually desirable to have large arches in the building wall in front of the boilers which allows easy access for coal from the track on outside of building.

A nice arrangement for this would be to have the track elevated about six to eight feet on an incline trestle, and beneath the tracks, and between tracks and building wall concrete the floor, this allows the coal cars to be run upon the elevated tracks, dumped and the coal easily carted into the boiler room. If the elevation would allow, this concrete mat could be made inclined towards the boiler room and the coal would roll into the arched doors by gravity.

If the boiler room floor is made of concrete, it is good practice to make about four (4') feet in front of boilers of hard burned paving brick laid on edge. This gives a surface that will not crack when the hot ashes are drawn when cleaning fires.

The wall separating the boiler room from turbine room should be a fire wall, running thru roof of building about three feet.

The elevation of the turbine room from floor to roof truss will depend on the required height necessary for the satisfactory operation of the crane. The space between bottom of crane and the highest piece of machinery should be sufficiently great to allow the crane to pick up the largest piece of the machinery and carry it over the other parts. This required height is furnished by the machinery builders. The required height above the crane rail is fixed by the crane builders, therefore from these two dimensions the distance from floor to bottom of roof truss may be determined. While it is not necessary, it makes a better arrangement to make the bottom chord of truss in the boiler room at the same elevation of that of the turbine room.

For a plant of this size the flat roof having about ½ inch pitch to the foot makes a nice arrangement, and with this type of roof it will be necessary to support the roof from steel trusses about 12 to 15 feet apart and with about 4 feet depth at outside edge of building and say 5 feet at partition wall. The design of these trusses are simple and the detail may be worked out by the steel contractor.

Both in the boiler room and turbine room there should be placed a sufficient number of ventilators. The roof proper may be made of concrete with cinder base for lightness and on top of this a water proof finish of some sort.

There should be plenty of light in the turbine room and since the elevation from floor to roof will be rather great, double windows give a good effect, having the lower section to swing or raise and the upper part to turn on a pivot. Above this may be placed the fixed arch (half circle) glass. This gives a nice effect from the outside and serves to give planty of light from the inside. The windows in the boiler room may be arranged to match the window arches of turbine room from the outside. If the ground level will permit there should be plenty of light in the basement. This may be had by allowing the window effect of the turbine room to be carried down to the basement. If the building is made of brick, it would be well to carry the fire proof effect out by using metal frames and wire glass windows and doors. Also make the floors of steel and concrete construction. While this is an expensive construction it makes a lasting as well as fireproof building.

The building walls will have to be designed strong enough to carry the load of the crane. This may be done by placing pilasters on the walls at points about fifteen feet apart. The pilasters may be built in as a part of the brick wall or they may be an independent steel structure running up from the ground.

There should be an easy means to get from the turbine room to boiler room, turbine room to basement and boiler room to basement, this will make a direct communication with turbine room to basement, also an indirect connection through the boiler room. It might also be desirable to arrange openings around the condensers so that the machinery in the basement may be watched from above. The building should be equipped with modern plumbing as well as an office for the engineer.

The crane should be a very simple hand power traveling crane, having a hand control for the crane itself, arranged through gears so that the effect will be on each pair of wheels, also a separate chain control for the trolley. On account of the additional expense which is quite high, and many times when the crane is desired there is no current, it is more desirable to make the crane to operate by hand instead of electricity. The capacity of the crane should be large enough to handle the largest piece of machinery (largest casting) at one time. In a plant of this size a 20-ton crane is about right.

This article completes this plant. In the next article we will treat a plant of different size and for different conditions.

Important Considerations in the Choice of Distribution Systems

A Discussion of Engineering Features.

BY F. T. STOCKING.

SINCE the general adoption of alternating current systems of generation and distribution, while no radical changes have been made in the systems, the methods of transmission and distribution have gone through different periods of refinement until today there are definite engineering reasons for the arrangements selected. Voltages which were not considered practical a few years ago are now commercial possibilities, not only in long distance transmission, but in distribution work as well. It has been found that apparatus can be made and lines erected at the moderately high voltages at a cost little in excess of that for the lower voltages, since the insulation on both apparatus and lines for such voltages is little more than that determined by mechanical considerations. In what follows a discussion, by a writer in a recent number of the Canadian *Electrical News*, is presented on some interesting features of distribution systems.

Higher potentials have been advocated to reduce line losses and the enormous outlay conductors, but in most instances it has been found advisable to use 2200 or 2300 volt apparatus for alternating current, 3-phase distribution and to put in sufficient distributing stations to keep the cost of lines to a reasonable amount. The principal advance, therefore, has been in so arranging the standard 2300 volt apparatus as to reduce the cost of distribution to a minimum. For this purpose the 4-wire Y connected system with grounded neutral has been employed and its use is steadily increasing. By this method the transmission voltage is raised from 2300 to about 4000 volts, the potential between any wire and ground being kept at 2300 volts which voltage not infrequently obtained with the delta connected system. From the victor diagram of a delta connection shown in Fig. 1 it is obvious that 2300 volts will be the potential between any two conductors. In Fig. 2 solving the triangle A, B, C, the potential between A and B is $2300\sqrt{3} =$ about 4000 volts which will be the potential between line wires, the potential between each of these and neutral or ground being 2300 volts.

For the same per cent of voltage drop or per cent power loss, the carrying capacity of a given conductor varies as the square of the voltage. The carrying capacity of the "Y" connected system is therefore 3 times that of the "delta." Partly offsetting this great advantage is an increase in cost of line where single-phase loads are supplied since a fourth conductor is necessary. This conductor, however, may usually be of minimum mechanical strength or say No. 6 copper.

Very effective use may be made of this fourth wire by carrying it at the top of the pole and grounding at every third or fifth pole, thereby serving the purpose of a ground wire to lessen the chances of disturbances on the line during thunder storms. For a balanced motor load this fourth conductor may be omitted, although if this is done it is advisable to ground the neutral of the apparatus at both the transmitting and the receiving end. Other disadvantages are an increase of 10 to 30 per cent in meter costs; 10 per cent to 20 per cent in the cost of motors for use on

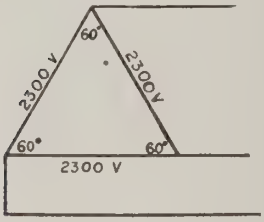


Fig. 1

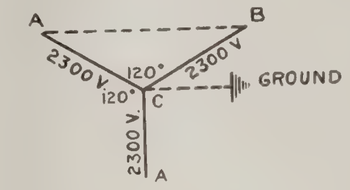


Fig. 2

Fig. 1 and 2. Delta and Star Connections.

line voltage, and frequently an increase in cost of switching and protective apparatus. Greater care is also necessary in keeping the line clear of accidental grounds since a ground that would not seriously affect a delta system might result in short circuit where a grounded neutral is employed.

SELECTION OF DISTRIBUTION SYSTEM.

Considering a lighting load only, the cost of line will be the chief factor in selecting the system. Assuming 5 per cent as the maximum allowable potential drop a single-phase 2300 volt line of minimum size—i.e. No. 6 copper—will carry a load at 100 per cent power factor of about 80-horsepower a distance of 1 mile. A 3-phase, 2300 volt line will carry twice this or 160 horsepower, while a "Y" connected to 4000-volt system will carry 6 times the first or 480 horsepower.

With a water power plant having a day peak it will not be necessary to consider power losses on the lighting circuits, hence the system to employ, and the size of conductors, may be determined from the regulation required. When, however, the line losses mean a direct increase in the cost of power such losses should be reduced to a point where the annual cost of same about equals the annual charges on conductors erected since the total annual cost is then reduced to a minimum. Considerable judgment is often required in deciding just what the load for the year and the resulting annual losses will be.

Assuming the cost of power at the station as $25 per horsepower per year, the cost of conductor erected as $0.26 per pound, with interest at 6 per cent and depreciation on conductors as 2 per cent the economical load at 100 per cent p. f. for No. 6 weatherproof copper with a single-phase 2300 volt line may be found as follows:—Cost, erected, of 1 mile of two No. 6 T. B. weatherproof copper conductors would be $310. Annual charges at 8 per cent = $24.80, which would be equivalent to the cost of $24.80 ÷ 25 = .992 horsepower = 740 watts for line loss.

The resistance of 1 mile of No. 6 copper single-phase line is about 4.18 ohms and watts loss = C^2R,

Therefore, $C = (\sqrt{740}) \div (\sqrt{4.18}) = 13.3$ amperes, which at 2300 volts = about 41 horsepower. Similarly it may be found that economical load for a 3-phase line of No. 6 copper and 2300 volts is about 71 horsepower and for a four-wire, 4000 volt line is about 143 horsepower. In Table 1 are given the annual costs per mile, including line costs and losses, of transmitting various loads with different systems. Prices of material and of power are as assumed above. In the 4000 volt system is included the cost of the neutral with its support erected and wire grounded at every fourth pole, the neutral wire in all cases being No. 6 triple braid weatherproof copper. Prices do not include the cost of poles, cross arms, etc., as these are practically constant for all three systems.

Table 1. Annual Costs Per Mile for Different Systems.

Annual Cost Per Mile Per H.P.

H.P.	No. 6			No. 2			No. 2/O		
20	1.84	2.45	3.40	3.71	5.45	6.47	7.05	10.50	11.55
40	1.36	1.45	1.75	2.04	2.82	3.26	3.62	5.32	5.80
60	1.48	1.21	1.27	1.55	1.97	2.21	2.52	3.60	3.88
100	1.70	.75	.91	1.30	1.37	1.39	1.70	2.25	2.35
150	1.70	1.41	.81	1.36	1.16	1.01	1.37	1.62	1.61
200	3.10	1.70	.82	1.53	1.13	.84	1.29	1.34	1.25
300	...	2.36	.96	1.99	1.23	.72	1.34	1.14	.92
500	...	3.77	1.35	3.41	1.67	.74	1.74	.95	.70
1000	...	...	...	...	3.03	1.09	...	1.67	.71

Size Copper	No. 6			No. 2			No. 2/O		
Volts	2300	2300	4000	2300	2300	4000	2300	2300	4000
No. of wires....	2	3	4	2	3	4	2	3	4
Annual Charge on Conductors .	31.00	46	67	72	108	129	140	210	231
H.P. Carried 1 mile with 5 per cent volts drop	60	120	360	150	300	900	285	570	1710

Under the conditions assumed above it would be uneconomical to use a single-phase system for transmitting more than 50 horsepower. For loads over 100 horsepower it would appear advisable to employ the "Y" connected system and this would doubtless be true for lighting loads since only the metering and switching apparatus at the station would be affected causing only a slight additional cost, while two station transformers would still be effective if the third were damaged. The regulation also would be very much improved, which, in itself, is an important consideration.

Where a motor load is carried, owing to the lower power factor and the resultant increased line losses it will be economical to use the 4-wire system—on somewhat lighter loads—considering transmission only. If the motors are to be supplied at voltages lower than 2000 this may hold, but where they are to be connected directly to the line the increased cost of motors, starting devices and meters will lessen or perhaps entirely overbalance the saving on transmission. The increase in cost in motors with starting devices is due largely to the latter, although, no doubt, the increase is to a great extent caused by the fact that 4000 volt apparatus has not become standard.

In the switching apparatus to handle the same load there should be little difference in price, as the neutral wire may be permanently grounded at the load and there is no necessity of breaking it, hence the ordinary 3-pole oil switch may be employed. In meters, however, working on unbalanced loads using the fourth wire there is a considerable difference in cost since three current transformers are required in place of the two as ordinarily used. Assuming the total cost of meters both for the station and the customer as $2 per horsepower, with annual charges of 14 per cent, and of motors with starting devices as $13 per horsepower with 12 per cent annual charges, station switching and protective apparatus $2.50 per horsepower with 12 per cent annual charges; then an increase of 30 per cent in cost of meters, 20 per cent in motors and 20 per cent in station protective and switching apparatus will increase the annual cost by .08 + .31 + .06 = $0.45 per horsepower.

DELTA CONNECTED SYSTEM.

Again when a "delta" system is adopted two transformers will still be effective for supplying 3-phase current after the third has been damaged, which is not the case with the "Y" connected system and for this reason it may be advisable to install a spare transformer. Assuming the cost of transformer installed as $12 per horsepower, then the annual charges for the spare taken at 12 per cent per annum, will increase the annual cost per horsepower by $0.48, bringing the total extra cost above that of the delta system up to about $0.93 per horsepower per annum. This figure should cover the additional cost in the most unfavorable case and usually this cost may be made much less.

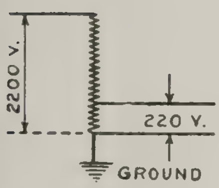


Fig. 3

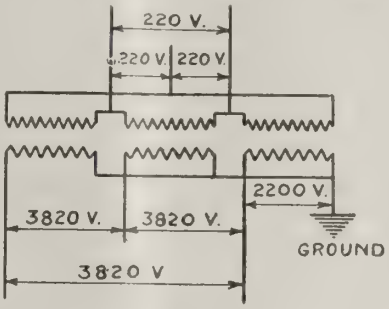


Fig. 4

FIG. 3. AUTO TRANSFORMER CONNECTIONS. FIG. 4. TRANSFORMER CONNECTIONS WITH DELTA PRIMARY AND "Y" SECONDARY.

Two or more 3-phase transformers may be substituted for the bank of three single-phase transformers bringing the cost down to little in excess of the latter and making the service fully as good. In many small stations the motor load is of such a nature that an interruption of one or two days would not be serious and therefore would not necessitate spare transformers or the whole system could be changed temporarily to V. On these stations the motor loads are small and are usually supplied at a potential lower than that of the line. In such cases no additional equipment is required at the motor, the only additional cost being in station switching and meter equipment. The additional cost here would probably not exceed $0.15 per horsepower per annum.

Y CONNECTED SYSTEM.

Generally speaking, for a mixed load where regulation is not a factor, it would be quite safe to install the "Y" connected system when the annual saving on transmission costs reaches $0.50 per horsepower. On the longer lines where it is necessary to consider regulation it would doubtless be wise to use the "Y" system on much lighter loads than would appear from an examination of the above figures.

In connection wtih this system various engineers have advocated the use of auto transformers for service use as shown in Figure 3. This would considerably reduce the transformer costs and should not be objectionable providing a good ground is assured. Some companies have even discarded the neutral wire and depend entirely on the ground wire for single-phase work. This would, however, become dangerous unless it is known that one side of the secondary is permanently and absolutely grounded. Fig. 4 indicates a common method of connecting transformers with "delta" primary to "Y" secondary or vice versa. Some care must be taken in making such connections, since it is possible to obtain unequal potentials between the different secondary wires, and it is advisable to test with a volt meter or lamp bank before connecting to load. For supplying a motor load from two transformers the connection shown in Fig. 5 is used and may be employed either on light loads to save transformer costs or as a substitute for three transformers in case one is damaged.

NEUTRAL WIRE OF 4-WIRE SYSTEM.

The question of what form of conductor to use for the neutral wire and how this conductor should be supported is one that requires considerable thought. With the lighter loads since little current is carried, mechanical strength is the chief consideration. For such cases copper clad steel and even galvanized iron has been proposed and would no doubt serve quite well on such loads, particularly when grounded at frequent intervals. Its chief use in such cases would really be to assure an absolute ground and, when properly erected, to answer as lightning protection.

Whether or not this neutral wire should be insulated would depend upon its position on the pole as well as on the type of the other conductors. If the latter are bare the neutral would naturally be. If the neutral is located close to insulated primary conductors where linemen are liable to come in contact with it while working on live lines it is advisable to have the neutral insulated. This also applies to the grounding wires. If the neutral can be supported in a more or less isolated position such as well above the upper arm there appears no necessity of insulating it and the saving on cost of insulation may be used in raising it still higher, thereby making it effective as a lightning protection. Various types of pole top brackets are on the market and serve nicely in cases where the arm can be placed well down on the pole. A short heavy porcelain knob secured by a lag screw to the top of pole also answers well, the porcelain being the cheapest article obtainable with smooth surfaces which will not injure the wire.

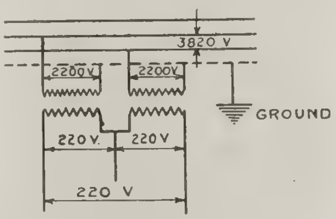


Fig. 5

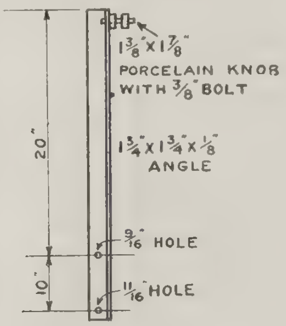


Fig. 6

FIG. 5. OPEN DELTA CONNECTION OF TRANSFORMERS. FIG. 6. GROUND WIRE SUPPORT.

For carrying the neutral well above the top of the pole an angle iron fitted with a porcelain knob, as shown in Fig. 6, is probably the simplest device that can be made. The through bolt for supporting the cross arm may be used as the lower bolt for this support, thereby saving a bolt and two washers. In using such a device it is advisable to carry the neutral on an insulator of some description to avoid danger to linemen. For the same reason the grounding wire should be carried up without touching this support.

There is, of course, no necessity of using special construction for this neutral wire, the only object of carrying it at the top being to have it serve as a protection which might considerably improve the service.

Inspections and Tests on Electrical Machinery

(*Contributed Exclusively to* ELECTRICAL ENGINEERING.)
BY HUGH T. WREAKS AND R. L. SHEARER, OF T. E. I. BUREAU.

Section 3. Tests on Alternating Current Generators and Synchronous Motors.

THE tests usually called for on alternating current generators, preliminary tests having been made (drop on spools, resistance measurements, air gap, fitting of collector brushes, phase rotation, and balancing of the voltage across the different phases) are saturation, synchronous impedance, open and short circuit core losses, wave form, non-inductive normal load circuit run, non-inductive overload heat run.

SATURATION. The saturation test is made on alternating current generators to ascertain the characteristics of the magnetic circuit. The characteristic curve may be obtained by either of the following methods: "generator saturation" or "motor saturation." Generator and motor saturation on direct current generators and motors was discussed in the June issue. These tests on direct current generators and alternating current generators are alike with the exception of a few points which will be taken up in this article. Taking a saturation curve on a polyphase alternating current generator, a reading of the voltage across each phase must be taken at normal field current to see if the phases are properly balanced. Care should be taken to insure accurate readings at above normal voltage, since with alternating current generators this is the portion of the curve used to calculate the regulation under load.

For motor saturation on alternating current generators, the machine is run as a motor and the impressed voltage varied as previously described. The speed is independent of the motor field, and instead of regulating the motor field for speed, it should be regulated to give minimum input current at each voltage. Readings should be taken of volts impressed, amperes armature, amperes field and volts field. In plotting saturation curve, use volts armature as ordinates and amperes field as abscissæ.

SYNCHRONOUS IMPEDANCE. Synchronous impedance is taken on alternating current generators to determine the field current necessary to produce a given armature current when machine is running short circuited. The regulation of the machine is calculated from the impedance and saturation curve. The armature should be first short circuited, then, with the machine running at normal speed and with a weak field current, current in each phase should be read. The field current should be increased gradually until about 200 per cent normal armature current is reached, readings being taken of amperes armature, amperes field and volts field. These readings should be taken simultaneously. In plotting the curve use amperes field as abscissæ, and amperes armature as ordinates.

CORE LOSS. In order to obtain running light core loss for alternating current machines, they should be operated as a sychronous motor at the proper frequency and rate of voltage; both frequency and voltage must be steady. With normal voltage on the armature, the direct current field should then be varied until minimum armature current is obtained. Read amperes and volts on all phases. At minimum input current, unity power factor is obtained, and, therefore, the power to drive such machines will be the volt amperes input. A good practice is to use a wattmeter in addition to check the volt-ampere readings. This measurement includes windage and friction losses, together with the open current core loss, plus the I^2R loss of the armature. If the value of the core loss need not be separated from the other losses, the test is useful for checking up full load efficiencies.

BELTED CORE LOSS. Synchronous alternating current machines generally have loss measurements taken as previously described on the open circuit and also with armature of machine undergoing tests short-circuited. In short-circuit core loss, the increase in power supplied by the driving motor over that required by the friction loss is plotted as ordinate and amperes armature as abscissæ, for the open circuited armature voltage due to a given excitation. In making these tests (short-circuited core loss) careful measurements must be made of the resistance of the short-circuited armature, including all leads before and after test, since to obtain the true short-circuited core loss, the I^2R loss must be subtracted.

WAVE FORM. Wave form on alternating current generators is obtained by the use of the oscillograph.

NON-INDUCTIVE NORMAL LOAD HEAT RUN. This consists of running an alternating current generator under normal load at unity power factor until temperatures are constant. The final temperatures are taken when machine is shut down.

NON-INDUCTIVE OVERLOAD HEAT RUN. Alternator is brought up to normal load temperatures then an overload at unity power factory is put on for a specified time. At the end of this time the machine is shut down and final temperatures taken. Readings for regulation at unity power factor should be taken after each of these heat runs. Wattmeters should be used together with volt meter and ammeter to determine the power factor.

SYNCHRONOUS MOTORS.

Synchronous motor tests consist of open and short-circuit core loss, saturation, synchronous impedance, overload and full load characteristics, wave form and starting tests. Open and short-circuit core loss, saturation, synchronous impedance, and wave form tests are described in tests on alternators. No load and full load phase characteristics were described in last month's issue under heading of Rotary Converters.

STARTING TEST. The starting test on synchronous motors is important. This test should be made with and without a compensator. Motor should have some load at starting. The motor should be first tested without a compensator. Starting this test, the center line of one pole is placed in line with the center line of the frame. At the head end of the motor, a length of 180 electric degrees is laid off in a clockwise direction from this line. This scale should be divided into four equal parts, each division line being numbered. On each of the scale divisions, the center line of the marked pole should be placed and motor started.

This will give tests to insure that the motor will not stick in any position. With pole line in line with the first mark on frame, a sufficient current should be sent through the armature to give reasonable amperes and volts on the various phases and the induced voltage in the field. The induced voltage in the field should be read, using a potential transformer and a voltmeter for this purpose. The readings with the machine at rest are taken to determine which phase gives the maximum reading of current and voltage so that the latter can be read at the moment of starting.

Non-Inductive Load Heat Run. This consists of running the machine at unity power factor, until it reaches a constant temperature. The final temperatures are taken after the machine is shut down.

Non-Inductive Overload Heat Run. This consists of bringing machine to normal load temperatures, applying the overload for a specified time, and recording final temperatures after closing down machine. Take readings of regulation at unity power factor after heat run.

Normal load power factor heat run is the same as normal load non-inductive heat run, except that the machine is operated at a specified power factor. This is also true with regard to alternating current generators.

The Use of Tungsten Lamps in Electric Signs

BY O. P. ANDERSON.

Discussion of Economical Operation and Arrangement of Different Sizes of Lamps.

It is estimated that there are in operation at the present time in this country something over 80,000 electric signs which, assuming 100 lamps per sign, calls for the operation of approximately 8,000,000 sign lamps. Although this number of lamps, even of small size, when burning a large part of the 2,000 hours that make up the time between dusk and midnight during a year, represent a considerable income from the current used, such income is only a small percentage of the possible business that central stations can secure through electric signs. The electric sign display has now developed to an important position in outdoor advertising, aided largely in securing this position by the successful application of the tungsten unit, the perfection of flashing mechanisms and the ability to produce artistic and attractive features in signs. Probably, however, the introduction of the tungsten unit has given the business the greatest impetus for the reason that with the carbon lamp, the operation cost of electric signs was such a large part of the average merchant's appropriation for advertising that the proper display to bring about possible returns was denied, while the proposition was far beyond the reach of the small merchant. The low current consumption of the small tungsten units, however, has made possible a more flexible application of the electric sign and largely for this reason its success is now assured as is shown by the large increase in numbers being installed on the thoroughfares of both small and large cities.

In what follows data will be given on the use of electric sign lamps and the economical lighting of signs as well as the arrangement of the wiring for best results as presented by Mr. Anderson in a recent issue of the *Canadian Electrical News*: The following table gives the total operating cost in dollars per thousand hours with various types of sign lamps, current calculated at 10 cents per kw. hour.

Table 1.—Operating Cost of Sign Lamps—Dollars per 1000 Hours.

7.5 c. p. watt carbon	$3.10
4.8 c. p. 20 watt carbon	2.10
6.7 c. p. 10 watt tungsten	1.20
2 c. p. 10 watt carbon	1.07
3.3 c. p. 5 watt 50-65 v. tungsten	.65
3.8 c. p. 5 watt 10-15 v. tungsten	.62
1.8 c. p. 2.5 watt, 10-13 v. tungsten	.37

In these figures the renewal cost is assumed to be the present standard package price. It will be seen that there is no longer any excuse for the continued use of carbon sign lamps.

Theoretically, as the operating cost decreases, due to the use of high efficiency tungsten lamps, there is a material increase in the number of consumers. In addition to this, the reduction in operating cost makes it possible for existing consumers to burn their signs longer for the same expense, thus getting more advertising, and at the same time greatly improving the load factor of the central station. The gross income to a central station varies with the product of the operating cost per hour, the number of consumers and the number of hours burning. The increase in the number of hours burning and number of consumers will more than offset a decrease in operating cost, the result being a material increase in income to the central station. Therefore, by reducing the operating cost a small amount, it is possible to considerably increase the net profits to the central station, and at the same time give the customer more and better advertising for the same amount of money.

There are a large number of carbon signs throughout the country which are not operated at all, or at best, only a very short time each night. Clearly this is not profitable business for the central station, nor does it give the merchant results in proportion to his investment. Therefore, everything seems to indicate that it is both to the advantage of the central station and merchant that tungsten lamps be used.

Table 2.—Data on Tungsten Sign Lamps.

	10 to 13 v.	50 to 65 v.	100 to 130 v.
Rated and average watts	2.5	5	10
Watts per candle	1.33	15	1.5
Lumens per watt	7.46	6.62	6.62
Mean horizontal c. p.	1.8	3.3	6.7
Mean spherical c. p.	1.4	2.6	5.3
Average total life, hours,	2,000	2,000	2,000

In table 2 is given the qualifications of tungsten sign lamps in use at the present time. It is now possible to use these lamps on any standard lighting circuit, whether alternating or direct current. The filaments in all tungsten low voltage sign lamps are now made of wire of the same diameter. This means that when these lamps are connected in series and necessarily take the same current they will operate at the same current density and efficiency in watts per candle. This makes it possible to get nearly as good results from series as from multiple operation. Since the diameter of the wire is the same through the entire voltage range, namely, 10 to 13 volts, it is evident that there will be a slight variation in the watts consumed, due to variation in voltage. This is to be desired, however, since the normal amperes are constant. It is therefore possible to operate with entire success a 10 volt lamp in series with 9 and 11 volt lamps. However, this is not recommended, as it will be responsible for either an increase or decrease in the efficiency at which all the lamps are operated. In order that there may be no misunderstanding regarding which is, and which is not, the correct way to operate these lamps, each type of lamp will be described separately and recommendations made accordingly.

10 TO 13 VOLT TUNGSTEN SIGN LAMPS.

Since these lamps are made for 10 to 13 volts they necessarily have a comparatively short and thick filament which makes them very rugged and able to withstand severe service. In cities supplied with alternating current it is always recommended that these lamps be used in connection with a transformer. The expense of the transformer is justified since by its use the best possible performance is secured through multiple operation. It is poor economy, therefore, to wire even small signs in series under these conditions. It is a very simple matter to change over old carbon signs to accommodate these lamps, as it is only necessary to insert a transformer between the service wires and the sign. Care, however, should be taken to see that the size of wire in the sign is heavy enough to carry, without excessive voltage drop, the increased current consumed by the low voltage lamps.

In the past these 10 to 13-volt sign lamps have been a perplexing problem to central stations supplying only direct current. Although many have wired these lamps ten in series with good results, others have had only indifferent success. The difficulty has been largely due to a system of wiring which would permit ten lamps to go out whenever one failed. Since, therefore, the success of series systems of wiring with 10 to 13-volt lamps has been questionable, it is no longer recommended for new sign lamps, especially in view of the fact that the 100 to 130-volt and 50 to 60-volt sign lamps make it possible to employ a better system of wiring. However, should a sign be already wired in series, very good results may be obtained by using carefully selected series sign lamps, the present method of selection allowing every one of the lamps in each series to burn at exactly the same efficiency when consuming the same current. Under no conditions should lamps of different manufacture be operated in the same series.

Although the straight series method of wiring may now be considered obsolete, the multiple series method may still be used with satisfactory results under certain conditions. These conditions are that the sign which is so wired should contain not less than 100 lamps and also that the burnouts be promptly replaced.

50 TO 65-VOLT SIGN LAMPS, TWO IN SERIES.

These lamps will be of great assistance in the sign lighting field, especially for direct current districts. The method of wiring this lamp will be the same on alternating current and direct current circuits. The lamps may be either wired two in series or in multiple-series. In a double-face sign it is suggested that each side be wired in multiple, and the two sides placed in series, thus making the condition of operation practically similar to straight multiple. If it is desired to wire two lamps in series it is recommended that the lamps be staggered so that the failure of one lamp will not cause two adjacent lamps to go out. With a double-face sign, by wiring one lamp on one side in series with a lamp on the other side, the failure of one lamp will only cause one lamp on each side to go out, and it can readily be seen that with a reasonable amount of care such a sign can always be kept in good condition.

The old signs containing 100 to 130-volt carbon lamps can, in the majority of cases, be re-wired very simply, so as to accommodate these lamps. If it is a double-face sign the change can be made by simply connecting one side of the sign in series with the other side at the cutout box. If it is a single-face sign, or a double-face sign with an equal number of balance circuits, the change can be made by connecting in series two circuits which contain an equal number of lamps. Such changes have been made in a number of cases with satisfaction.

100 TO 130-VOLT, 10-WATT SIGN LAMPS.

The introduction of these lamps has made possible the simplest and most satisfactory method of operating sign lamps, *viz.*, in straight multiple on standard lighting circuits. Their use means the elimination of a transformer, which will mean a considerable saving in the initial cost. The writer knows of one sign containing about 400 of these lamps which have burned in excess of 2,000 hours, giving an average life of 1,800 hours, with 60 per cent of the original lamps still in service. The results given in other places, under different conditions, have shown up equally well.

These lamps should prove a blessing to central stations supplying direct current, who have heretofore objected to the series system of wiring. They make it possible to change over all old carbon signs to this lamp without any re-wiring and also to so equip all new signs. In fact there is no logical reason why any new sign should not be supplied with tungsten lamps.

WIRING OF SIGN LAMPS.

The wiring of tungsten sign lamps is very important, especially that of the 10 to 13-volt lamps. It is very essential that the size of the wire be calculated very carefully in order that the Fire Underwriters' rules be not violated, and also in order that the voltage drop be not excessive. According to the Fire Underwriters' rules: "Where wire not inferior in size and insulation to approved No. 14 B. & S. gauge is used, connected to standard sockets or receptacles, 1,320 watts may be dependent upon final cutout."

TABLE 3.—CAPACITY IN AMPERES OF VARIOUS SIZES OF COPPER WIRE, AND NUMBER OF 5 AND 10-WATT LAMPS THAT MAY BE OPERATED IN MULTIPLE THEREON.

14	12	27	137	137
12	17	38	195	*
10	24	55	275	
8	33	76	*	
6	46	106		
5	54	124		
4	65	149		
3	76	175		
2	90	207		
1	107	246		
0	127	*		

(*Exceeds the 1320 watts as allowed by National Board of Fire Underwriters).

In table 3 is shown the carrying capacity of wires as approved by the National Board of Fire Underwriters, and also the number of tungsten sign lamps, used in multiple, that they may safely carry. It can be seen from this table that the carrying capacity of the wires is the governing feature with low voltage lamps. With 10 to 13 volt lamps it is very essential that the voltage drop in all cases be less than one-half volt. This is evident, since if a large drop be allowed the percentage drop would be so high that the appearance of the sign would be affected. For instance, a drop of one volt means a drop of 10 per cent, which is entirely too much for satisfactory service.

Table 4 gives the number of lamps that can be operated on each of four different sizes of wire with a voltage drop not exceeding one-half volt. Table 5 gives the maximum number of 5-watt, 10 to 13-volt lamps, wired in multiple, that can be supplied from feeders having the size and length in the table, with a drop not exceeding 0.2 volts.

With the 100 to 130-volt 10-watt, and the 50 to 65-volt 5-watt lamps, the ampere rating is very small, and hence the governing feature of the wiring will be the 1320 watts which is imposed by the National Board of Fire Underwriters. With 10 to 13-volt lamps wired in multiple, it is, however, necessary to calculate very carefully the size of wire to be used in each particular sign. Knowing the current to be carried, it is a fairly simple matter to determine the size of wire to use by referring to the given wiring tables.

There are several methods of connecting the feeders to the circuits when lamps are wired in multiple that will greatly affect the performance of the lamps. This subject has not been given the attention it deserves, and as a result a number of signs are not operating under the best possible conditions.

Sign lighting is now on a very firm and stable basis. City authorities are very favorably inclined toward it, as it is responsible for lighter and brighter streets, without any additional expense to the taxpayers. The merchants are pleased, since they are getting more and better advertising without additional expense. A wonderful advance has been made in the art of manufacturing signs, and as a result sign companies are now erecting better and more artistic signs than ever before. In fact, the present conditions are very favorable for a big increase in the sign lighting industry.

Table 4—Number of 5-Watt, 10 to 13-Volt Lamps That May be Operated on Each of Four Sizes of Copper Wire With a Voltage Drop Not Exceeding One-Half Volt.

Spacing of Lamps in Inches	Size of Wire (B. & S.) 14	12	10	8
3	48*	68*	96*	132*
6	48*	68*	88	112
8	47	60	75	97
10	42	54	68	86
12	38	49	62	79
16	33	42	54	68
20	29	38	48	61

Table 5.—Number of 5-Watt, 10 to 13-volt Lamps Wired in Multiple that Can be Supplied from Feeders of the Various Sizes and Lengths Given, With a Drop Not Exceeding 0.2 v.

Combined Length of Pair of Feeders	Size of Feeder (B. & S.) 10	8	6	4	2
3	64*	92*	130*	184*	262*
4	50	77	125	184*	262*
5	40	62	100	158	254
6	33	53	84	135	210
8	25	40	63	101	160
10	20	31	50	79	127
15	13	21	33	53	85
20	10	15	25	39	63
30	7	10	17	26	42

(*These limits cannot be passed without exceeding the safe carrying capacity of the wires).

Electrical Research Laboratory and Bureau at Massachusetts Institute of Technology.

Gifts and promises for the advancement of Electrical Enginering at the Massachusetts Institute of Technology amounting to more than $200,000 have been announced, making possible the establishing of a division of electrical engineering research and the maintaining of a well equipped electrical library. The bureau will be in charge of Dr. Harold Pender with H. F. Thomson as assistant.

A part of the endowment comes from the American Telephone and Telegraph Company through the initiative of its president, Theodore N. Vail. This endowment is a grant of $10,000 per year for five years. A second part of $5,000 per year for five years comes from an anoymous doner to be used to investigate the distance to which a street car passenger can with reasonable profit be carried for five cents.

The Massachusetts Institute of Technology has gained an enviable reputation as a technical school through its research work, the most recent of which is the vehicle research undertaken at the initiative of President Edgar of the Boston Electric Illuminating Co., of Boston, and financed by his company.

The work to be taken up at once will be an investigation of the clearness of speech as heard through the telephone and an investigation of transmission of alternating currents over wires.

Information Requested by I. E. Society on Present Day Lighting Conditions.

There has been mailed to those interested in illumination, by President Preston S. Millar of the Illuminating Enginnering Society, a set of questions, the answers to which it is hoped will show the general tendency of present day lighting in America. The questions have been sent to representative companies and individuals of central stations, gas companies, municipal engineers, manufacturers of lamps and lighting units of all kinds, fixture manufacturers, decorative post manufacturers, schools and commissions, railroads, etc., the country being divided into 90 districts, each of approximately one million inhabitants.

The scheme as outlined has decided merit and all receiving the questions should endeavor to supply as much data and information as possible for in compiling, summarizing and interpreting this data it is certain that certain useful and interesting facts will be made known. All questions should be in the hands of Preston S. Millar, President Illuminating Engineering Society, 80th street and East End Ave., New York City, by August 10. All those sending in answers to questions will receive a copy of the compiled results for the entire country.

Grounds on High Tension Systems

(*Contributed Exclusively to* ELECTRICAL ENGINEERING).

BY W. A. HELM.

IT is most essential that high tension systems be designed and installed with proper provisions for safety in event of grounds. As an example, consider a high tension system, which consists of generators connected to a single bus through disconnectors and non-automatic oil switches. The feeders are connected to the single bus through disconnectors, automatic oil switch and line disconnectors. Feeders are protected in event of grounds outside of station by means of current transformers and relays, the two current transformers being in circuit on the two outside lines of the three phases. This is a simple method of protection providing all grounds occur outside of generating station, which is not always the case.

The sketch in Fig. 1 shows a method of relay operation, providing trouble occurs outside of station and all feeders and tie lines have their current transformers systematically arranged. Under these conditions, the system will operate successfully with a ground occurring on any two lines of any feeder or a ground on one line of a feeder, and another ground on opposite line of the second feeder. Fig. 2 shows a ground on *B* phase of one feeder and a ground on *A* phase of second feeder. In this event, feeder *X* relay will not trip, owing to no current transformer being in *B* phase, but feeder *Y* relay will trip, as sufficient current will flow through current transformer of *A* phase of *Y* feeder to cause relay to operate, thus opening the short circuit through earth between phases *A* and *B* on feeders *X* and *Y*. In illustrating this case, it is to be understood that the ground has not produced a sufficient arc to cause phase *B* to short circuit with *A* phase of *X* feeder.

A defect in reliable protection of a high tension system is shown in Fig. 3, which shows a generator, bus and feeder with two current transformer method of rely control. In event of a ground on *B* phase of any feeder, shown in sketch 3 at point (a) and a ground on *A* phase of generator or bus as shown at point (b), feeder switch would not trip, as it has no control transformer on *B* phase, consequently the system has no protection from the short circuit through earth between phase *A* in the station and phase *B* of feeder.

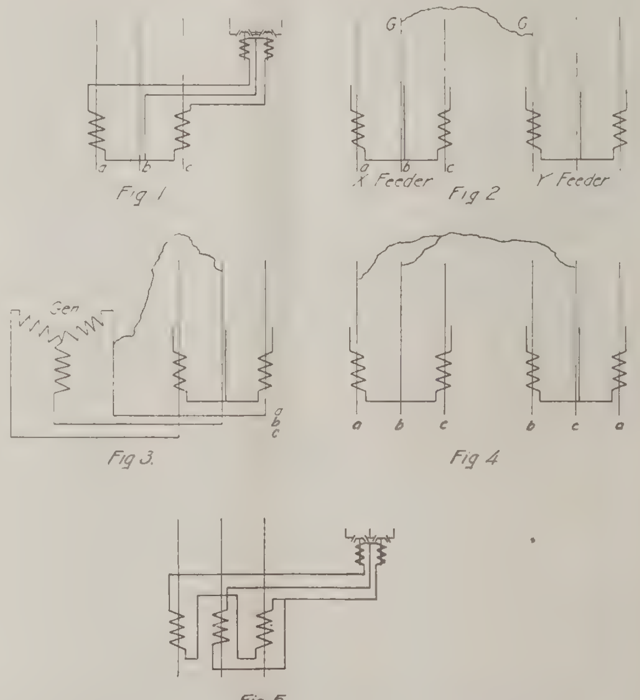
It will be readily seen from the following, that the above condition would be disastrous. The short circuit currents of alternators are of two kinds. First, the short circuit current of an alternator at full load excitation is usually from three or more times the full load current, being called the permanent short circuit current. Second, in the first moment after short circuiting, the current is many times the permanent short circuit current and in large alternators of high armature reaction and low self-inductance, the momentary short circuit current may exceed the permanent value ten or more times, and in such cases the mechanical shock on the generator becomes enormous.

With polyphase machines in case of a short circuit on one phase as described in sketch 3, the armature reaction is pulsating and the field current, in the first moment after short circuiting occurs, pulsates with double frequency and remains pulsating even after the permanent condition has been reached. This double frequency pulsation of the field current, with short circuit on one phase of a three-phase generator, generates in the armature a third harmonic of Emf. The short circuit current wave becomes greatly distorted thereby and causes a very high voltage to appear in the other phase, which is greatly distorted by the third harmonic and may reach several times the value of the normal voltage. This destructive voltage would cause insulation to break down on phase *C* of other feeders and consequently cause more than one feeder to ground out, and also produce a severe strain on generator insulation.

Similar conditions of defect of protection can exist between tie lines and feeders. For example, if all feeders leaving the main station have no current transformers on *B* phase. A tie line, after leaving the sub-station, may have phases crossed at current transformer as shown in sketch 4, in which case there is no current transformer in phase *C*, but in phase *B* as shown in sketch 4 at point (a). Should a ground occur between phase *B* of feeder and phase *C* of tie line, no current transformer would be in circuit to operate relays, consequently the results would be the same as a ground on phase *A* in station and phase *B* of a feeder.

To eliminate this defect in the protection of high tension systems, it is advisable to install an additional current transformer in phase *B* of all feeders. The installation of a current transformer on *B* phase of all feeders should be connected in *Z* with the other two current transformers, with the three leads brought out to the two tripping relays as shown in Fig. 5.

With a system protected as described, a ground on *B* phase of any feeder and a ground on *A* phase of the generator, bus or tie line would cause the feeder to trip the switch and separate short circuit through earth, due to the



FIGS. 1 TO 5. DIAGRAMS SHOWING POSSIBLE GROUNDS.

excess current in the current transformer on phase *B* of the feeder. The installation of aluminum lightning arresters by absorbing surges due to short circuiting of one phase of a polyphase generator, will prevent, as a rule, more than one feeder to ground out, but will increase trouble with two current transformer relay protection. For example, should a ground occur as described in Fig. 3, the aluminum arrester absorbing the surges, does not permit the insulation to break down on phase *C*, consequently the relay cannot open the switch to relieve the system of short circuit through earth until sufficient time has elapsed for the ground at point (b) to arc and destroy insulation on *C* phase of feeder.

Types of Outdoor High-Tension Transformer Installations.

BY H. W. YOUNG, PRESIDENT DELTA-STAR ELECTRIC COMPANY, CHICAGO, ILL.

With the growth of high tension extensions into rural communities has come the demand for simple forms of sub-station construction which can be installed and maintained at a minimum cost. As an example of such construction, the installation shown in Fig. 1 will be of interest to those central station managers seeking consumers along the high tension lines. The transformers are connected in closed delta, stepping from 33,000 to 2,200 volts at 60 cycles, and are protected by three underhung type of carbon-tetrachloride fuses of standard form easily accessible from the platform.

With this type of installation switching is accomplished by means of a pole-top, three-phase switch mounted on a separate pole and controlled by a locking type of handle about ten feet from the ground, as shown in Fig. 2. This

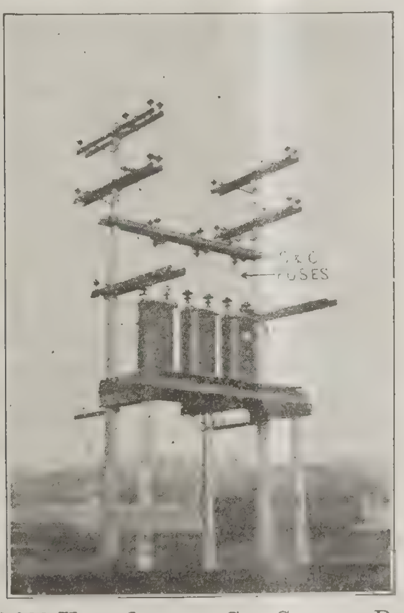


FIG. 1. A 33,000-VOLT OUTDOOR SUB-STATION PROTECTED BY CARBON TETRACHLORIDE FUSES.

combination gives a low-priced installation and has but few parts to give trouble. The switch is designed to open under load conditions, the arc being ruptured on the horn in the usual manner. In selecting switch gear for outdoor service it should be borne in mind that high voltage disturbances in a transmission system usually manifest themselves at the switching control devices, the transformers, or at any point where the general characteristics of the system are changed. Switches are therefore subjected to abnormal strains, and to safeguard this element, must have what is generally termed an abnormal insulation. In short, they should be de-rated to take care of conditions far in excess of the normal.

In localities subject to smoke, dust and dirt, the ordinary type of insulator of a given rating for normal line voltage will frequently fail when used on switches where excessive surges appear. Such failures may be due to flash-over through the accumulation of foreign material on the insulator surface.

Switches should be designed to withstand such abnormal conditions and the leakage and arcing distances far in excess of those usually employed for line work. The following tabulation shows the insulation strength advisable for switches of different commercial voltages.

Rated Voltage of Switch	Rated Voltage of Insulator	Test Voltage of Insulators
6,600 Volts	13,200 Volts	50,000 Volts
13,200 Volts	27,000 Volts	80,000 Volts
22,000 Volts	33,000 Volts	100,000 Volts
33,000 Volts	44,000 Volts	120,000 Volts

Provision should also be made for permanently grounding the operating handle to eliminate all danger of static shock when operating the switch.

The low cost per Kw. of this type of station is of interest as it is essential that both the initial and maintenance cost be low. The complete equipment cost including transformers of a 33,000-volt, 60-cycle, 75 Kw. station will approximate $17.00 per Kw. The cost of poles and labor of erection will depend upon local conditions but it is quite low as the construction is extremely simple.

The type of station illutsrated in Figs. 2 and 3 represents a construction which conforms to modern practice and is simple enough in design for the ordinary line gang to erect and has such a factor of safety that the possibility of men coming in contact with the incoming lines is practically eliminated. This desirable feature is secured by using properly designed or rated insulators, by sufficient operating space on the platform and by locating the high tension

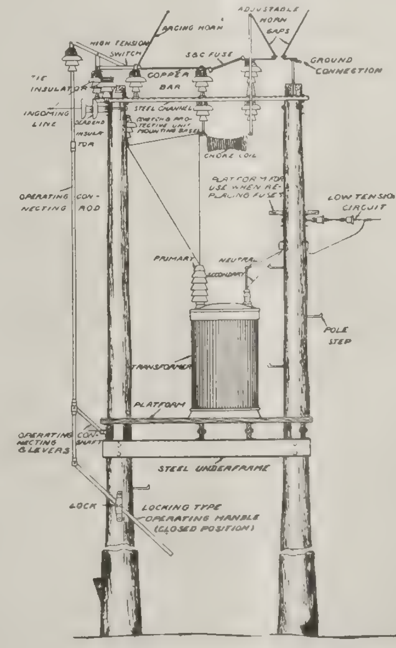


FIG. 2. DETAILS OF AN OUTDOOR SUBSTATION.

switch lever below the platform. With this location a lineman when called upon to replace blown fuses has to climb over the switch operating lever, thus bringing to his attention the fact that the switch is closed, and the equipment "hot." The various elements are plainly marked on the drawing and require no further comment.

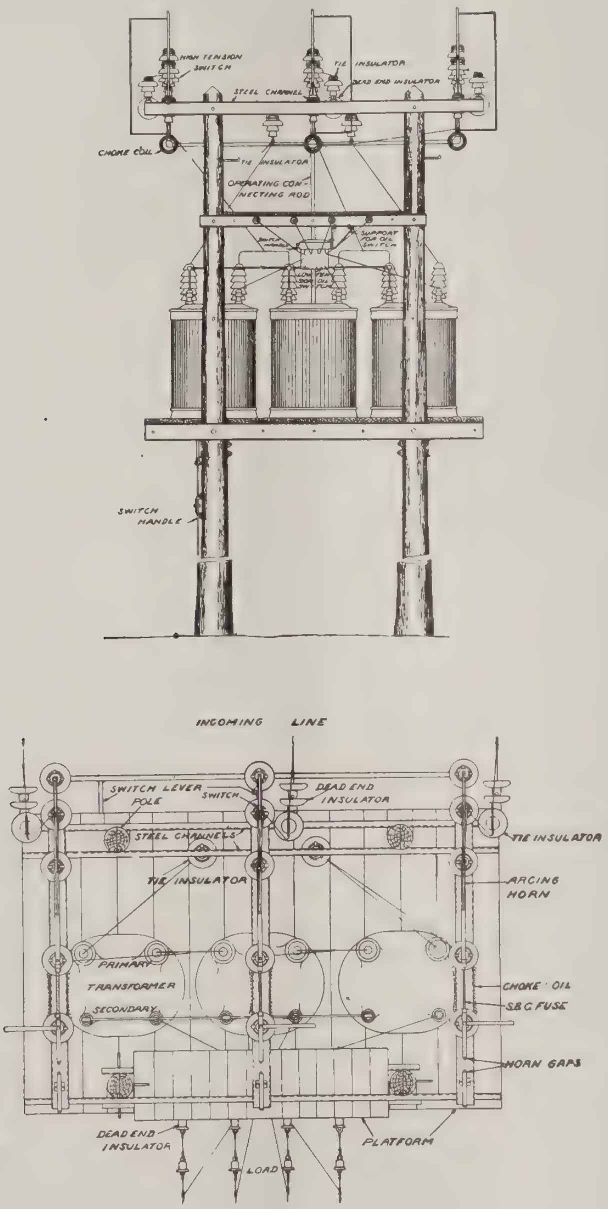


Fig. 3. Side and Top Views of Substation in Fig. 2.

When estimating the total cost for such a station fully equipped and erected it will be apparent that labor conditions will slightly affect this, but in general the complete station as shown will cost $1,500.00 or $20.00 per K. W. fully erected, including three standard transformers of 25 K. W. each. The station can be erected alongside of an existing transmission line without difficulty and will form a paying investment with a reasonable load factor and price for current. The equipment is all standard, can be easily secured, in the open market and the cost of maintenance is very low. It is a type of construction permanent in character and comparable with the standard high grade indoor stations.

Higher Electric Lamp Efficiency.

An announcement of further advancement in the higher efficiency of the incandescent lamp comes from the General Electric Company. The research carried on during the past few years has developed a metal filament unit that is claimed to be fully twice that of the best lamps now available. The new unit will operate on a high current consumption of 6 amperes and above at an efficiency of 0.5 watt per candlepower. It contains a specially shaped tungsten filament and is filled with an inert gas, such as nitrogen, at a pressure of about one atmosphere. The field for these new lamps seems to be one not heretofore covered by incandescent lamps and should greatly broaden applications in the direction of very large candlepower units.

In connection with this announcement it is interesting to note the following from the editorial columns of the *Electrical Review* (London) of July 11: "The latest development in connection with a low watt consumption per candlepower is reported from Germany, where the A. E. G. intends to place on the market in the autumn a new lamp which is claimed to consume only one-half of a watt per candle, as compared with 0.8 watt to 1 watt per candle of the existing wire lamps. It is announced that the Incandescent Gas Light (Auer) Co., which manufactures Osram lamps, will also introduce a lamp having a similarly low watt consumption. The figures, of course, refer to the Hefner candle, which has a value about 10 per cent less than the English candle."

Pittsburg Convention of Illuminating Engineering Society.

It has been definitely decided to make the Hotel Schenley the headquarters of the Illuminating Engineering Society convention to be held in Pittsburg, September 22-26. This is a fitting selection as the hotel is in a popular residence section which is rapidly becoming a civic center and is also in walking distance of the Carnegie Museum and Library, Carnegie Technical Schools, University of Pittsburgh, several prominent clubs and the Soliders' Memorial Hall. The last mentioned building will prove of particular intesest to illuminating engineers because of the wonderful lighting effects used therein and said to be unequalled anywhere in the United States.

In addition to the technical sessions of the Society, the local committee has arranged for a series of entertainment features in which the ladies are included. These features cover golf, tennis, base ball games, automobile rides, theatre and card parties, and conclude with a banquet at Hotel Schenley at which some innovations are promised.

Inspection trips have been arranged to several industrial plants including the Westinghouse Electric & Mfg. Company, Macbeth Evans Glass Company and the Carnegie Steel Company; also a luncheon at the H. J. Heinz Company, the home of the 57 varieties.

The papers as scheduled at this time include, among a number of other subjects, the Quartz light, Fontune, and Neon tube; church, factory, store, hospital and street car lighting, the present commercial development in several forms of lighting, errors in photometric measurement, and the history of artificial lighting. In addition to these, a number of others on equally interesting subjects will be presented by authors well known to the engineering profession in illuminating as well as other fields. The development of the new flame carbon arc lamp will also be discussed by representatives of the manufacturing concerns.

An interesting feature in connection with the technical sessions will be the holding of symposiums on the various general subjects to be led by those particularly well posted on the different subjects. These meetings will afford an opportunity for free and open discussion that it probably would not be possible to obtain in a more formal meeting.

Plans for Macon, (Ga.) Convention of Southeastern Section, N. E. L. A.

The committee in charge of the papers, entertainment and other arrangements for the convention of the Southeastern section of the N. E. L. A., to be held at Macon, Ga., August 14, 15 and 16, are now rushing the final details according to a carefully laid out plan. Chairman Wm. Rawson Collier, general contract agent of the Georgia Railway and Power Company, of Atlanta, has given a great deal of time to the securing of a number of excellent papers and Chairman W. L. Southwell, commercial agent of the Macon Railway and Light Company has arranged an entertainment program which in every respect will set a hard pace for future conventions. It is the determination of all connected with this convention, the first of the Southeastern Section, that nothing shall be wanting to make the meeting in every way an event to be remembered and thoroughly in keeping with the spirit and purpose of the newly formed section, now one of the largest geographical sections of the national organization. President Deal is making an earnest appeal to all stations not yet affiliated to join in the movement at Macon and all those who have not at the time these lines are read, will profit by a careful perusal of the following program and a speedy arrangement to be present with a representative from all departments.

The program this year, at the suggestion of T. W. Peters, commercial agent of the Columbus Railroad Company will be arranged with technical, commercial and general sessions. The topics selected for papers to be delivered at these sessions are as follows:

Technical Session. Regulation of Hydroelectric Transmission Lines; Wood, Iron and Concrete Poles; Transformers; and Joint Ownership of Poles.

Commercial Session. Sale of Current in Connection with Current Limiting Devices; Electric Trucks; the Load Represented by Large Hotels; a Discussion of Horsepower from a Sales Standpoint.

General Session. A Public Policy paper entitled, "Why"; Considerations of N. E. L. A. Membership; Perpetual Meter Readings; a Discussion of Load Builders.

It is probable that the technical session will be divided in two parts, and held Thursday morning and afternoon, August 14. The commercial session will be held Friday morning and the general session Saturday morning. In addition to these sessions a public policy discussion will be held on Friday evening.

The entertainment features include a reception and dance Thursday night, a barbecue Friday afternoon, and inspection of industrial plants. On Friday evening a Rejuvenation of the Sons of Jove will be held. Special arrangements are being made by the transmission companies and manufacturers for a complete display of photographs showing recent hydroelectric construction work in the South as well as a display of electrical apparatus.

The headquarters of the convention will be at the new million dollar Hotel Dempsey and reservations should be made early for accommodations.

Central Stations Merge at Louisville, Ky.

The consolidation of the central stations at Louisville, Kentucky, has been formally completed under the name of Louisville Gas and Electric Company. The companies represented by the new organization are the Byllesby properties, the Louisville Lighting Company and the Louisville Gas Company, together with the Kentucky Electric Company, the Kentucky Heating Company, The Geo. C. Felters Lighting Company, and the Campbell Electric Company. The city of Louisville has withdrawn its suit endeavoring to prevent the merger and the H. M. Byllesby and Company has purchased the franchise offered by the city of Louisville at $25,000, agreeing toa schedule of rates.

General George H. Harris, formerly president of the Louisville Lighting Company and Louisville Gas Company, has been chosen president of the newly organized company with Donald McDonald, formerly president of the Kentucky Heating Company, as vice-president and general manager. None of the officials of the Kentucky Electric Company have been taken into the new organization.

It is reported that all the various plants in Louisville will be operated by the new company until such a time as the most efficient arrangements can be decided upon. It is probable that the station of the old Kentucky Electric Company at Second and Washington streets will be the central generating station of the system and that the machinery of some of the other stations will be moved to it.

Atlanta Engineering Societies Hold Get-Together Meeting.

On Saturday, July 12, the several engineering societies in Atlanta held a joint meeting and barbecue. The object of this meeting was to bring together the members of the various organizations both for the purpose of getting acquainted and for discussing a form of organization.

The meeting was called to order by Allen M. Schoen, chairman of the local section of the American Institute of Electrical Engineers, the following societies having local chapters in Atlanta being represented: American Society of Civil Engineers, American Institute of Architects, American Society of Mechanical Engineers, American Chemical Society, American Institute of Electrical Engineers and the Engineering Association of the South. Besides these, individual representatives of the American Society of Mining Engineers and of the National Electric Light Association, American Society of Municipal Engineering, American Water Works association, American Public Health association were present.

Several talks were made in regard to the proposed organization, the matter being turned over to an executive committee for final analysis and formulation of a plan for the permanent organization. The executive committee consists of the following: J. N. Hazlehurst, L. T. Hill, Jr., Hal Hentz, W. T. Heath, Park A. Dallis and A. M. Schoen.

I. E. S. Officers—1913-14.

At a recent meeting of the Illuminating Engineering Society the following officers were elected for various terms beginning October 1, 1913: president, Charles O. Bond; vice-presidents, George H. Stickney and Ward Harrison; general secretary, Joseph D. Israel; treasurer, L. B. Marks; directors, F. J. Rutledge, C. A. Littlefield and F. A. Vaughn. Messrs. Israel and Marks were re-elected to their respective officers.

E. W. Rice, Jr., Elected President of General Electric Company.

An event that has caused considerable interest in electrical circles took place June 13, when Mr. C. A. Coffin, president of the General Electric Company since its organization, retired from active work and presented his resignation to its board of directors. Mr. Coffin is one of the founders of the electrical manufacturing industry and has been connected with it for something over thirty years, his business foresight and perseverance having won for him the position of leader among captains of industry. As the result of his years of effort he can now look back upon his organization as the largest and most powerful manufacturing company in this country, and truthfully say without the slightest egotism, "This is my work."

Mr. Coffin will be succeeded as president by E. W. Rice, Jr., a vice-president of the company since 1896. He has been identified with electrical manufacturing interests since 1880, when he became associated with Prof. Elihu Thomson in the manufacture of arc light machines. He was assistant to Prof. Thomson in this work under the company name of American Electric Co., of New Britain, Conn. When in 1882 Messrs. H. A. Pevear, C. H. Coffin and Silas A. Barton purchased a majority interest in the American Electric Co. and transferred it to Lynn, Mass., renaming it the Thomson-Houston Electric Co., Mr. Rice was given an opportunity to develop his ideas and with Professor Thomson was responsible for a number of patents covering arc lighting systems. In 1885 Mr. Rice, although under thirty years of age, was appointed superintendent of the works at Lynn, which had taken on in addition to arc-lighting, motor work, incandescent and railway work while the alternating-current transformer system of lighting was being developed.

In 1902 another change in Mr. Rice's career took place when the Thomson-Houston and the Edison General Electric companies were consolidated under the name of the General Electric Company with C. A. Coffin as president, and Mr. Rice as technical director. On June 26, 1896, he was elected third vice-president of the company in charge of all the technical and manufacturing departments and later became senior vice-president. From this position he succeeds Mr. Coffin as president, the unanimous choice of the directors of the General Electric Company.

In Memory of One of Our Staff.

In the great scheme of life created by an Almighty God in which the idols of today are but memories of tomorrow and where the tomorrows are so soon todays and the todays yesterdays, it is often our lot to mark the passing of a friend and acquaintance. On July 26th, death, that makes no distinction of persons or places, swept down on its silent, chill-destroying wing, overtook in a very short earthly pilgrimage and carried away to the place unknown, and from whence no traveler has yet returned, the person of our beloved business manager. Such is the fate of us all, and as one by one in turn we go, the world moves on—we are soon forgotten, save that some traveler may chance to read the words of praise we may justly merit as recorded by those who have participated with us in the history of the past. We are tempted to inquire the reason in the words of the poet:

Leaves have their time to fall
And flowers to wither at the north wind's breath,
And stars to set—and all,
But Thou hast all seasons for Thine own—O, Death!

Mr. Herbert N. Mackintosh died July 26, following an operation on his brain and after a brief illness of 12 days. He was born at Liberty, Indiana, September 15, 1888, the second son of George A., and Helen Mackintosh. He received his education in the Cleveland high schools and Wooster University, graduating with the class of 1911, his work showing unusual mental power. He was an enthusiastic athlete, playing for three years on his college football team. For a year following his graduation, he was principal of the high school at St. Marys, Ohio, leaving this position to become business manager of *Electrical Engineering* and *Cotton,* published by the Cotton Publishing Company.

Herbert N. Mackintosh.

Very few of our readers, perhaps, realize the importance of this cog that has been replaced in the machinery of our organization, yet each has in many ways felt his personal touch, if at all analytical in the study of what makes a publication and how it is maintained. If you read the advertising pages and are interested in the arrangement of the type faces that creates in you a desire to read these advertisements, if you are interested in the legibility of the printed page and the clearness of the illustrations, and if you notice the production of a better and better publication at the same price to you, then you realize what we have lost in the person of one who could make possible these things. Again and perhaps a closer relationship and one in which your attention without question has been called, is through those strong, convincing and courteous letters soliciting your subscription, a renewal or perhaps an overdue remittance. In the make-up of a great industry, we all have our places, and insofar as we all find them and fill them to our best ability, just in that proportion may that industry prosper and we in turn. Such was the belief of our departed brother and such was the spirit that he instilled into all with whom he came in contact. If efficiency in life's work, devotion to high and straightforward principles and a close observance of the golden rule, draw a reward hereafter, then he has a liberal one. The lesson of such a man is a simple one—a hard one—and a good one for all of us to study.

His body has perished and is buried, but the man lives on. His life work is left and his monument has been erected, not in marble or in stone, it may be, but in the memories of his friends, in the influence for good he wielded and in a moulded, rounded useful life which passes not away. After all, death is only the lifting of the thin veil separating time and eternity and as he left this earth, he simply went across to the other shore of the river to rest. While his place here is vacant, his name is recorded in the minds and hearts of those who knew him.

New Business Methods and Results

Representing Interests of Central Station, Electrical Jobbers, Dealers and Contractors.

Current Topics and Events in Central Station Fields.

There seems to be a decided tendency at present toward central station consolidation. The larger company has the advantage in the matters of engineering, operating, and commercial specialization, and this tends towards higher efficiency in all departments. The principal disadvantages lie in the prejudice which many communities have towards corporations, the multiplied amount of red tape, and an imaginary loss of personal touch with the consumer.

The consolidation of manufacturing interests creating a monopoly usually will, unless carefully regulated, result in increased prices to the consumer. In contra distinction to this we find that the public generally has benefited greatly by the increased economies possible where public service corporations or properties have been operated from a common head. In reference to this matter, Mr. Byllesby says: "I believe the movement to be well conceived, and that being economically sound in its principles, it will continue. It has great manifest advantages and violates no theory regarding restraint of trade."

In Germany many municipalities invest in stock of public utilities. In some cases the amount is sufficient to give control, in others it is not. This scheme combines in some measure the advantages of both public and private ownership, and favors a high grade of management with comparative freedom from political intrigue.

COMMISSION NEWS.

The fear that public service commissions would be unduly influenced by political considerations, seems to be proving largely imaginary, for as a rule the opinions and rulings so far handed down have been free from partiality and prejudice. The Connecticut commission in the annual report expresses the opinion that, "the net income and profits of any public service company, after the payment of reasonable dividends, should be used for the improvement of the plant and equipment of such company, rather than in unwarranted expansion or the acquisition of property more or less foreign to the chartered purpose of the parent company.

The New Jersey Commission has decided that 8 per cent return on the investment is not unreasonable under the operating conditions found in that state.

The new Illinois public utility law possesses a number of excellent features. Its weak point, however, is in exempting municipally owned plants from its provisions. If it is fair (and it is) that private corporations should be compelled to supply good service at reasonable rates, or be supplanted by public enterprises, it is in turn essential that municipal plants be liable to the same regulation as other ones.

NEW BUSINESS METHODS.

In St. Louis the sale of electric washers has been greatly stimulated by a charge of $3.00 per year for water used for running water power machines.

The Kentucky Utilities Co., of Lexington, is going hard after rural business, having several large estates on its lines.

The Union Electric Light & Power Co., of Missouri, is gradually reducing its rates from time to time, offering a number of optional schedules from which the customer may choose. These rates are offered to all customers, regardless of existing contracts.

It is not an easy thing to get the owners of property to wire houses for tenants. If, however, the tenants will agree to pay a small additional rental in consideration of this being done, it makes the proposition easier. Any way, this is worth trying.

The Alleghney County Light Co., of Pittsburg, has been running some strong advertising in which tenants are advised not to rent unwired houses. Several property owners and real estate agents have been protesting angrily. It must have been doing some good.

An "Electric Tea" was served by the Union Electric in St. Louis on the occasion of the opening of its down-town display room.

The Toronto company is issuing a monthly bulletin to its customers and others. The value of such publicity is so great that it should be used more than it is. Many stations even in cities of moderate size would find it a good investment.

ELECTRIC VEHICLES.

Just now there is a very lively interest taken in the matter of distribution methods for electric cars and trucks, as evidenced by recent papers presented at the conventions of the N. E. L. A. and the Electric Vehicle Association. It is agreed that the vehicle business is looming up big, bigger, perhaps, than any of us realize. The manufacturers are accusing the central station managers of being asleep at the switch, indifferent, and unwilling to co-operate, and even add insult to injury by referring to increased use of horses and gasoline machines. On the other hand the central station man claims that the manufacturers are largely at fault because of wrong advertising methods, poor salesmanship, unjustifiably high prices, and poor service after sales are made. No doubt both statements have an element of truth. The problem is surely one that can and must be worked out in such a way as to give the best results, each party taking up that branch of the business which they can handle to the best advantage, and working in co-operation with the other.

TROUBLE AT CINCINNATI.

At present the relations between the Union Gas and Electric Co., of Cincinnati, and the local dealers and contractors is most antagonistic. The dealers accuse the central station of outrageous price-cutting on fixtures, appliances and lamps, as well as making arrangements to open a down-town competing electric store, at which bargain sale methods will prevail. On the other hand the public service corporation claims that all appliances have been sold at list, with the exception of a few short time sales of old and out-of-date stock. It is further stated that the company has been forced into the merchandising business by the indifference, and the poor sales methods of the dealers and the contractors. The company further claims that as regards the sale of lamps, it has a right to fix the re-sale price of tungsten lamps to its consumers at any figure necessary to properly stimulate the extension of lighting service. A study of the evidence offered seems sufficient to convince any unprejudiced person that the central station has the better side of the arguments, and that the attack of the contractors is unjustified. Instead of bitterly attacking the central station for developing a business which they might have had themselves with proper methods, they should co-operate, realizing that the stimulation given to the electrical industry cannot fail to benefit themselves. There are only 9000 residence customers in Cincinnati, out of a population of over 400,000, and it would seem that with such a field in which to work, it is foolish to waste time in such childish maneuvers.

MISCELLANEOUS ITEMS.

The United Electric Light & Power Company, of New York City, in addition to announcing to its customers a substantial reduction in prices of tungsten lamps in small sizes, after August 1, will furnish renewals of tungsten lamps in sizes of 100 watts and larger, the same as heretofore done with carbon and metal-filament lamps in all sizes. Tungsten lamps of 400 and 500 watts with suitable fixtures will also be loaned and connected by the company, all tungsten lamps furnished remaining the property of the company in case service is disconnected. This is an important step and its success will be eagerly watched.

The Public Service Corporation of New Jersey has established a wage minimum of $9.00 per week for its 300 women employes. This is not only good ethics, but good business.

The question of high tension is entirely one of economy. There seems to be no physical limit to the voltages which may be employed. The Au Sable Electric Co., of Michigan, is now regularly transmitting at 140,000 volts, and the Pacific Light and Power Co. is building a line to be operated at 150,000 volts.

Concrete posts without cross arms are coming into use for residence districts where appearance is of value.

Heating devices have been greatly improved during the past year by the use of improved resistors, composed of nickel-chromium alloys. Carbide of silicon is also used, for some purposes, having the advantage that it can be brought to incandescence in the open air without oxidation or disintegration.

The Dayton Electric Co. has adopted as its slogan, "If It Isn't Electric, It Isn't Modern." The West Penn Electric has a motto, "Safety First," and all of its employes have been presented with a neat watch fob bearing the words.

DO YOU KNOW?

That the electric truck has about 3 times as great a load factor as the average motor?

That there are a lot of small residences you could get on a controlled flat rate?

That fans will keep out flies as well as screen doors?

That now is the time to push house wiring? Many people take up rugs, pack up their bric-a-brac for the summer, and live out-doors most of the time, and you can make this an argument for doing the work now.

Power, Load, and Diversity Factors—Their Relation to New Business, and Station Income.

The following discussion of these factors is based upon some of the fundamental principles of electric service, with which many of our readers are doubtless familiar. Since, however, we aim to be complete, for the sake of accuracy and the benefit of those who have never made a study of these quantities, we will briefly outline the entire subject.

Power factor may be expressed in different ways. It is the ratio of the true power in watts to the apparent power in volt-amperes. If the voltage and current are in phase, as they always are in direct current circuits, the terms of the ratio are identical and it is equivalent to unity. If there is present any inductance in an alternating current circuit, an inductive emf is produced, which is out of phase with the impressed emf and combines with it in such a way as to produce an angular variation in phase between the impressed voltage and the current flowing. We say, then, that the current lags behind the impressed voltage by a certain angle, which we call the angle of lag. The cosine of this angle is the numerical value of the power factor.

Theoretically we may analyze the current flowing into two components, one in phase with the voltage, and one at right angles to it. The proportion of the current in phase with the voltage to the total is again the power factor. This is quite analagous to the analysis of forces in mechanics where the force is not applied in the direction of motion, and we consider it as resolved into an effective and an ineffective component.

In direct current work, as we have said, the power factor is always 100 per cent or unity. One ampere flowing at 110 volts always means 110 watts. However, in the case of an inductive circuit, for instance, in which the current lags 45° or 1-8 of a cycle behind the current, the true watts would be 110 × .707 (cos 45°) or 67.7 watts. This means that each unit of current drawn from the generator only has about 71 per cent of its effective power at 100 per cent power factor. Not that there is a loss of 29 per cent, but that 29 per cent of the current is ineffective, that is, it has to be passed through the generator, transformers, and distributing system, and is dissipated as heat or "copper loss." The power wasted is equal to this current times the volts necessary to carry it through the resistance of the windings, etc.

Not only is there a copper loss, but there is an investment loss. If, in the above case, the true load were 71 kw, it would require a 100 kw. generator to supply it. We have thus reduced the station capacity 29 per cent, or in other words, added 41 per cent to that part of the fixed charges varying with the line current. It is evident therefore, that highly inductive loads are to be avoided. Central station managers should co-operate with the manufacturers in the introduction of apparatus having high power factor. There has been a constant improvement along these lines, in connection with which we might mention the introduction of the repulsion motor, the improvement of the series alternating arc system, and the reduction of iron loss in transformer design. Some of the most common power factors of apparatus are now about as follows: Incandescent circuits 75 to 98 per cent; heating loads, practically 100 per cent; induction motors (mixed loads and sizes) 70 to 80 per cent; repulsion motors, 85 to 90 per cent; constant potential A. C. arc lamps, 55 to 65 per cent; series A. C. arc lamps (lamp alone) 85 to 90 per cent; mercury vapor lamps and rectifiers 50 per cent.

There are means employed by which the power factor may be improved, but this is an engineering rather than a commercial topic. When the field current of a synchronous motor is properly adjusted the machine draws a leading instead of a lagging current from the line, acting as a condenser, and is called, in fact, a synchronous condenser. They are often connected on the line at the end of transmission lines, the leading current correcting, to a great extent, the lagging current caused by the inductance in the circuit.

The question is often asked why it is not possible to include some kind of an allowance for power factor in the rate schedule. The answer is that so far it has not been considered practicable, because it would take additional and expensive instruments for power factor determination, and even when determined, it would be difficult to devise an adequate system of apportioning the charges. In extreme cases, however, it might be well to make some provision for it.

LOAD FACTOR.

The load factor of a central station is the proportion which the equivalent 24-hour load bears to the station peak, or, in other words, the ratio of the actual station output to the maximum possible output with continuous service. It depends upon two things, first, the length of time the individual customer makes of the demand, and. second, upon whether the individual demands are or are not simultaneous. These will be considered separately. The load factor of any consumer's installment is the ratio of his average to his maximum demand. Obviously any installation operated during a long period at a steady load will have a good load factor, while one used but a short time each day will have a poor load factor. A motor or lighting load which is in use one hour per day has a factor of a little over 4 per cent, or, in other words, it is necessary to make an investment for machinery capable of supplying 24 times as much electricity as is consumed. Obviously the fixed charges per kw of demand by such a customer will be 24 times as great as they would be for one who used a steady load continuously. In lighting parlance these would be called "short burners" and "long burners," respectively.

As might be expected, different classes of business vary greatly in this respect. Commercial business, especially that of the early closing stores, has a very poor load factor, much worse than that of residences. Some motor loads are good, others are poor. Elevators, for instance, are usually low, while refrigerating machinery is very good. Factories which run steadily during the day are good. For instance, an installation of motors totaling 100 horsepower, or 75 kw, might have a maximum demand of 40 kw. If the daily consumption were 240 kw-hours, or an average of 10 kw, the load factor would be 25 per cent. With all motors fully loaded for a 10-hour run, the factor would be 42 per cent, but this is not often reached. In fact, the average motor load runs from 10 to 15 per cent for individual drive to 15 to 30 per cent with group drive. This is considering the installation as a whole.

Obviously, therefore, the new business department should bend its efforts towards getting business with a good load factor. Among such may be cited long burning and all night stores, steady factory loads, industrial heating apparatus, such as glue pots, tailors and laundry irons, 24-hour pumping loads, refrigerating machinery, charging electric trucks, for which a load factor of 35 per cent is claimed, etc. It may be urged that with the scientific rates coming into use, in which the fixed and variable charges are separated, that this need not be watched so close because the fixed expense is provided for and that if the consumer's load factor is poor, he and not the central station bears the loss. While it is true that with such rates the expense is more accurately distributed than is possible under the meter rate, still every effort should be made to improve the load factor, first, on general principles, as it enables the central station to serve the community at less expense, second, because where separate fixed charges are made, long use of the demand makes a low rate to the consumer and thus boosts the use of current, and, third, because there will likely always be a certain class of business taken on straight meter rate, and the better the load factor, the more income can be secured with a given investment.

Furthermore, load factor is a question of ratio, and so far we have only considered one of the terms. Not only should we seek to fill up the "valley," but we may also improve the load factor by reducing the "peak," thus enabling the taking on of more business with no increase of capacity. For instance, one residence customer may have an installation of 20 lights or 1 kw. His maximum demand may be 500 watts. Another customer supplied on the controlled flat rate system, may have his indicator set for 200 watts. It is quite evident that we can supply 5 customers of this kind with the same station capacity that would be required for two of the former, and quite likely with quite an increase in gross revenue. This does not mean that it would be wise to induce all present meter customers to go on flat rate, but it indicates that the load factor may be improved by adding business with a good revenue and small demand. Again, a central station having a customer using an electric sign with carbon lamps, will gain by making a flat rate proposition based on the use of tungsten lamps, which, with some reduction in gross revenue, will save a great deal of station capacity.

Continuing this subject one would naturally consider the great desirability of such loads as do not occur on the station peak at all, but which take place at such times as the machinery is working under load, and in taking up this question we naturally come to a discussion of the diversity factor.

DIVERSITY FACTOR.

Diversity factor simply refers to the fact that while some loads are on, others are off. While the housewife is ironing, she is not using lights, while one motor is running full, another one will be at rest or running light. While Jones is giving a party, and using all the lights in his house, Brown's and Robinson's are dark, for they are his guests. Of course, it is only on account of low load factors that we are able to consider diversity factors at all, because if the load factor of every installation were 100 per cent, the diversity factor would necessarily be 100 per cent as well. However, if we cannot get customers who will use current all day and all night, the next best thing to do is to scatter the periods of maximum demand as widely as possible, and since the greatest demand at this time of the year is in the first hours after darkness, the chief effort of the central station manager is to get business which will not overlap this period, or what is called "off-peak" business. Hence the vigorous campaigns for electric irons, and such appliances. Of course, when it comes to the point where a station has to start up an engine every Tuesday for the ironing load, this is working up to a little peak all of its own, and in case the heating and cooking load should ever exceed the evening lighting load, then such would represent the peak, and in this case the business would not be nearly so attractive, because the burden of the fixed charges would be on it instead of on the lighting load.

That the diversity factor is an important item, is shown by the fact that in a typical group of residences the maximum demand of the group was only one-third of the sum of the individual maxima. In other words, we can take on 3 times as many customers as we could if they all used the maximum demand at one time. However, while this is important, it is really not under the control of the station, to any extent, and hence need not be considered in new business work. What is important is to build up the valley of the load curve, both by getting long hours, and off peak business. Certain classes of business, as, for instance, refrigerating machinery, may be shut down by agreement during certain hours each day. Special efforts may be made to get summer business, such as amusement parks, and the supplying of summer service to the owners of isolated plants, since the load on the station is much lighter in summer than in winter. There are constantly coming to light new uses for the electric current, which enterprising new business managers may exploit to advantage if carefully analyzed.

As typical of central station practiced in general, we may consider three load curves. One of these from a station with a lighting load, largely residences with a small amount of motor and commercial business. The load factor is 37 per cent. Another is from a town with a good deal of manufacturing. In this case the load factor is 47 per cent. The third curve is practically all power load, with but little lighting. The peak comes during the daytime, and the load is fairly uniform during working hours, yet the load factor is but 51 per cent. If this latter station had a good evening lighting load in addition, it would likely reach 60 per cent, which would be exceptional.

A. G. RAKESTRAW.

COMMENTS FROM READERS.

Electric and Gasoline Trucks for Central Station Use.

Editor Electrical Engineering:

The writer has noticed an item appearing on page 279 of the June, 1913, issue of *Electrical Engineering*, that calls attention to the fact that Denver last year sold two million K. W. Hrs. for electric vehicle business and mentions at the end that one company can be named that uses a gasoline truck in its meter department.

I may be wrong, but I believe reference is made to our meter department, and for that reason, I am taking the matter up, as I feel that perhaps the circumstances that led us to purchase a gasoline truck are not fully understood. We cover a great deal of distance outside the city with our trucks on account of the fact that our commercial lines have been extended, within the past two or three years, for some distance into the country. To properly take care of our customers on these long extensions, we decided that it would be necessary to use a truck and for several months tried to handle renewals for customers in the territory and to read their meters by means of the electric truck. We found, however, that in this business we had really passed the zone of usefulness of the electric truck and were really trying to get more out of it than we should really expect to get. With this idea in view, we purchased a gasoline truck to handle the long distance business and moved the electric truck into what we call the inner zone. We then found that we had practically doubled the usefulnesss of the electric truck and that we covered the trouble calls, meter readings, and lamp renewals in the outer district in about one-half the time formerly taken by the electric truck.

In other words, our experience is nothing in the world but the typical experience of any central station that really studies the situation carefully before it purchases its trucks or is forced to study it carefully after it purchases its trucks. All of us, I think, are beginning to realize that the electric truck has its limitations, that is, that the electric truck is not intended for use on long runs or where time is of the greatest importance. I am, of course, a great believer in the electric truck and a great booster of the electric truck game, but I feel sure that the electric truck situation can not be materially helped by knocking the gasoline truck as a general proposition. In other words, I believe that the proper way that we should push the electric truck game would be first to train the public up to see that the electric truck is primarily the proper truck to use for short hauls, or where economy and realiability of service is of the greatest importance. If we start with this idea and get it firmly fixed in the public's mind, and if, at the same time, we try to make it realize that we believe that the gasoline truck is a good proposition, when used in its proper field, that is, when it is used for long distance hauling or hauling in localities where battery charging is not available, then the public will begin to realize that perhaps we are truthful and sincere in the statements we are making about the electric truck.

In short, what I want to bring out is that the selling of electric trucks is really very little different from the selling of any commercial article. I do not believe that we can sell any article by trying to knock the article that our competitor tries to sell. On the other hand, I think if our time is spent in boosting our proposition, and in trying to show the public that our proposition is the one that they should accept, then we will not have time to say anything against our competitor.

Commercial Manager Important Southern City.

C. E. Michel, Manager Appliance Department, Union Electric Light & Power Company, St. Louis, Mo., Gives Data on Remarkable Iron Sale.

On May 13, the appliance department held the biggest one-day sale of electric irons in the history of the company, and probably any other company. A month prior to the sale ads were placed in street cars and besides this a comprehensive and far-reaching advertising campaign carried on.

Three mediums were then employed. On the night of May 9th, 23,000 postal cards announcing the sale of electric irons on a ten days' trial, for $2.95, were mailed to all our residence consumers. Each postal card contained a return coupon, requesting the delivery of an iron. The customer's name and address was printed on the return card, and all he had to do was to sign and mail it. After the postal cards had been printed, it was decided to give a shirtwaist ironing board free with each iron. An order for 40,000 hanger cards printed on both sides announcing the sale, with cut of electric iron and ironing board was placed with the Nies-Kaiser Printing Company on Monday, May 5th. The cuts were made, the proofs corrected and O. K.'d, and the printer started to printing Wednesday, the 7th. On Friday, 12:30 p. m., the first lot of 10,000 was delivered and the final delivery was made Saturday morning at 10 o'clock. A gang of forty men hung these cards on the door knobs of all the houses throughout the residence portion of city. The men had hardly begun distributing when the telephone orders began to come in. The first newspaper ad appeared in the Post-Dispatch on Friday evening, the 9th, followed by the Times and Westliche Post on Saturday, the 10th, the Star on Sunday, the 11th, and the Globe and Republic on Monday morning, the 12th. The show windows of the main office and branches were artistically dressed for the occasion, on Friday, May 9th.

The results of this vigorous campaign exceeded the fondest expectation of the appliance and advertising departments. A total of 1,875 irons were sold. The cost of the irons, ironing boards, 40,000 hanger cards and their distribution, 23,000 return postal cards stamped on both sides, large spaces in the daily newspapers and delivery of the irons, was $6,403.35. The total receipts were $5,531.25, making the sale cost $872.10.

For this amount we secured the following results:

Kilowatts connected, 1,031.

Cost per Kw. connected, 84.6 cents.

Estimated annual consumption, 215,625 Kw. hours.

The sale lasted for one day only and on the day following 100 orders were rejected on this account. About 4.5 per cent of the 23,000 cards were returned as orders for irons.

Appliance Show Room of Union Electric Light & Power Co., St. Louis.

The company has re-decorated and installed new furnishings in its appliance show room at Twelfth and Locust streets. The new wall and show cases were made to order, of selected quarter sawed oak and lined with black broadcloth, the interior illumination of these cases being accomplished by the use of linolite units, the source of light being concealed from the eye, and is most effective. In the general lighting of the room, Brascolite fixtures are used with pleasing effect. Originally the lighting was by tungsten lights and Holophane shades, the connected load being 4.8 kilowatts giving 3.9 foot-candles at three feet above the floor. By the use of the Briscolite the connected load has been reduced to 2¼ kilowatts and the foot-candles at the same elevation as in the first place increased to 8½.

This room is of value to solicitors, as it may well be used as a model of correct illumination and the general effect is so pleasing that a merchant looking for ideas in the correct illumination of his premises would undoubtedly be impressed with the results obtained both from a standpoint of economy and efficiency. There are other appliance shops in this country, the property of central stations, wherein a more lavish expenditure of money has been made, but in none of them has the general effect of a high class salesroom been more artistically carried out.

E. S. Roberts, Commercial Agent of the Savannah Electric Company, Outlines Commercial Work in Savannah, Ga.

While Savannah is one of the oldest of Georgia cities, and one of the most conservative, the way in which its merchants and citizens have interested themselves in street lighting and the application of electricity in other ways, has placed it among the first in the state in the diversified use of electricity. Until June, 1910, the lighting of the business streets of Savannah was by the ordinary arc system with little special lighting of any kind. Today sees one of the most modern of white ways on the main thoroughfares and electric signs which in number per square mile exceed the number for any other city outside of New York. There are installed and operating in Savannah making up a decorative lighting system, 180 five-light standards and 113 three-light standards. Of this number 75 five-light standards are installed in the Chatham Crescent residence district and 55 five-light standards in Ardsley Park. All these decorative posts are operated from dusk to midnight. The electric sign business in Savannah was developed practically simultaneously with the white way development, the signs being installed by the Savannah Electric Company, and operated on a flat rate based on a low price per Kw. hour. The customer was given six months in which to pay for the sign, the payment being made in installments with the monthly lighting bill. The progress in the installation of electric signs is told in the fact that for three years about one sign has been installed every three days.

The electric vehicle situation in Savannah is now interesting on account of the fact that there is in operation a successful electric garage. This garage operates exclusively for electric vehicles, repairing same, demonstrating and selling them. The garage is operated by an expert battery and electric vehicle man and repairs are made at reasonable cost, the old vehicles rebuilt and returned to the owner in good operating condition. This feature of the garage service has placed many vehicles of the old type in successful operation and given the electric vehicle proposition added confidence in the minds of possible purchasers. The details of the electric vehicle business in Savannah was presented in the July issue of *Electrical Engineering.*

While the commercial department has given this garage every co-operation, it is mainly on account of the successful nature of the garage management that the electric vehicle situation of Savannah has been a success. The writer is of the opinion that while the electric vehicle has successfully entered Savannah permanently, the sales opportunities are only beginning for pleasure and commercial vehicles. The commercial department of the Savannah Electric Company has secured a new 1,000 pound Baker delivery wagon to be used for meter and lamp delivery and a runabout is also used as a demonstrator.

Electric irons are now being handled by the company on a cash basis and on an average of about 25 irons placed per month, the contractors placing an equal number. During the past year or so about 500 fans have also been sold per year, while a number of others are operated on the system purchased and rented from contractors. The next popular devices of the small current consuming nature seem to be the toaster and coffee percolator, of which numbers are in use.

A photograph is shown here of the show window of the new quarters of the Savannah Electric Company, which were occupied February 17, of this year. The building has been thoroughly remodeled and adapted to the use of the company, the executive offices being located on the second floor and the commercial offices on the first floor. The third floor is devoted to the meter and repair department. The location of these offices is in every way practical on account of the fact that the City Edison sub-station is next door, as shown in the illustration.

New Home of Savannah Electric Company.

The arrangement now in force in connection with window displays seems to be working out satisfactory. The six city solicitors are divided into three groups, each having charge of the window display for one week. These groups compete with each other on nature of display, a prize being given for the best display during a period of two months.

Convenient Forms for Central Station Commercial Business.

The following forms are those used by Mr. T. W. Peters, commercial agent of the Columbus Railroad Company of Columbus, Ga., and have been found by him convenient and practical for handling complaints and recording other commercial data in connection with customers.

Electrical Display Room of the Columbus Railroad Company, Columbus, Ga.

Form No. 1 is used to record trouble and bring its nature and location to the attention of the proper person. Form 2 receives a carbon impression of Form 1, when the latter is filled out, and is held by the commercial agent until Form 1 is properly filled out and returned. Form 3

Form 1. Trouble Card—Troubleman's Copy.

COLUMBUS RAILROAD COMPANY.

Trouble Card No.............

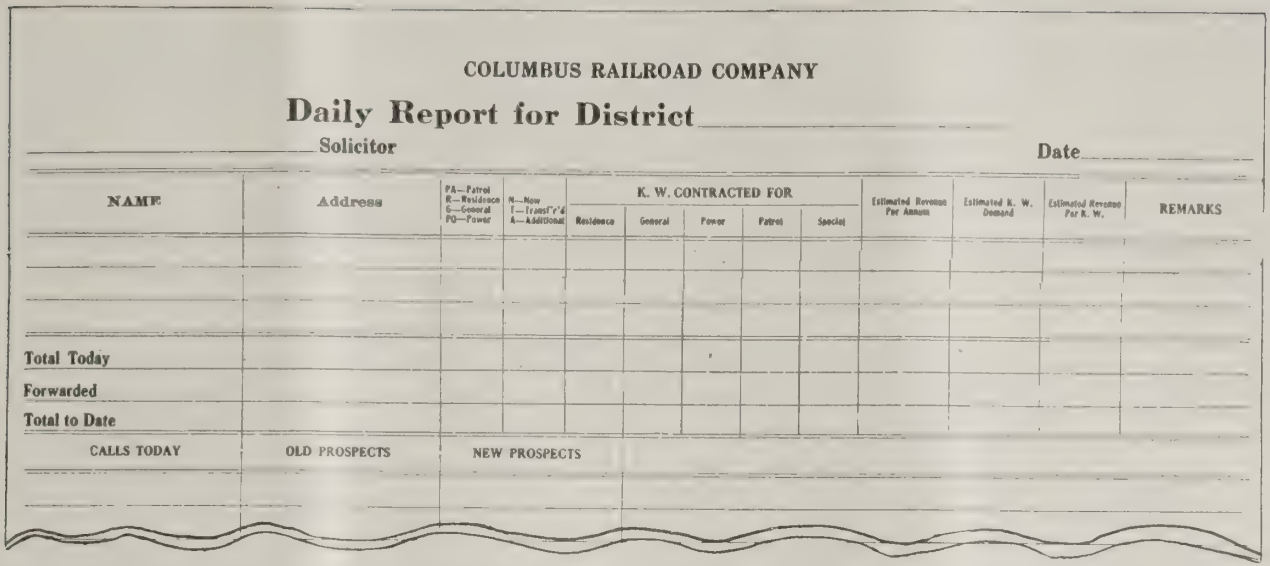
Date ....191.... Time..............M.
How Received ....
Received by ....
Name ....
Address ....
Nature of Trouble ....
....
....
....
Disposition of Trouble ....
....
....
....
....
....
Removed by .... at..............M.
Customers are requested to sign trouble card upon completion of work.
....
Customer.

Form 2. Trouble Card—Contract Agent's Copy.

COLUMBUS RAILROAD COMPANY.

Trouble Card No.............

Date ....191.... Time..............M.
How Received ....
Received by ....
Name ....
Address ....
Nature of Trouble ....
....


COLUMBUS RAILROAD COMPANY

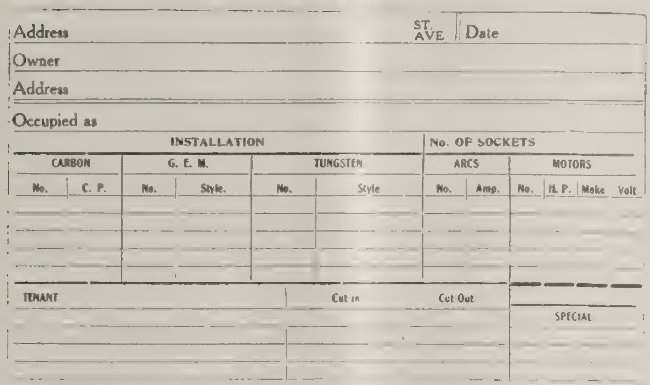
Daily Report for District ______

______ Solicitor Date ______

NAME	Address	PA—Patrol R—Residence G—General PO—Power	N—New T—Transf'r'd A—Additional	K. W. CONTRACTED FOR					Estimated Revenue Per Annum	Estimated K. W. Demand	Estimated Revenue Per K. W.	REMARKS
				Residence	General	Power	Patrol	Special				
Total Today												
Forwarded												
Total to Date												

CALLS TODAY	OLD PROSPECTS	NEW PROSPECTS

FORM 4. SOLICITORS' DAILY REPORT CARD.


Address ST. AVE Date

Owner

Address

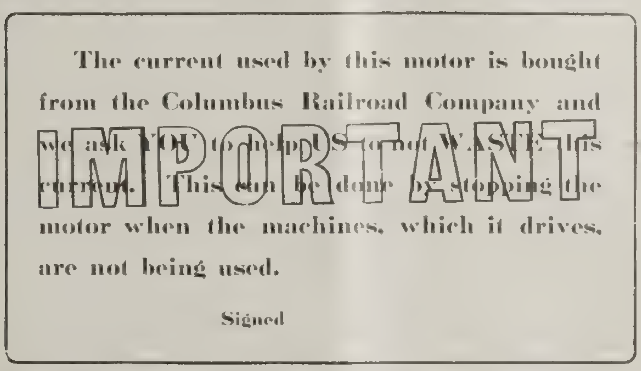
Occupied as

INSTALLATION								No. OF SOCKETS					
CARBON		G. E. M.		TUNGSTEN		ARCS		MOTORS			
No.	C. P.	No.	Style.	No.	Style	No.	Amp.	No.	H. P.	Make	Volt

TENANT	Cut in	Cut Out	SPECIAL

FORM 3. INFORMATION CARD ON EACH CUSTOMER.

permits a record of the connected load for each customer, and presents the necessary history of the service after the first connection. Form 4 is a daily report sheet used by solicitors and from which the data on Form 3 is secured.


IMPORTANT

The current used by this motor is bought from the Columbus Railroad Company and we ask YOU to help US to not WASTE this current. This can be done by stopping the motor when the machines, which it drives, are not being used.

Signed

FORM 5. STICKER FOR MOTOR TO PREVENT WASTEFUL USE OF CURRENT.

The sticker shown as Form 6 is placed on or near all motors. It tends to convey to the customer an interest on the part of the company that the bill for current be no larger than necessary and plainly makes it evident to the customer that he is responsible for a wasteful use of current.

R. B. Mateer, Sales Manager, Great Western Power Co., Discusses Electrical Advertising.

The sign specialist, engaged by many central stations to promote the use of current for display purposes, is usually a commercial engineer familiar with general solicitation as practiced in all successful new business departments. He must possess originality. He must know how to combine first in a sketch, and later in the completed operating sign, those features pertinent to each business, that will stud his city with displays attractive to the public, and profitable to his company. Such a specialist, illuminating or display engineer, should be placed in charge of all electrical advertising. He should work in harmony with the salesman, conducting all important negotiations and report directly to the sales manager in charge of all commercial activities.

The sign specialist's duties include the listing of all business houses, theatres, hotels, etc., as prospective users of electrical displays. He secures the ideas of each merchant which are incorporated in attractive sketches together with estimates on construction and operation. Such sketches submitted to the prospect form the basis of the subsequent sale.

Display business is operated on either (1) a meter basis, or by (2) flat rate per month or by a (3) time switch. The first is general in all cities where electrical displays are the result only of a desire on the part of some aggressive merchants to burn their location in the minds of those traveling the thoroughfares in the evening hours. The second method, that of a flat charge per month per lamp based on candle power is general in all centers of population where public pride is awakened. It is exceptionally profitable to utilities, though it affords a ready means of discriminating among consumers. The third is in force in such cities where short time service is desired on meter rates or where rate fixing ordinances prohibit a flat charge per month. The time switch is generally provided at the expense of the consumer.

Display lighting is only another attempt to improve load factor by encouraging the use of current in quantities through the evening hours. Undoubtedly many stations have connected thousands of four candle power lamps and benefited by better load conditions and increased revenue, yet it is a fact that the increasing magnitude of the displays with the added operating expense cause merchants to seek refuge in other units returning to lighting companies a rapidly decreasing revenue. A few years ago one utility reported display revenue aggregating two hundred and fifty thousand dollars per annum, which is now materially reduced, partly by the installation of units of greater efficiency operating on meter rate in preference to a flat charge per month and also to the elimination of free construction, free lamps, and time payments, items so liberally granted to promote the use of electric current for display purposes in earlier periods. In view of this, every city of fifty thousand inhabitants and over should have the services of a display lighting specialist, eager to direct public attention to the value of electrical advertising either of the projecting or roof sign, window lighting or decorative exterior.

Douglas Burnett, Commercial Manager, Electric Division, Consolidated Gas, Electric Light and Power Company, of Baltimore, Uses Unique Window Display.

For several weeks beginning June 21st, thousands of Baltimoreans broke into their daily routine of marketing and shopping, long enough to take a good look into the Lexington street and Park avenue show window of The Gas and Electric Company. The reason is made partly plain by the illustration below, where a wax dummy of the Goddess of Liberty is shown lighting the world with the modern illuminant—the Mazda Lamp. An imitation dummy or the "Mechanical Doll," as he was termed, changed places with the wax dummy in the window and it was amusing as well as enlightening to mingle with the people outside as they expressed their beliefs and doubts as to the genuineness of the "Mechanical Doll," who, for fifteen minutes at a time would hold an almost immovable pose. It was only until this fifteen minutes pose was finished, and the demonstrator stepped out of the window, that those who thought him a real wax dummy found they were mistaken.

The exact advertising value of the display is hard to estimate. Lamp sales showed a healthy increase and numerous inquiries about Mazda lamps were satisfactorily answered. The display brought many into the store and certainly created the feeling that Mazda lamps set the standard, making the way easier for future sales. Since lamps of all sizes, from 15 watt to 500 watt, were displayed, the window undoubtedly held for everyone who saw it, a message of better light and more light.

WINDOW DISPLAY OF CONSOLIDATED GAS, ELECTRIC LIGHT AND POWER CO., BALTIMORE, MD.

The cost of dressing the window was very low, as but few fixtures and ornaments were needed. The "Goddess of Liberty" costume was rented. The standard held in the hand of the goddess was topped by a 500 watt lamp. The group of lamps scattered about the window were made up of standard sizes. The flags were made to flutter by electric fans.

At this point, it is appropriate to mention that the Gas and Electric Company have been using the "Mechanical Doll" in connection with displays or irons, fans, vacuum cleaners and washing machines. These displays never fail to draw the crowds, as in all of them the demonstrator cleverly imitates the mechanical movements of an automaton. The windows have been particularly effective in causing comment when the real dummy and the "Mechanical Doll" have been displayed at the same time, as it was almost impossible to tell which was which, especially when, on every other day, the places were reversed.

Even if sales had not shown the increase they did, the company would have still been satisfied in using these displays, since they have attracted widespread attention to the new office now better equipped than ever to serve the public.

Courtesy.

It matters little who the person may be or the position he may hold, courtesy on the part of the other fellow is always recognized and usually appreciated. On the commercial end of the central station business, this fact can be made a valuable asset for the company if properly handled. The illustration shown here is one example of how this matter of courtesy may be made use of. The card was received following a telephone call for new fuses. The call was made at about four o'clock and the fuses delivered by a trouble man within an hour. When the fuses were installed, to a "thank you," the trouble man responded, "Not at all; call us at any time, we are glad to serve you."

GEORGIA RAILWAY & POWER COMPANY

ATLANTA, GA.

WE UNDERSTAND THAT RECENTLY YOU HAD OCCASION TO CALL ON OUR TROUBLE DEPARTMENT FOR ASSISTANCE. WE TRUST THAT YOUR CALL WAS ANSWERED PROMPTLY, THAT THE TROUBLE WAS REMEDIED, AND THAT YOU WILL CALL ON US AGAIN IF NECESSARY.
CALL BELL PHONE FORTY-NINE FORTY-FIVE AND ASK FOR TROUBLE DEPARTMENT

VERY TRULY YOURS,

GEORGIA RAILWAY & POWER COMPANY

CONTRACT AGENT

A GOOD WAY TO SHOW WILLINGNESS TO SERVE.

This card, following such prompt, courteous (and free) service, goes a long way toward establishing that much-sought disposition between public and public utility, known as "good will."

Keokuk Station Takes on Load.

The first load to be served from the hydro-electric plant of the Mississippi River Power Company at Keokuk, Iowa, was connected the first week of June, power being supplied to Keokuk, Hamilton and Warsaw, Ill., over 11,000 volt lines. The 110,000-volt transmission line to St. Louis was ready for operation shortly after.

Questions and Answers from Readers

Readers are invited to make liberal use of this department for discussing questions, obtaining information, opinions or experiences from other readers. Discussions and criticisms on answers to questions are solicited. However, editors are not responsible for correctness of statements of opinion or fact in discussions. All published answers and discussions are paid for.

HOW CAN CORROSION OF SWITCH BLADES BE STOPPED?

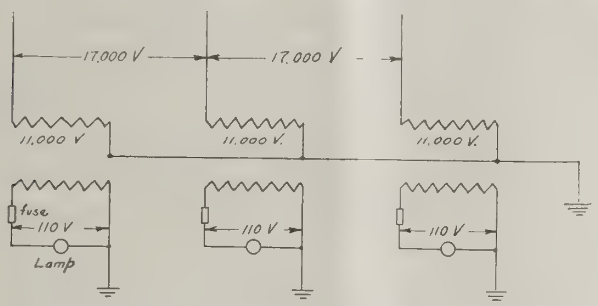
Editor Electrical Engineering:

(390) The switch blades on our switchboard corrode so badly that the corrosion interferes with good contact making. This is caused from the sulphur fumes from our producer gas plant. In what way can this corrosion be stopped? T. C. N.

TRANSFORMER GROUND DETECTOR ARRANGEMENT.

Editor Electrical Engineering:

(391) We have a 17,000-volt, 3-phase, 25-cycle, ungrounded transmission line on which I wish to install a ground detector. I have been advised to install three single-phase, 11,000-volt, potential transformers connected in "Y," as shown in the diagram herewith, with neutral point



SCHEME TO USE TRANSFORMERS FOR GROUND DETECTOR.

grounded. Explain the action of the transformers with no line to ground and with one or more lines. With the transformers connected as shown to the line, is there a strain placed on the insulation to ground of power transformers and other apparatus connected to the system? If so, why? Is this detector scheme a good one? T. C. M.

WILL GENERATORS PARALLEL WITH ONE FIELD COIL OUT?

Editor Electrical Engineering:

(392) If one field coil of one of two generators operating in parallel is burned out, can this coil be shunted out and the generators paralleled satisfactorily, or will it be necessary to cut out the pair of coils? The machines are both A.C., 2,300 volts, 60-cycles, with revolving fields. One machine has 32 field poles, 100 kw., the other 28 field poles, 75 kw. By the loss of one pole the Emf will be reduced. Will the frequency also be affected, and if so in order to maintain it, will the speed of the machine have to be increased to satisfy the formula, $(120 \times f) \div p =$ Rev. per min. where f is the frequency and p the number of poles? What objections are there for operating with one pole gone, provided the machines can be paralleled? Does the speed or frequency or both determine the voltage for the parallel operation? V. K. S.

WHY DO TRANSFORMERS HUM?

Editor Electrical Engineering:

(393) Please advise what causes transformers to hum and as to whether the loudness depends upon the frequency or the voltage, or both. E. A. R.

PROPER SIZE OF MOTOR FOR PUMP.

Editor Electrical Engineering:

(394) We are installing three motor-driven, three-stage centrifugal pumps for water supply. The capacities are one 350 gallons per minute; one 450 gallons per minute, and a fire unit of 750 gallons per minute. The two small units operate under 250 foot head. The fire unit takes water from a well and elevates it to a tank at an elevation of 220 feet. An 8-inch pipe line one mile long connects pump and tank. What size of 3-phase, 2,300-volt motor can best be used on each pump? Kindly furnish calculations on first cost and operation of motor for the pump supplying water to the tank assuming that 250,000 gallons of water must be pumped per day. Also show in calculation as to whether or not the 8-inch pipe line is large enough for best economy and as to whether or not a larger size would reduce friction head enough to use a smaller size of motor. V. K. S.

DELTA VS. STAR CONNECTIONS.

Editor Electrical Engineering:

(395) The writer has seen the statement that for the same per cent voltage drop or power loss, the carrying capacity of the star connected system is three times that of the delta. How is this calculated, if true? Also it is stated that when a star system is used and single-phase loads connected a fourth wire is necessary. Why is this? W. C. E.

TROUBLE IN OPERATION OF ROTARIES.

Editor Electrical Engineering:

(396) The writer begs to submit for publication in your columns the following trouble with a rotary converter: The writer knows of an installation of three rotary converters. They all start from the A.C. side as induction motors by use of auto-transformer starters. Two of these rotary converters have never given any trouble in starting, and hold their polarity when shifting from starting to running position on the starters. The third, however, frequently changes its polarity at this point and loses its D.C. voltage, reverses and builds up in the wrong way. The mains coming from the buses to the starters are run in conduit. For each phase, in each circuit of three phases, there are two conductors making six conductors per circuit. For two of the rotaries these six conductors are run in two sets of three each through two circuits so that each conduit has one conductor of each phase. For the third rotary there are also two conduits but one carries two wires of one phase and one of another so that the two conductors of one phase are divided as to their location, one being in one conduit and one in another. Could the method of wiring cause the trouble. If not, what could cause it? If the trouble comes from the method of wiring, please explain why and how?

Wm. M.

Comments on Ans. to Ques. No. 352.

Editor Electrical Engineering:

In the answer by Frank L. Zemp to question No. 352 in the June issue, he speaks of putting resistance in one phase of the 3-wire single-phase circuit connected as 3-phase and inductance in the other. If the inserting of the resistance, as he says, does not affect the phase angle, what is the use of putting it in? Under a light load the motor will start with only the inductance in one phase, but if more starting torque is necessary, won't the inserting of capacity in the other phase increase the phase difference between the two windings and thus give a greater starting torque? When the motor is up to speed, of course, both inductance and capacity must be cut out.

M. H. Baumgartner (Ga.)

Design of Series A. C. Arc System. Ans. Ques. No. 355.

Editor Electrical Engineering:

If the farthest lamp on the circuit is 1¼ miles from the transformer, I would say that 4 miles, or about 20,000 feet, of wire should be able to reach all the lamps. No. 6 wire has .39 ohms per 1,000 feet, or 7.8 over the circuit, which, multiplied by 6.6 amp. gives 51.5 volts drop. The lamps have 72 volts at the arc and the terminal voltage will be about 80 or about 3,200 volts for all the lamps. Of this, 51.5 volts is 1.6 per cent, which is a very moderate drop. Similarly calculating for No. 8 wire at .60 ohms per 1,000 feet, we get 76 volts drop or 2.4 per cent. Either size of wire could be used economically, but it is likely that No. 6 would be chosen on account of greater mechanical strength. For the diagram, I would recommend you to the bulletins of the Westinghouse or the General Electric Company. Either would be glad to send bulletins on A. C. arc systems.

Motor Circuit With Ground Return. Ans. Ques. No. 356.

The questioner does not make the connections clear. The only explanation would seem to be that this motor was connected across one side of a 3-wire 55-110 volt system with grounded neutral, as shown in Fig. 1. Of course, if there were only 55 volts across the armature, the motor would run at only half the normal speed. As regards using the ground as a return for any kind of a motor circuit, would say that it is very bad practice, and absolutely forbidden by the Underwriters. Not only is it unsafe, but very wasteful, as the drop in voltage through the ground will be quite high.

Grounding Secondaries. Ans. Ques. No. 357.

Most transformers are now made with two coils each in both primary and secondary, either of which can be connected in series or multiple. With primary coils in series on 2,200 volts, the secondary is connected usually with coils in series, giving a 3-wire circuit of 110-220 volts, as shown in Fig. 2. The load is then balanced on these three wires in the usual way, the middle wire being grounded as a protection to the residence customers against stray high-potential currents. The so-called power transformers with secondaries connected for 220-440 volts, are usually not grounded. Some companies ground the cases, but the majority do not, believing that it adds nothing to safety, and is simply an invitation to lightning to puncture the insulation to ground.

Transformers for Different Size Motors. Ans. Ques. No. 361.

I should not think separate transformers necessary. There would be some drop on starting, but unless the speed requirements were unusually strict, I do not think it would be prohibitive. The plan of running the three 5 horsepower motors as single phase is entirely feasible, but for the sake of uniformity, flexibility and arrangement, as well as lower cost, I would rather have them all 3-phase.

Single vs. 3-Phase Motors. Ans. Ques. No. 362.

The first cost, space occupied, the weight and the losses, are all somewhat less when a 3-phase transformer is used as against three single phase. In spite of this the single phase transformation is the more used, and more favored, because it is more flexible and reliable and requires less apparatus to be carried in stock by the central station. If one transformer of the three breaks down, it can be cut out and the motor run on two until a spare can be connected, but in the case of a three-phase, everything is out until it can be repaired or replaced.

Largest Practical Size of Motor. Ans. Ques No. 363.

Motors of 2,000 horsepower are now in operation. The highest voltage that I have noted was 6,600 volts. The National Code does not permit wires carrying more than 3,500 volts to enter buildings, except power houses and sub-stations, and the parties installing the same would have to make the wiring safe, according to the best engineering practice, and assume the risk, or get special permission from the insurance department having jurisdiction.

Grounding Secondaries. Ans. Ques. No. 364.

According to the National Electrical Code, the ground wire for A. C. distributing systems must be of the size of the mains, and in no case smaller than No. 6. The ground wire is not a protection against a ground, only to the extent that in case of a ground, or crossed circuit of any kind, it protects any person working around the wires or apparatus connected thereto, from a dangerous rise of potential above the ground. As to grounding cases, see answer to No. 257.

Unbalanced Conditions. Ans. Ques. No. 369.

Unbalancing, when applied to a polyphase A. C. circuit, always refers to unequal loading of the phases, and since unequal loading produces varying drop in the conductors, the voltages as well as the currents are unbalanced and the vector diagram is distorted. This, of course, reduces the capacity of the circuit.

A. G. Rakestraw.

Comment on Article Page 210 May Issue.

Editor Electrical Engineering:

On page 210 of the May issue of Electrical Engineering, I note a quick method of finding center of a room for locating an electrolier outlet. I believe I have a simpler method, in that the electrician requires no assistance.

Take a string long enough to reach from corner to corner of room. Take another string the same length from opposite corners; the point of intersection, or crossing of the two strings is the center of the room, and a plumb bob dropped from the ceiling to touch this crossing gives the center of the electrolier outlet. J. B. Fanger (Ariz.)

Design of Induction Coil. Ans. Ques. No. 367.

Editor Electrical Engineering:

In answer to question No. 367 I wish to submit the following. The voltage and current in the secondary of an induction coil varies with the design and construction of the coil. The average coil used for ignition will give about 5,000 volts and 2 milli-ampere at secondary when using 6 volts and 2 amperes in the primary.

The construction is practically as follows: A core of soft iron is wrapped with a few turns of large insulated wire, this being called the primary coil. This coil is insulated and the secondary winding of a great many turns of very small insulated wire then wound on. An automatic make and break is placed in series with the primary and batteries and a condenser placed in shunt across the make and break, or what is generally known as the vibrator.

When the current passes through the primary, it magnetizes iron core, attracting the soft iron armature, usually fastened by a spring, and breaks the current in the primary. As soon as this is done, the core is no longer magnetized and the armature is thrown back by the spring, when the contact is again made and the action repeated. When the current is made in the primary coil, a current in the opposite direction is induced in the secondary, and when the current in the primary is broken there is an induced current in the same direction in the secondary. The self-induction of the primary when the current is made acts against the battery current flowing in it, and reduces the induced E.M.F. in the secondary; but, when the current is broken, the self-induction acts with the battery current and increases the E. M. F. of the secondary.

Charles D. Blackwelder, (S. C.)

Unbalanced Conditions. Ans. Ques. No. 369.

Editor Electrical Engineering:

The term "unbalanced conditions," used in reference to a three-phase alternating current circuit, means either that the voltages across the three phases are unequal or that the currents in the three wires are unequal, irrespective of whether these differences have the same phase relation or not. If the voltage across any one phase is different from the other two, or the current in any one leg different from that in the other two, the circuit is said to be unbalanced.

Surging of Generator Currents.—Ans. Ques. No. 371.

Mr. V. K. Stanley's trouble is probably due to poor speed regulation of one or both of his engines. This can be determined by applying a tachometer to each. If this appears to be the case, it can be remedied only by either making the governor more sensitive or by installing a heavier flywheel.

Action on Cable.—Ans. Ques. No. 372.

This action would seem to be due to the presence, in the air coming from the mine, of some chemical element which acts on the copper when it has current flowing in it. If the joints in question should be thoroughly soldered, then covered first with a layer of Empire tape or rubber tape and finally with friction tape on the outside, this action should cease.

P. N. Pittenger (N. C.)

Transmission Line Calculations. Ans. Ques. No. 370.

Editor Electrical Engineering:

Most writers on the subject of transmission line calculation have made no distinction between long and short lines, but in a recent book—Transmission Line Calculation; by H. B. Dwight—lines less than 20 miles in length are considered short and the simpler formulus used for their calculation. For longer lines the capacity of the line must be considered and more accurate formulas used. For the 75-mile line mentioned in question 370, the more accurate formulas should, of course, be employed.

To fully explain the calculation of a long distance transmission line would require considerable space, so I am going to recommend to W. S. D. that he purchase the above mentioned book, which I believe he will find a good investment and much more satisfactory than any brief explanation which could be given in these Questions and Answers columns. The book is published by D. Van Nostrand Co., 25 Park Place, New York, price $2.00.

Of course W. S. D. may be stating a purely hypothetical case, but even so, it seems desirable to call attention to the fact that the conditions given are far from standard practice. It is seldom economical to transmit such a small amount of power more than 25 miles, the economical radius of distribution depending, of course, on the price of power. In spacing wires on high voltage lines, it is usual to allow one foot for each 10,000 volts between wires and the voltage adopted is usually approximately 1,000 volts for each mile of length of line. The loss has also been placed low for the power loss is usually between 5 per cent and 20 per cent of the power transmitted.

J. E. Volk (Wis).

Effect of Frequency on Meters. Ans. Ques. No. 337.

Editor Electrical Engineering:

I have noticed question 377 appearing in your issue for June, 1913. As the question concerns a matter that I have investigated to a considerable extent during the past year, I consider it worth while to answer it, for I have found that quite large errors can exist under the conditions mentioned in the question.

When the frequency of a circuit is changed from one standard to another it will be found necessary to either change or re-calibrate an induction watt-hour meter, both on inductive and non-inductive loads, or large errors will result. It is quite probable that the meter mentioned in this question will be found slow, particularly on inductive load. Different types of induction watt-hour meters vary greatly in their behavior under these conditions. (See Electrical Meterman's Handbook, page 339; also report of Committee on Meters submitted June 2-6, 1913, at the N. E. L. A. convention, Chicago).

If the watt-hour meter is of the commutator type there will, practically, be no change in the registration due to a change in frequency from sixty to forty cycles. I should judge that the meter should be taken to some laboratory, re-lagged and re-adjusted, or perhaps it will need a new potential circuit or parts pertaining thereto. The best way to do is to consult the manufacturer of the meter.

W. H. Fellows, Chairman Meter Committee, N. E. L. A.

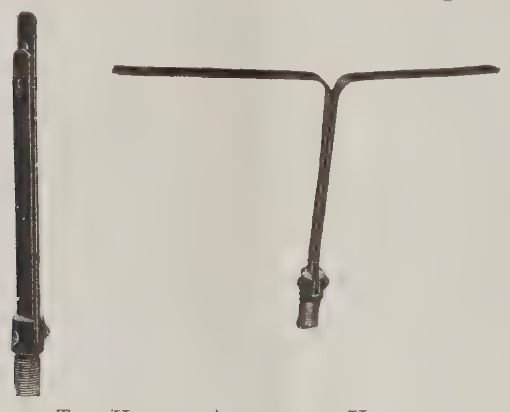
Annual Meeting of Colorado Electric Light, Power and Railway Association.

The Colorado Electric Light, Power and Railway Association will hold its eleventh annual convention in Denver the week of October 6, at the same time as the Electrical and Industrial Exposition to be held under the auspices of The Colorado Electric Club.

New Apparatus and Appliances

A Knight Adjustable Hanger.

The accompanying illustrations show a fixture hanger marketed by the Empire Engineering and Supply Company of 227 Fulton street, New York City, as selling agents for the J. G. Knight Mfg. Co., manufacturers of the hanger. As shown this hanger is made up of band steel with a solid malleable iron nipple fastened with a rivet. The figure at the right in the illustration shows how it can be made to suit different variations of floors or conduits entering the outlet



The Knight Adjustable Hanger.

boxes. The hanger is especially adapted to mill construction with concrete floors where the hanger is easily and substantially adjusted to eye beams or imbedded in the concrete. It can be used equally well with wood beam construction, the hanger being spread so that one leg can be nailed or screwed to each beam. In this case it is not necessary to use a board to screw the fixture support to as is usually the case. The hanger also makes a good pipe support.

Economy of Clean Globes and Reflectors.

The depreciation of illumination with the various units has been shown to consist of relative inherent and acquired factors, due in the first place to the natural characteristics of the lights and in the second place to accumulative deposits inside and outside of reflectors and globes. Tests have shown the acquired depreciation to be anywhere from 15 to 50 per cent, depending upon the application and attention given the unit. With domestic flame arc lamps, the average acquired depreciation due to deposits on the outside and inside of globes and reflectors after one burning of about 100 hours, is 28 per cent.

An interesting series of illumination tests conducted for a period of five weeks in a foundry showed up vital facts in connection with light absorption ordinarily designated as acquired depreciation due to accumulative deposits forming on globes and reflectors. The tests embraced luminous, flame and mercury arcs. Foot candle measurements on the working plane were made under regular operating conditions. The loss of light due to smoke and vapor deposit for the period mentioned was about the same for the three systems tested, the curve shown in Fig. 1 giving the falling off in the light for the last two weeks as approximately double the drop as compared with the preceding three weeks, the critical point occurring at the end of the third week. During the tests the luminous arc and flame arc lamp globes were wiped out in the usual manner at each trimming, but no attempt was made to clean them thoroughly until the end of the fifth week.

For the purpose of securing an economy shown from the above remarks, a cleaner for globes and reflectors has been introduced by the Myrlite Company of America, Pownal,

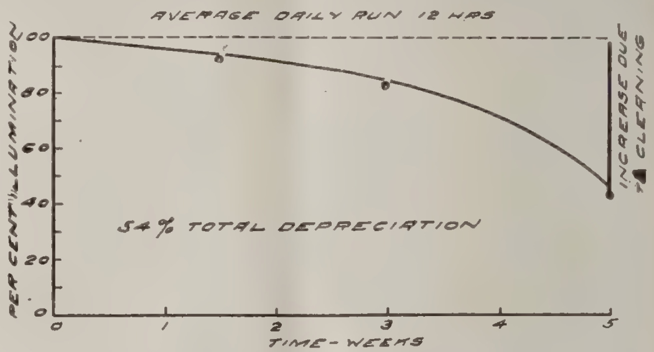


Fig. 1. Depreciation and Cleaning Curve.

Vt., which works quickly and gives a crystal brightness without leaving a dirt collecting filler as with some soap cleaners. This cleaner is known as "Myrlite" and is an insoluble, neutral carbonate free from silcon, acids, alkalies and soap compounds leaving no scratches on the glass to collect dirt. It is put up in pint and half pint tubes for the convenience of trimmers of lamps so that cleaning of arc lamp globes can be made at each trim. It is also put up in gallon cans for station use.

An Insulating Wire Connector.

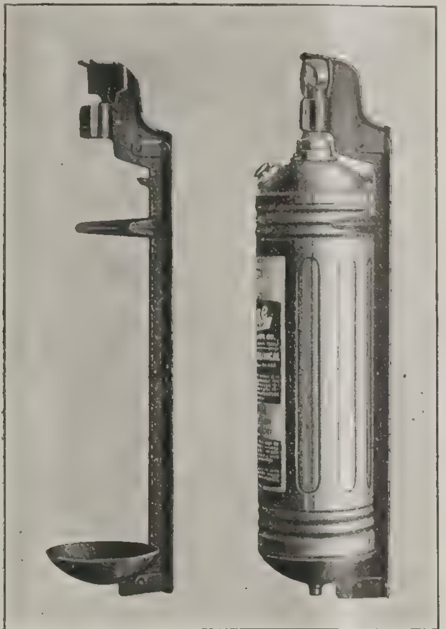
An insulating wire connector permitting splices to be made without the use of solder has recently been introduced by the U. S. E. M. Company of 209 West 33rd street, New York City. As shown in the illustration, the wires are skinned and twisted and inserted as far as they will go into the connector so that the conical point of the screen

A Wire Connector and Splicer.

kinks them into the corresponding recess of the sheel. When the screw has been set up and the insulating cap screwed on, the connection is complete. The connector is approved by the National Board of Underwriters and can be used for splicing wires of No. 12 B & S guage or smaller, solid or stranded. Also wires of the same or different sizes can be spliced with it.

Bracket for Fire Extinguisher.

The Pyrene fire extinguisher is well known for its small size and consequent ease in handling. A further mechanical improvement has now been made by designing for it a bracket which will hold the extinguisher more conveniently than has been the case heretofore. The new bracket, which has been recently placed on the market by the Pyrne Manufacturing Company, New York, N. Y., is shown in the accompanying illustration. The bracket is 14 in. long and weighs only 11 oz. It has a bearing surface of 1½ in. x 12 i., so that it can be securely attached to the wall of a building, the side of a car other place with minimum disturbance



Pyrene Fire Extinguisher and Bracket.

of the woodwork or other permanent fittings. This bracket is made of three strongly constructed parts, which hold the extinguisher firmly and keeps the handle securely locked. The bracket is finished in black, blue and red enamel, galvanized steel, nickeled brass or other finishes to harmonize with car or building interiors, switchboards, etc., and thus produces an exceptionally neat and even ornamental appearance.

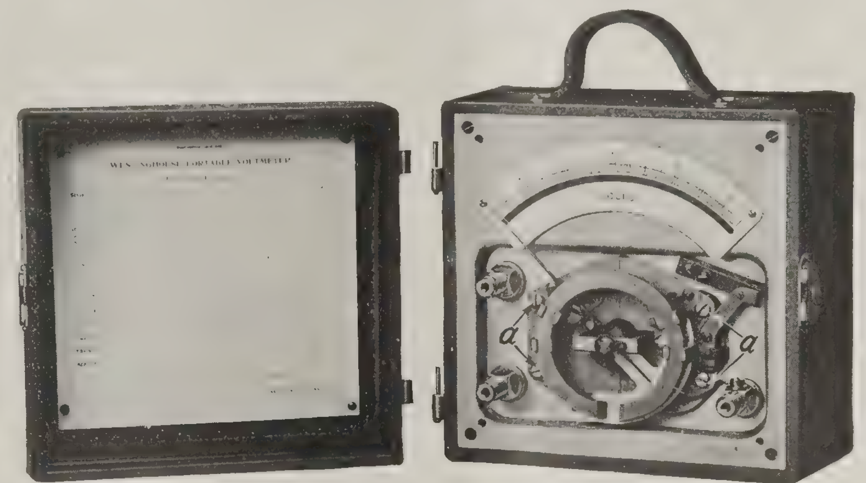
Portable A. C. and D. C. Meters.

A new line of high grade direct-reading instruments for general testing and laboratory work where especially high accuracy is desired, particularly on alternating current, has recently been introduced by the Westinghouse Electric & Manufacturing Company. The volt-meters and wattmeters operate on the moving coil principle. The perfectly damped character of the indications enables readings to be taken quickly and accurately, and makes these meters very desirable in measuring fluctuating loads. The fundamental advantages of moving coil meters are the high accuracy attainable and the fact that they can be used on either direct or alternating current circuits.

The movement is mounted as a unit and can be removed complete after taking off the faceplates, which makes a dust-proof joint with an inner aluminum mounting plate. The meters have a laminated iron shield riveted to the aluminum mounting plate, protecting the movement both from dust and from stray magnetic fields. The weight of the moving element is in all cases low, preserving the pivot jewels from wear, and the torque is relatively high.

The meters attain their highest accuracy on alternating current, and are free from temperature, frequency, and wave shape errors. On direct current, the meter may be subject to slight errors due to residual magnetism of the laminated iron shield, but this can be entirely eliminated by taking the average of reversed readings. A contact switch operated by a button on the front of the instrument is provided on each voltmeter. The voltmeters are entirely self-contained, all necessary resistors to obtain the calibrated scale readings being contained in the case, which is well ventilated.

The wattmeters are also entirely self-contained, all resistors necessary for the rated voltage ranges being contained in the case. Those that have double current or



New Westinghouse Portable AC and DC Meter, With Cover Plate Removed.

double voltage range are provided with a switch operated by a knob on the face-plate, which makes the proper series or series-parallel connection of coils when the knob is turned to the proper position. Only two current and two voltage binding posts are, therefore, necessary. The scale covers an arc of 90 degrees, giving large, open divisions. The scale for the wattmeters is wider at the lower end to give high accuracy for low readings, and for the voltmeters wider at the middle, where readings are most frequently made. A mirror extending the entire length of the scale prevents parallax in reading.

The meters are mounted in hardwood carrying cases 7¾ by 7¾ by 6 5/16 inches, and have hinged covers that are easily removable, and flexible sole-leather handles.

Copper Clad Wire.

Important litigation in regard to copper clad wire, which has been contending in the United States court in Pittsburg for the past two years between Duplex Metals Company, complainant, and the Standard Underground Cable Company, defendant, was virautlly decided June 25, when the case came before court on motion made by complainant to dismiss the bill in respect to patent infringement. The bill as originally filed charged inrfingement of the patent and infringement of a trade mark. The motion made by complainant was to dismiss without prejudice; that is to say, a dismissal leaving the complainant in a position to renew the suit at its pleasure. The motion was opposed, defendant contesting that the bill should be dismissed in this regard and a dismissal should be on the merits of the question, as the court finally ordered. The only portion of the suit not thus disposed of is in regard to the right to use the trade name "Copper Clad," and which is expected to go to a hearing in the early fall.

Electrical Construction News

This department is maintained for the contractor, dealer, manufacturer and consulting engineer.

ALABAMA.

ANNISTON. It is understood that work will soon begin on the generating plant to be constructed by the Alabama Traction Light & Power Co., outside of Anniston. Power will be generated from Jackson Shoals for Anniston, Talladega and other towns in that district. A transmission line will be connected with Anniston, the voltage being 110,000.

BIRMINGHAM. The Tuscaloosa Birmingham Railway & Utilities Co., has filed mortgage for $5,000,000 in bonds and it is understood that the construction of the proposed railway and the erection of an electric light plant will be carried out.

BIRMINGHAM. The Tide Water Securities Co., has asked for a franchise to sell electricity in Birmingham.

FLORENCE. The Board of U. S. Engineers on improvement of the Mussell Shoals Section of the Tennessee River has postponed action on bids until December 11th. Bids may be received under specifications already mentioned up to this time.

FLORIDA.

ST. ANDREWS. The St. Andrews Ice & Power Co., is preparing to install two 75 K. W. alternating current generators, switchboards and lightning arresters. J. H. Drummond, of St. Andrews, Fla., is manager.

WEST PALM BEACH. The Ariston Ice & Electric Co., is to construct a transmission line to serve the towns of Lakeworth, Lantana, Hypoluxo, Boynton, and Delray at the south of West Palm Beach. P. H. Ellis is general manager.

GEORGIA.

AMERICUS. The Americus Gas & Electric Co., and the Americus Power Co., have effected a consolidation under the name of the Americus Power Co. W. M. Chase is general manager.

MACON. It is understood that the Central Georgia Power Co., is to install three transformers at their substation increasing the capacity of the plant from $6,000 to 12,000 H. P.

SAVANNAH. It is understood that a hydro-electric plant is to be installed on Little Tybee Island, using machinery that will drive generating apparatus by wave motion of the ocean.

KENTUCKY.

LOUISVILLE. The Louisville Gas & Electric Co,. is to issue $7,500,000 in stock to acquire the Kentucky Electric Co., and to pipe gas to Louisville and plans for merging utilities. Charles McDonald is general manager and the H. M. Byllesby & Co., engineers.

NORTH CAROLINA.

CHARLOTTE. Reports state that the Southern Public Utilities Co., has recently been organized to take over the Public Service properties in Charlotte, Winston-Salem, Hickory, Thomasville, China Grove, Belmont and Mount Holly, N. C., and Greenville Anderson, Chester, and Fort Lawn, S. C. Z. B. Taylor is president, A. V. Harrill, vice-president, and E. C. Marshall, treasurer.

CHILHOWEE. It is understood that the Aluminum Co., of America of Pittsburg, Pa., will ask for bids during July for the construction of three dams on the Tennessee river. The plans and specifications for the first dam will be on file about July 15th. Dams are to be located at Alcoa, near Chilhowee; another eight miles further up the river at Choea, and a third across North Carolina state line eight miles further up and probably near Fontana. The scheme of construction will back water along the Little Tennessee river between Chilhowee and Bushnell some 25 miles. The plans to develop 200,000 H. P. and entail an ultimate investimate of about $15,000,000.

SOUTH CAROLINA.

ABBEVILLE. The city has recently completed an auxiliary steam plant of 200 kw., and is installing an ornamental street lighting system. E. M. Anderson is superintendent.

COLUMBIA. The Parr Shoals Power Co., controlled by the Columbia Railway, Gas & Electric Co., will construct a $30,000 distributing station on the Congaree River. This station will receive electrical energy at 60,000 and step down to 13,500 for large customers and to 3,300 volts for smaller customers and lighting. The station will be connected to the generating station at power shoals, 22 miles above Columbia. J. G. White Co., New York City, are engineers in charge and contractors.

SPARTANBURG. The Southern Power Co., is to erect a one-story brick transformer station and install three 1,500-volt direct current rotary converters for operating the Spartanburg-Greenville division of the G. S. & A. Railroad. It will also eect an outdoor type sub-station consisting of three 3,000 kw. transformers to take energy from the 110,000-volt transmission system.

TENNESSEE.

CHATTANOOGA. The Chattanooga Tennessee River Power Co., is reported to be planning an auxiliary plant to develop 25,000 horsepower. W. E. Boileau is general manager.

DYERSBURG. It is understood that a white way system is to be installed around the public square. Sixteen ornamental five lamp standards are to be used. T. A. Shafer is superintendent of the city plant.

FRANKLIN. The Harpeth Electric Light & Power Co., is to change its street lighting system from arcs to series tungstens. The change will be made in the next few months. It is understood that electrical energy will be secured from the Parksville dam on the Ocoee River. Mr. A. C. Lilly is manager of the company.

PARIS. The city is to purchase within the next few months a 300 kw. three-wire direct current generator and switchboard. N. W. Youkin is superintendent.

TEXAS.

HOUSTON. The Texas Public Service Co., has been organ..ized with offices at Houston and will construct an electric light and power plant, gas plant and water works systems in a number of towns. The capital stock of the company is $500,000 and the incorporators are Albert Emanuel, of Dayton, Ohio; H. A. Van Eaton; Raymond Neilson; C. H. Wilson; R. C. Patterson, and W. A. Parrish, of Houston.

SAN ANTONIO The San Antonio Gas & Electric Co., has increased its capital stock from $1.160,000 to $1,500,000. Improvements will be made to the property. The San Antonio Traction Co., has also increased its capital stock from $210,000,000 to $1,400,000 for the same purpose. W. B. Tuttle is vice-president of the company.

WACO. The Texas Power & Light Co., is to construct a steam generating station of 15,000 kw. Sargent & Lundy, of Chicago, are engineers.

Book Reviews.

ELECTRIC WIRING AND LIGHTING, by Chas. E. Knox and Geo. E. Shaad. Published by American School of Correspondence, Chicago, Ill. Price, $1.00.

This work has recently been revised and the data brought up to date. It is divided into two parts as the title article indicates, the first part being written by Mr. Knox, and the second by Mr. Shaad. Each section takes up the subject in a practical way, much data in the form of tables, illustrations and curves being given. On this account the book is one that every practical man, and especially the electrical contractor, can read with profit. On account of the widespread interest in illumination and the growing demand that lighting installations be made on a scientific basis, the section on lighting should be of decided interest to those installing systems. The treatment of the subject is brief, yet complete enough to give a thorough working knowledge of the practical features of good illumination. D. H. B.

STEAM ENGINEERS' MANUAL WITH ELECTRICAL APPENDIX, by Charles Penrose, E. E. Published by Julian D'Este Company, Boston, Mass. Price, $2.00.

The second edition of this work has just been issued. It is a revision of material appearing in previous editions and contains an entirely new electrical appendix of some 356 pages. This addition makes the new work an excellent handbook giving general information on steam and electrical work. The steam section contains new steam tables, rules, formulas and practical data as well as descriptive matter treating valve gear, indicators, etc. The electrical section takes up the operation of D.C. and A.C. machines, with numerous diagrams of connections and other illustrations and data. The subject of illumination and lighting units is thoroughly discussed, all data being of a decidedly practical nature. The last part of the work is given up to illustrations of different types of electrical apparatus and layouts of stations, together with an excellent discussion of the features of the alternating current generating station. In this section the nature of the different types of apparatus is taken up, the size and functions being explained. The types taken up are, A.C. generators, equipment of generator circuit, equipment of generator neutral circuit, generator field circuit, low tension bus system, station feeders, exciter system, outgoing feeders, lightning arresters, high tension transmission equipment and calculation of wire sizes. It appears to the writer that this manual is especially well compiled for the electrical engineer of a steam plant and since it fulfills his needs it goes without saying that any and every steam engineer in charge of a station where alternating or direct current is generated, will find it practical and valuable, especially for the electrical information it contains.

D. H. B.

TRANSMISSION LINE FORMULAE, by H. B. Dwight. Published by D Van Nostrand Company, New York City. 137 pages, 28 illustrations, and 17 tables. Price, $2.00.

This treatise seems to be one o fthe first to discuss the calculation of long distance high tension transmission problems in a practical, yet fairly accurate manner. The work is especially designed to enable the engineer to handle the design of transmission lines with the least possible calculation and the successful way in which the author has done this deserves special credit. For those who desire to be assured of the basis of the formulae presented for use, a special section discusses the mathematical derivation and gives methods that will enable the securing of results as accurate as time and patience will permit. Formulae are given for the calculation of long and short lines with very good accuracy. We believe this work possesses especial merit.

D. H. B.

RESUSCITATION, by Dr. Charles A. Lauffer, Medical Director Westinghouse Electric & Manufacturing Company, East Pittsburg, Pa. Published by John Wiley & Sons, New York City. Price, 50 cents.

This book includes a reprint of a paper on this subject delivered by the author before the Philadelphia Section of the National Electric Light Association. The author, after explaining a number of successful results which have been obtained from employing resuscitation methods on men who were supposedly dead, gives a clear description of the mechanism of respiration, illustrating same by a number of views of the various parts of the anatomy. The Prone Pressure or Schafer method of resuscitation which has been adopted by the National Electric Light Association, and a number of other Engineering Societies, is described in detail. This book brings out in a clear, concise manner the necessity of people in general being versed in the principles of resuscitation, and clearly shows how they can be learned so as to prove of valuable assistance to persons in the ordinary walks of life.

Personals.

CHARLES O. BOND, president-elect of the Illuminating Engineering Society, was born November 15, 1870, near the town of Lehigh, Webster County, owa. He was graduated from the United States Naval Academy, Annpolis, Md., in 1890. After graduation he served one year at sea on board the U. S. S. Enterprise and U. S. S. Philadelphia, resigning from the navy in 1891. He later taught school in the states of owa and New York for five years, and in 1897 became connected with the United Gas Improvement Company in Philadelphia. In 1898, during the Spanish-American war, he served five months as an ensign in the navy on board the U. S. S. ancaster and the U. S. S. Newport. At the close of the war, he resumed his connection with the United Gas Improvement Company, taking charge of the photometric work of the company. While continuing in this position, he also held command of one division of the Naval Force of Pennsylvania for three years. Since 1909, Mr. Bond hs been manager of the photometrical laboratory of the United Gas Improvement Company, which was established in that year.

CHAS. L. BENJAMIN, Advertising manager of Cutler-Hammer Manufacturing Company, Milwaukee, Wis., delivered an interesting and instructive lecture on advertising in trade and technical press at the national convention of the Associated Advertising Club of America, held at Baltimore, Md., June 11.

MR. ZENAS W. CARTER, secretary, The Electric Development Association, Boston, Mass., sailed for Europe on July 13, on the steamer "Ionian" of the Allan Line, Montreal. He was accompanied by Mrs. Carter. They expect to spend about two months in England, France, Belgium and Scotland.

Industrial Items.

THE WESTERN ELECTRIC COMPANY, on July 1st, opened a distributing house at New Orleans to take care of business that has heretofore been in the territory of Atlanta and St. Louis.

THE BRISTOL COMPANY, of Waterbury, Conn., has issued bulletins Nos. 175-176-178. Bulletin 175 contains two illustrations and brief descriptive matter on a new line of electrical resistance. Bulletin 178 gives two illustrations and preliminary description of another new line of Bristol instruments, Bristol's Wet and Dry Bulb Recording Thermometers which have been designed for recording temperatures of wet bulb and dry bulb on the same chart on the basis of which the humidity of the atmosphere can be computed.

H. W. JOHNS-MANVILLE COMPANY announces that in accordance with its long established policy of business expansion, this concern has recently opened a branch office at Charlotte, N. C. The new office, which is located in the Commercial Bank Building, is in charge of Mr. E. U. Heslop, who is assisted in covering the western section of North Carolina by Mr. P. J. McCusker and Mr. Paul Whitlock.

THE OTIS ELEVATOR COMPANY, New York City, has issued a booklet entitled, How Otis Elevators are Increasing the Central Station Load. This booklet discusses the use of elevators, escalators, and inclined elevators, suggesting the possibilities of increased sales. Illustrations and descriptions of machines are given.

THE THOMPSON ELECTRIC COMPANY, of Cleveland, Ohio, has issued an 8-page booklet describing and illustrating the Thompson high voltage series cut-out hanger. This hanger takes the place of suspension equipment used on serie sarc lamps and automatically cuts the lamp out of the circuit when lowering it.

THE GARLAND PATENT OF THE SAFETY ARMORITE CONDUIT COMPANY, Pittsburg, Pa., has been sustained by the United States Circuit Court of Appeals in an infringement suit against the Mark Manufacturing Company, of Zanesville, Ohio. The patent covers a method of removing all foreign substances from the interior surfaces of pipe used for conduit.

THE ELECTRIC APPLIANCE COMPANY, of 205-209 Chrtres Street, New Orleans, La., has leased the building formerly occupied by Woodward & Wight on Canal Street, and will occupy same in the near future. The former concern has occupied its present location for the past ten years, but its business has so expanded that the move to more spacious quarters was necessary. Col. C. Robert Churchill is president of the Electric Appliance Company, well known in military and business circles not only of New Orleans, but of the South.

Trade Literature.

ELECTRIC SERVICE is a new booklet for central station distribution now being published by the Rae Company of New New York City. It is of convenient size, 3 x 6 inches and is cheap to distribute, the price ranging from 2½ cents each for 5,000 to 3½ cents each for 250. This price includes the central station's imprint on all the cover pages. Electric Service is being edited and published under the direction of Frank B. Rae, Jr., whose wide experience in the central station field and long connection with the National Electric Light Association, on the executive, publications and electrical merchandising committees of the commercial section, peculiarly qualify him to edit a publication of this kind. Sample copies of Electric Service will be supplied upon request to The Rae Company, 17 Madison Ave., New York City.

THEATRE DIMMERS. Bulletin No. 8502 issued by The Cutler-Hammer Mfg. Co., Milwaukee, describes the latest type of Simplicity theatre dimmer for two-wire and three-wire circuits. These dimmers are made especially for use with tungsten lamps and where an extremely fine regulation of the lamp brilliancy is desired, there being twice as many steps on the new plates as on the dimmer for the carbon filament lamps. The diameter of the plates has also been increased two inches and two complete resistance windings can be carried on each side of the plate. These plates, however, can be carried on the same frame as the smaller ones. The bulletin contains very complete description and has many illustrations. Means of banking and control are discussed and dimensions given. The new Medinah Temple and Auditorium of Chicago and a number of eastern theatres have already been equipped with the dimmers described. Bulletin 8515 describing Spot Light Dimmers is also being distributed.

THE CENTRAL ELECTRIC COMPANY issues a small publication known as ELECTRON and devoted to electrical development and incidentally advertising the lines of electrical supplies and apparatus carried. The company is located in Chicago at 320-326 South Fifth Ave.

Electrical Devices Recently Passed by Underwriters

These devices and materials have been examined under the specifications given in the National Electrical Code and working in practice, and are approved by the Underwriters Laboratories, Incorporated.

Attachment Plugs.

DIEHL MANUFACTURING CO., Elizabethport, N. J. "Diehl" attachment plug, 660 W; 250 volts. Approved May 13, 1913.

Cabinets.

ELECTRIC APPARATUS CO., 127-129 South Green Street, Chicago, Ill. Standard designs. Approved June 13, 1913.

ELECTRIC MANUFACTURING CO., 1363 W. Second Street, Cleveland, Ohio. "E. M. Co." Steel panelboard cabinets with steel trim and door. Approved June 16, 1913.

ROHN, GEO. F., 446 East Water Street, Milwaukee, Wis. Standard design. Approved June 13, 1913.

Cables-Armored.

EASTERN FLEXIBLE CONDUIT CO., 41-59 Gardner Avenue, Brooklyn, N. Y. Standard requirements. Approved June 13, 1913.

Conduit, Flexible Steel.

EASTERN FLEXIBLE CONDUIT CO., 41-59 Gardner Street, Brooklyn, N. Y. Standard requirements. Approved June 13, 1913.

INSULATORS. A mailing folder showing 43 designs of glass insulators has just been sent us by the Brookfield Glass Co., New York City. Many of the designs are new. The folder will appeal to anyone who uses insulators. A free copy will be mailed on request.

Conduit Boxes.

ADAPTI MANUFACTURING CO., Winter and Leonard Sts., Cleveland, Ohio. "Adapti boxes"—outlet boxes for use with rigid conduits, ½ to 4-inch inclusive. Also threadless connectors for these boxes. Aproved May 1, 1913.

Conduit, Rigid.

GREENFIELD CONDUIT MFG. CO., La Belle Iron Works, Stubenville, Ohio.—For Sprague Electric Works. "Sprinfield duct" galvanized inside and outside. Approved April 14, 1913.

NATIONAL ENAMELING AND MFG. CO., Youngstown, Ohio. Made for C. S. Knowles, "Enamelduct," "Armyduct," Aulmaduct," and "Alumaduct Special." Approved May 13, 1913.

Fuses, Cartridge Enclosed.

UNITED ELECTRICAL SUPPLY CO., 241 37th St., Brooklyn, N. Y. "United" fuses, 0-200 amperes, 250 volts and 0-200 amperes, 600 volts. Approved April 29, 1913.

Panelboards.

STANDARD MECHANICAL EQUIPMENT CO., 1913 Elm St., Dallas, Texas. Panelboard approved May 6, 1913.

TITTLE, H. S., 245 Minna St., San Francisco, Cal. Panelboard approved May 6, 1913.

Receptacles, for Attachment Plugs.

BRYANT ELECTRIC CO., Bridgeport, Conn. Heater control combinations. Receptacle for attachment plug, indicator lamps or receptacle and switch. Approved April 30, 1913.

HUBBELL, INC., HARVEY, Bridgeport, Conn. Flush combinations for use with push snap switch and lamp indicator at outlets for heating devices. Approved May 7, 1913.

Switches, Automatic.

BUTTE ENGINEERING AND ELECTRIC CO., 683 Howard St., San Francisco, Ca. Triple-pole remote control knife switch, 100 amperes. 125 volts. Approved April 21, 1913.

PALMER ELECTRIC AND MFG. CO., 161 Franklin St., Boston, Mass. Remote control switches for direct and alternating current. Approved May 1, 1913.

Switch Boxes.

BAUER MFG. CO., 2384 East 43rd St., Cleveland, Ohio. "Bauer" one-piece cast iron switch box for use with flexible tubing. Approved May 1, 1913.

Receptacles for Attachment Plugs.

CENTRAL ELECTRIC COMPANY, 320 S. Fifth Ave., Chicago, Ill. Receptacles for attachment plug s and plugs. Approved May 23, 1913.

RUSSELL AND STALL COMPANY, 48 Cliff St., New York City. "R and S Co." Recptacle and plug can be mounted in four-inch square outlet box. Approved May 14, 1913.

STANLEY AND PATTERSON, 23 Murray St., New York City. Charging receptacle. Approved May 14, 1913.

Switch Boxes.

ALLINO SWITCH BOX MFG. CO., 1015 Pine St., St. Louis, Mo. "Allino" pressed steel switch box for use with flexible tubing. Approved May 22, 1913.

MACHEN AND MAYER ELECTRICAL MFG. CO., 21st Street and Fairmound Ave., Philadelphia, Pa. "M and M" single and sectional gang, pressed steel switch boxes for use with rigid conduit or flexible tubing. Approved May 28, 1913.

ELECTRICAL ENGINEERING

PUBLISHED MONTHLY

Vol. 45. SEPTEMBER, 1913 No. 9

PUBLICATION OFFICE
DALTON, GA.

EDITORIAL and ADVERTISING DEPARTMENTS
GRANT BUILDING ATLANTA, GA.

D. H. BRAYMER, Editor.
A. G. RAKESTRAW, H. H. KELLEY, F. C. MYERS, L. L. ARNOLD — Associate Editors.

SUBSCRIPTION RATES

Domestic .... $1.00 For Two Years
Canada .... $1.00 Per Year
Foreign .... $1.50 Per Year

Complaints of failure to receive ELECTRICAL ENGINEERING regularly or of any errors of any nature, should be promptly made to the Atlanta office.

Advertising copy or change orders for standing advertisements must reach the Atlanta office by the 5th of the month preceding the month of publication.

Entered at Dalton, Ga., Postoffice as Second-class Matter.

CONTENTS.

Why Public Utilities Succeed.

It is frequently and logically inquired how public utility companies, though much younger than railroad and industrial interprises, can in marketing their securities or in enlisting capital, use such convincing arguments as high safety and high earnings. Further, it may be asked and this question be a partial answer to the first, how is it that a view of such securities, equivalent to 5 1-2 hundred billion dollars, can show that during the 30-year period between 1882 and 1912, not more than 1 3-4 per cent has been in the hands of receivers? The answer to these questions, we believe, is twofold. First, the business of the public utility company is based upon facts substantiated by economical and social development and is practically free from speculative schemes. Second, the business is largely influenced by what may well be termed "company thrift" or economical management. This latter factor is fast reaching a high state of development, probably in as great if not greater proportions than in any other line of business—the present being a constructive policy period in public utility affairs.

Somewhere, sometime, there appeared the following words: "A hatful of hot air may weigh as much as a bullet, but you can't shoot it through an oak plank." True as life and the ramifications of the human mind, are these words, yet how many times in a single day of the experience of one man can he remind his neighbor of this remark and in return receive the same compliment? We dare say that if each number was placed one above and one below a horizontal line, the fraction in its lowest terms would be equivalent to unity. What we need in our work is truthful facts, "f-a-c-t-s." Results of experience are good, but they must be arranged, culled, systematized and compared with previous data and made to serve as a measure of progress and the basis of future calculation and estimation.

In the field of the public utility, facts such as mentioned are being rapidly formulated through individual organizations and through company co-operation in a national organization, the National Electric Light Association, at present the largest commercial organization in the world for the advancement of a single industry. This tendency toward an analysis of the economical conditions of operation and management is building the industry along no game of chance lines. It is cultivating a spirit of progress and advancement among the small companies as well as the large ones and emphasizing the fact that a fair return can be secured and a fair rate made under the proper conditions.

In regard to economical management or company thrift, we quote from H. N. Sessions of the Southern California Edison Company in what follows: "Our country at the present time is in a state of drunken prosperity; so much so that enterprises may thrive notwithstanding an extravagance and waste that are utterly incompatible with legitimate business. The result is demoralizing. But that bad business succeeds does not commend it, for sooner or later it will be honeycombed, and go to pieces because of its faults and vices. Thrift alone is a guarantee of permanent prosperity; and yet thrift is not mere saving. It is not a pennywise policy, it is governed by discretion; therefore it must be broad enough to correspond with the ends and purposes proposed. In fact, the chief criterion of thrift in business is expediency. Thrift may and often does require a liberal, if not a lavish expenditure of money. Prudence suggests that the outlay be larger or smaller, depending altogether upon the plan and scope of the enterprise. In any event we should hold in mind as a warning that, 'there is a withholding that leads to poverty.' There is an idea that it is economical to lay away all things that are not in use, but how about it if, when these things are called for, they are unavailable or unfit and have to be replaced with new? On the other hand, if such things are going to fall into disuse, why not convert them into money and thus keep them alive and productive? Thrift demands constant preparation and readiness against adverse contingencies."

Economical management based upon experience and judgment born of this experience, compares with haphazard management and rates based upon guess work with little reference to generation and distribution costs, in the same way as thrift compares with waste. The formulation of operating and management information, therefore, in such a manner as to cause it to be recognized as facts that actually govern the successful development of the industry, is surely to be an important corner stone in the completed structure and place the exploitation of public utility properties on such basis that little question in the future will be given to any features of operation.

The One Man Business and Its Competitors.

In practically all lines of manufacturing, this is a day of specialization. Every concern has its expert engineers devoting their entire time to the perfection of one main idea, namely, economical production. As in the engineering and manufacturing departments, likewise in the business department, a single class of work as far as possible is handled and where the business is large and complicated a division and subdivision of departments is found until the business organization is a net work of related activity in connection with converting orders into a product and delivering this product to a consumer.

It is known by those who have been in the capacity of the buyer, that a delivery date is a variable quantity even with those concerns that maintain elaborate and systematic business methods such as already indicated. In the electrical field, we have been forced to believe that the increasing demands for special apparatus and the constantly increasing necessity for changes in designs and therefore in manufacturing facilities, brought about through fast expanding and changing conditions, have been responsible for the failure in some few cases, to deliver a product at a certain previously fixed date set at the time of making the order. We quote here the remarks of a small organization appearing in their publicity publication, in which it is made to appear that delays in delivery and change orders are due to the extent of the large organization and their business "red tape." We are aware that in some cases a business system, not carefully executed, may expand to such an extent that a tape of considerable length and probably some color, would be required to mark the course of an order, yet it is remarkable how such conditions can be remedied when the proper executive is in charge who knows his business so well that he can see the shortest possible route in his organization from the receiving mail clerk to the shipping clerk and in this route convert an order into a finished product in the shortest possible time. We quote as follows:

"Despite the fact that business naturally gravitates toward the big and conspicuous concern, the day of the small concern has not ended and there is no evidence that it soon will. Business is called cold-blooded—but after all it is intensely human. Herein lies the real secret of the small concern's success. 'Every successful business institution,' said Emerson, 'is but the lengthened shadow of one man,' and the bigger the business the longer the shadow. But the shadow does not satisfy—average human nature wants to see—to speak to—the man himself.

"Only in the small concern is this possible. The great business institution must wrap itself in a mummy-case of red tape. Life has departed and system has taken its place. But the head of a small concern is accessible. He can be reached directly by letter, by telegram, by telephone. When you make an inquiry it is not referred from one department to another and then to another. Instead of days or even weeks required to thread the mazes of a big concern's red tape, you get to the head of a small concern in a few minutes or at most, a few hours."

We are not sure what particular small concerns are here referred to, but if in the electrical field, we agree that there is always room for the creative genius and in whatever way he may choose to execute that genius, if he only executes it in a practical and useful manner, he is a benefactor to the industry and to mankind. We believe however, that the day of a one man business, where the one man is creative head, executive head, administrative head and general superintendent combined, is well nigh if not entirely past. Economic reasons have made it so, for any one man who possesses creative ability, can secure a larger return on that ability and his capital if he gathers about him those who are capable of executing his ideas. It is therefore more for this reason than on account of being crowded out by the influence and monetary power of the larger concerns, that the one man business is with us in increasingly small numbers. There is a happy medium between the one man business and the so-called "big and conspicuous concern" mentioned in the above remarks and this is found in the combination of the few creative and executive heads coupled with a sufficient number of individuals trained and capable of carrying out accurately and efficiently any directions that may be furnished. This does not take away any of the personal element in the business relations possible in the smaller or one man concern for here we have simply an expansion of the one man idea with the details transferred to his assistants and his time less occupied by such and devoted to the larger and important phases of the one man idea first mentioned, economical production. Under this class of organization we find today the majority of small successful concerns, and there seems to be no good reasons why a fewer number of such concerns may be expected in the future, if developed along these and other economic lines peculiar to the particular industry with which they may be connected.

The New Riverside Station of the Savannah Electric Company

Written for Electrical Engineering.

PROMPTLY at 12 o'clock on May 19, the new million dollar Riverside power station of the Savannah Electric Company was thrown open to the public for inspection. This station, which is located at River and West Broad streets, is of the most recent design of steam generating stations, both in type of equipment used and in the layout for economical operation. The building of this plant in Savannah has been the result of a rapidly increasing power and lighting load, the extent of which is indicated by the fact that among Georgia cities, Savannah stands well in the front rank of those showing a diversified use of electrical energy, the earnings expressed in dollars per capita for the white population being 22.11.

Early in 1912, a careful study was made to determine the most desirable location for a power plant for the Savannah Power Co. This location had not only to provide space for present requirements, but on account of the rapid growth of the city of Savannah, especially along the river front, it was deemed wise to provide land for all requirements for at least the next twenty years. A lot on the corner of River and West Broad streets was finally selected. This lot is 630 feet long on the river front; 160 feet on the western end, and 116 feet on the eastern end. For various reasons, the lot is very nearly ideal for its purpose. It is bounded on the north by the deep sea channel of the Savannah River; on the south by a street containing a spur track of a trunk line railway, while just across West Broad street and also on the river front is a lot approximately 200 by 220 feet suitable for coal storage. The first two facilities assure economical and sure supplies of coal, while the latter provides storage for 15,000 tons of coal at one time. The Savannah River also provides an ample supply of suitable water for both boiler and condenser purposes. The land will well take care of an ultimate development of 46,500 Kw., the present installation being 11,500 Kw. On March 17, 1912, the deal was closed for the land and the Stone & Webster Engineering Corporation at once began the design, and very soon after the construction of the plant; this with the understanding that at least one 5,000 Kw. unit must be delivering power by November 1.

The station building consists of a turbine room on River street, 77 feet by 130 feet, and a boiler room, 54 feet by 64 feet, on the river front. The east ends of both being temporary construction, providing for future extensions. The building is fireproof throughout; the steel frame is fireproofed; the walls of brick; the roof and floors of concrete, and skylights of metal and wires glass. On the coal storage lot, across West Broad street, has been installed suitable unloading apparatus for the use of the coal carriers; a crusher outfit, which is fed by a Browning Engineering Company locomotive crane, and a Robbins belt conveyor of a capacity of 50 tons per hour, which delivers the fuel from the crusher to the hoppers over the boiler room. An automatic weighing device is installed to weigh the coal in its passage from the stock pile to the station bunkers. Over the fire room is installed a 300-ton coal bunker, which, at the present rate of coal consumption, holds over five days' supply.

THE BOILER ROOM.

On the boiler floor are four Babcock & Wilcox water tube boilers rated at 665 Hp. each, on a basis of ten square feet of heating surface per horsepower. The boiler pressure is 200 pounds. Each boiler is fitted with Green Engineering Company chain grate stokers of 132 square feet area. Coal is delivered to the stokers through a chute, on which is installed an automatic weighing device, which registers the shift consumption, daily consumption, and checks the weights of the conveyor scales.

Two enclosed Wachs engines are belt-connected to the stoker driving shaft, either engine being capable of driving the present stoker installation. The stokers drop the ashes into hoppers under the boilers, and these hoppers empty by gravity into flatcars, and the ashes are hauled away for use as ballast and filling on the suburban lines of the company. A steam railroad spur also runs through the ash room. Provision is made for installing forced draft in case it is desired to do so at any time in the future. Superheaters of the Foster type are fitted to the boilers to give 135 degrees F. superheat at normal boiler rating.

Fig. 1. Riverside Station (Savannah) Showing Coal Storage and Conveyor.

The steam is brought from the boilers to a steam header located in the rear of the boilers and a little above the level of the boiler room floor. The feed water is taken through the intake funnels from the Savannah River; thence pumped to the sedimentation tank and properly made up for boiler use. An Organ feed water heater of 5,000 Hp. capacity has been installed and is designed to raise the temperature of 150,000 pounds of water per hour from average normal temperature to 210 degrees F. Steam for the heater is taken from the auxiliaries.

The boiler room auxiliaries are installed on the turbine room floor. The partition between the boiler and turbine rooms is only carried down to the boiler room floor, thus leaving a bay under the boilers back to the south side of the ash pits. The boiler auxiliaries occupy this space, together with the Underwriters pumps, air pump, and future forced draft apparatus. They consist of one 10-in. Alberger-Curtis centrifugal boiler feed pump; one Worthington duplex feed water pump 16 and 10 x 18-in.; one Worthington duplex feed pump, 7½ and 4½ x 6-in.; one Blake fire pump, 16 and 9 x 12-in.; one low service pump, 7½ and 8½ x 10-in.; and one 3-in. centrifugal pump.

The stack is of reinforced concrete, built by the General Concrete Construction Company, and is ten feet inside diameter and 254 feet high. It is lined with red brick for a distance of about 60 feet above the flue entrance.

THE TURBINE ROOM.

In the turbine room are installed one 1,500 Kw Allis-Chalmers and two 5,000 Kw. General Electric horizontal Curtis turbo-generators. The Allis-Chalmers machine was moved from the Indian street station to the new station. There is also installed one 1,000 Kw. General Electric railway synchronous motor generator, 2,300 volts on the A. C. end and 600 volts on the D. C. end. There is room and provision has been made for three more of the same type machines.

All the auxiliary apparatus, including the condensers, circulating pumps, dry vacuum pumps, hot well pumps and exciters, are also on this floor and as closely assembled as possible. The condensers are of a surface type and of a capacity of 50,000 pounds of steam per hour, and have a cooling surface of 13,000 square feet. They were furnished by the Henry R. Worthington Company. The circulating pumps are of the Worthington Valute single suction type, direct connected to 10 x 12-in. enclosed crank vertical engines. Operating at 225 R. P. M., they will deliver 11,800 gallons per minute against a head of twenty feet. The hotwell pumps are of the vertical Worthington type, driven by Terry vertical steam turbines, and running at 2,000 R. P. M. will deliver 230 gallons of water per minute. The dry vacuum pumps are of the horizontal rotarive type; cylinders 10 x 26 x 18-in stroke, and built by Henry R. Worthington Company.

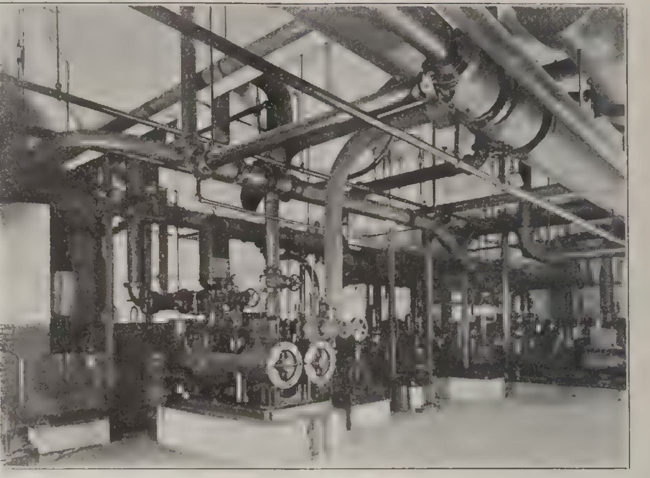


Fig. 3. Pumps in Turbine Room Under Boilers.

The two exciters are 125 Kw. General Electric generators, direct connected to horizontal Curtis turbines. There is also a Westinghouse compound air compressor of the locomotive type, and the station is completely piped for air cleaning purposes. The station is supplied with a 45-ton electric traveling crane, built and installed by the

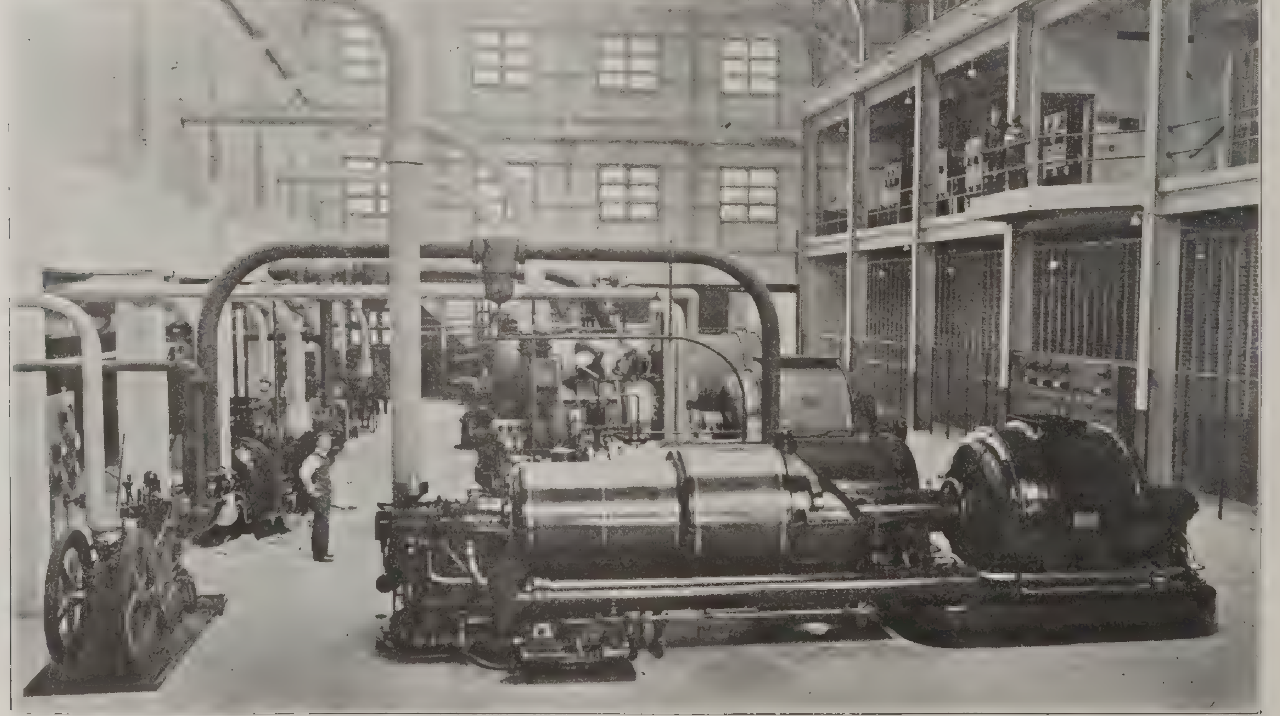


Fig. 2. Turbine Room of Riverside Station.

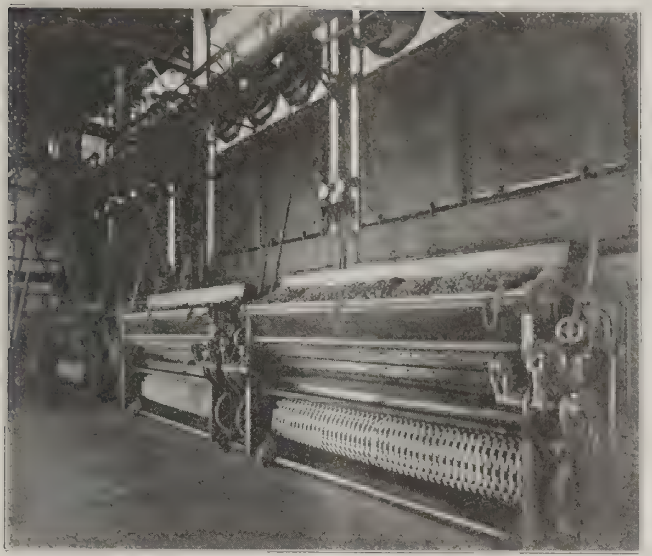


Fig. 4. Front of Boilers Showing Chain Grate Stokers.

Case Crane Company. This crane spans the turbine room, and is capable of handling the heaviest part of any piece of apparatus in the station.

Under a portion of the turbine room and extending the length of it is both a pipe tunnel and an air tunnel; the former connecting all the exhaust, hot and cold well piping, atmospheric relief, etc. Under this tunnel are the condensing water intakes and discharge tunnels; these connecting with the screen walls on the river through two brick tunnels 5 feet, 6 inches in diameter on the inside. These latter were installed by the compressed air method, the work being done after the inside tunnels were completed and while the station was rapidly rising overhead. Horizontal screens protect the intake, and a diverting bulkhead directs the discharged water away and down stream from the intake. A double system of screens is installed, and apparatus for raising and cleaning the screens is supplied.

SWITCHBOARD GALLERY AND SWITCHBOARDS.

The switchboard gallery extends along the south side of the turbine room at an elevation of about eighteen feet from the floor, and is about 23 feet wide. The switch-

Fig. 5. View of Edison Substation at Savannah.

Fig. 6. Showing Entrance to and Lines Leaving Mill Haven Substation Serving Factory District.

board section is enclosed between fire proof walls on the sides. The machine board is of the bench-board type and faces south. All switching apparatus was furnished by the General Electric Company.

As future plans contemplate two 7500 Kw. and two 10,-000 Kw. turbo units, designed for three-phase 13,200 volt, 60 cycles operation, the board is designed to take care of these units and their operation with the present two-phase, 2300 volt equipment. Provisions have been made for tying together the two-phase and three-phase busses through two banks of Scott connected transformers. One bank is now installed, and is at present used as an outgoing feeder to the Mill Haven factory district, where a step-down distributing transformer house has been installed.

The machine board consists of the following panels: 1 panel for two turbo exciters; 1 stage battery panel; 1 panel for two 10,000 Kw. turbo-generators; 1 panel for two 7,500 Kw turbo-generators; 1 panel for two 5,000 Kw. turbo-generators; 1 panel for one 1,500 Kw. turbo-generator, and Indian street tie line; 1 transformer panel and 1 panel for one 1,000 Kw. railway motor generator. Provisions are made for three future railway motor generators and two future exciter panels.

The distributing board faces the machine board and contains the following: 4 double feeder railway panels; 1 railway bus tie line (Indian street station); 3 four-feeder, single-phase lighting feeder panels (six feeders installed); 1 two-feeder power feeder panel (series arc lamps and station light and power feeder to station service board); 1 two-feeder, two-phase feeder panel (two tie lines to Bay street Edison substation); 3 two-feeder, two-phase power feeder panels (3 feeders installed); and 1 Tirrill regulator panel.

Both of the above boards are of the remote control type, with the exception of the railway feeder panels and the D. C. tie line to Indian street station. The station light and power service board is on the turbine room floor, and is of the hand control type, controlling all the station lighting power, the coal crusher, the traveling crane, etc.

At the left of the switchboard room are the rectifier sets for Magnetite arc system. There are fifteen 50-light sets installed at present, and provision is made for five more sets. These are all of the General Electric, single

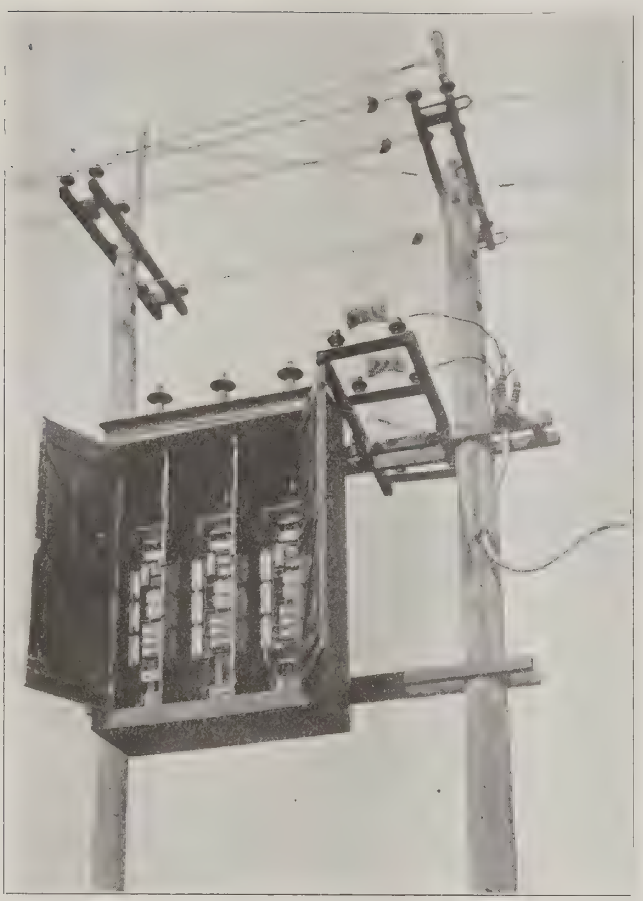


Fig. 7. Showing Connections of Cable to Aerial Lines —Bay Street Extension.

Fig. 8. View Showing Office of Savannah Electric Company and Edison Substation at Left.

tube type, with the exception of the last three sets installed, which are the double-tube type. It is of interest that a mechanical water cooling outfit is being installed for the purpose of cooling the oil in the tube tanks, the expansion of air in water system of refrigeration being used.

Under the main switchboard gallery are installed the switch cells and bus bar compartments. On the west end of this section is also a fireproof room containing the two starting compensators and the three station service light and power transformers. Over the gallery on the third floor are the lightning arresters in one bay; the machine rheostats in another; and an enclosed battery room. In the latter is installed a 60-cell, 200 ampere hour Electric Storage Battery Company battery for operating the remote control apparatus. Adjoining the station, on the east, is a fireproof transformer house, in which are installed two 1250 Kw., 13,200 volts, 60-cycle water cooled Westinghouse step-up transformers. These are mounted on trucks and well arranged for careful inspection.

The office of the chief engineer is in the southwestern corner of the station and on the first floor. Above this office is a large locker room for the operating force, with a room adjoining containing shower baths. Over the locker room is a room to provide for future locker space.

On the switchboard gallery is a telephone booth containing a line to the private board at the general office; a private line to Indian street station, and a private line to the Bay street sub-station. In the chief engineer's office is a telephone connected direct to central.

Notwithstanding the fact that every precaution has been taken to make the new station as near as possible fireproof throughout, a complete outfit of fire extinguishers has been provided in the building and three Underwriters standards hydrants with hose houses have been provided in the yard. The latter are connected to the city water mains and to a 50,000 gallon tank, as well as to a standard Underwriters fire pump. There is also a city fire station one block away, equipped with two automobile fire engines and a ladder truck.

The station was designed and constructed by the Stone & Webster Engineering Corporation. Commercial current was promised for November 1, 1912, and on October 31, at 12:30 p. m., Number 2, 5,000 Kw. turbine was phased in and began to help the Indian street plant carry the load. The exceptionally short time required to design and build this station bears testimony to the systematic and effective methods employed throughout the work by the constructors and to the hearty co-operation of the organization of the Savannah Power Company, for which the station was built.

Much of the material presented in this article has been taken from a recent issue of the Stone and Webster Public Service Journal, also a number of the photographs are presented through the courtesy of the Engineering Corporation.

Responding Electric Push Button.

An electric push button designed to indicate a return signal is said to have been invented by a Norwegian electrician. The apparatus is a very simple contrivance which can be attached at a slight cost to any push button connected with an electric bell. By means of an electric magnet, directly behind the signal button, a dull buzzing sound makes known whether the person called is present. Besides assuring the one signaling that he has been heard, it will save the one called the annoyance of listening to repeated ringings. The convenience should appeal especially to physicians and others who may be summoned during the night. The appliance can be used in connection with call buttons in hotels, ships or other places where the employe called cannot always immediately respond by his presence. A patent has been taken out in Norway, and applications filed in England and Germany.

A windmill is employed in England to generate electricity for lighting a neighboring church and parsonage and to furnish power to pump the church organ.

Important Considerations When Ordering Power Transformers

(*Contributed Exclusively to* Electrical Engineering.)

BY H. G. DAVIS.

BEFORE ordering a transformer, the first points to be considered are primary and secondary voltages and capacity. These considerations are necessary in order to deliver the required power. The next point to consider is cost of operation. In what follows these considerations will be taken up.

VOLTAGES AND CAPACITY.

Primarily the capacity of a transformer is determined by the load which is to be carried and the voltages by the transformers to be operated in parallel or by the voltage of supply and delivery. Large water power stations have their transformer capacities determined by the generating capacities and the voltage on the high tension side determined by the transmission voltage most economical for the delivered power and predetermined distance everything considered and on the low tension side by the generator voltages. Large stations of any description have the transformer low tension voltages determined by the generators and the high tension voltages by the most economical distribution voltage. In any case the voltages are determined by the system supply and the consumers required voltage. These then are the points to be met in ordering a transformer for any system whether to supply a given motor or to operate in parallel with any network.

In supplying distribution systems, where secondaries are connected in multiple to a distributing network, the capacities usually vary from five kilowatts to fifty kilowatts or higher. The network usually begins with one small transformer supplying a few consumers and as the demand increases, small transformers are added to meet the demand. This network thus began by one transformer serving one or two customers each, it being found that the larger the number of consumers for each transformer, the lower the transformer capacity required relative to the sum of the maximum demands of the individual consumers. Thus, if two consumers with twelve 50 watt lights each, required a transformer of one kilowatt capacity, two more consumers of like demand could be added without doubling the connected capacity of transformer required. This is due to the fact that maximum demands do not occur at the same time, so that the greater the number of consumers the greater the diversity factor or the better the load factor or ratio of average load to maximum load. As an example the four consumers could perhaps be served by one 1.5 Kw transformer. By thus increasing the number of consumers for each transformer and forming a network with a maximum of four transformers connected at most economical points for the size of copper required, the ratio of transformer capacity to connected load is reduced to a minimum with the most economical use of copper. Thus a few small transformers can be used in building up a network such that as the load requires, the smaller transformers could be replaced by a standard size adopted for networks. With the use of the larger transformers a higher efficiency is obtained. Enough transformers should be used in a bank so that trouble with one transformer would not leave an excessive overload on the others. This applies to distribution transformers.

This general idea will hold for paralleling transformers for any service. The power to be delivered by the transformers in the bank should not be greater than 1.25 multiplied by the capacity of each transformer multiplied by $(n - 1)$ where there are n transformers in the bank. This allows for the failure of one transformer without an overload being put on the remainder of the bank greater than that which transformers of standard guarantees will stand.

Transformer installations for motors and special service should have a capacity determined by the service demand as required. As these installations are mostly three-phase, the installation should consist of three single-phase transformers. The kilowatt transformer capacity should equal the horsepower of the motor. For a three-phase installation each transformer capacity in kilowatts or kilovolt-amperes, which is the real transformer rating, would be one-third of the motor's rating in horse-power. This refers to motors of ten Hp or more. A delta connection is always preferable for a motor installation for if one transformer of a three-phase delta should fail the two remaining transformers can carry full load on the motor for a short period and 58 per cent of the motor's rated load continuously. Furthermore each transformer in a delta primary and delta secondary has standard voltages should it be required to use them on the system for single phase supply. Thus for a 220-volt motor operated from a 2300 volt primary on delta connection of both secondary and primary, the transformer would have a 2300 volt primary and 220 volt secondary. The spare transformer for the motor service could thus be used on other parts of the system for three wire lighting service and the transformer thus be a standard interchangeable piece of apparatus. If a *Y-Y* connection were used in the three-phase bank, the transformer voltages would be 1330 volts primary and 127 volts secondary.

It may be well to mention here that large motor loads should never be supplied from the same secondary network as that used for lighting. The starting currents required by the motors cause a fluctuation in voltage which is very objectionable for lighting systems. In some cases the lights are fed from one phase of the secondary network while the three-phases supply the motors. The lighting load if large and supplied from one phase will cause an unbalancing of the three-phase voltages which will be objectionable in the operation of induction motors especially causing unbalanced currents with resultant overheating.

CONNECTION OF TRANSFORMERS.

Some primary distribution systems use three-phase, four-wire distribution with 4000 volts between phases which gives 2300 volts to the neutral with each phase. In this case the transformers for motor supply can be Y connected on the primary side using standard 2300 volt transformers. These have the disadvantage of a Y connection which is that the loss of one transformer would render the combination inoperative and cause a shut down until a transformer could be replaced. However, if the primaries were connected in Y using the neutral and the secondaries in delta, the advantages of the delta connection results and if one transformer fails the motor supply can be fed from the open delta until the third transformer can be replaced.

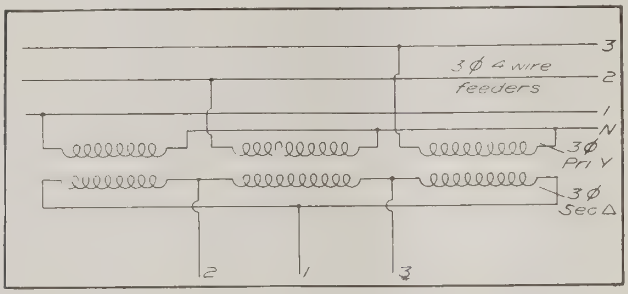


FIG. 1. CONNECTIONS OF TRANSFORMERS WITH Y PRIMARY AND DELTA SECONDARY ON 3-PHASE, 4-WIRE SYSTEM.

Line volts equals E primary. Transformer primary voltage equals E divided by 1.73. Secondary voltage of transformer equals secondary line voltage. For 4,000-volt primary feeders with neutral voltage between feeder and neutral equals 2,300 volts. Secondary delta voltage equals the voltage of individual secondaries. Primary winding of transformers 2,300 volts. For single-phase lighting, individual net-works can be fed from standard 2,300-volt transformers connected between line and neutral. The neutral wire can take up unbalancing. For a three-phase bank or combination, failure of one transformer leaves the remaining two operating in V if the neutral is brought out from the generator.

For lighting, the primaries are fed from each phase using the neutral. Thus standard transformers can be used throughout for this system. In any case each transformer of a bank of three used in three-phase transformations must have a rating equal to one-third of the power to be delivered. This arrangement is shown in Fig. 1.

DELTA—DELTA AND OPEN DELTA TRANSFORMER CONNECTIONS.

As already mentioned when using three transformers connected delta on the primary and delta on the secondary, if one transformer should fail the remaining two will operate but cannot deliver the same load that was delivered by the original three. In the original delta, the current per transformer was 1.0 and the current per line 1.73. With the open delta or V connection, if the line current or power is to remain the same, the line current is 1.73 and the transformer current is 1.73. Thus the copper loss of each transformer which varies as

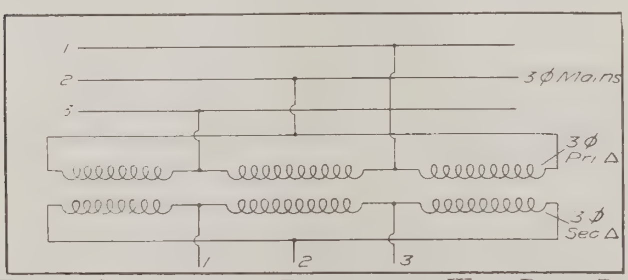


FIG. 2. CONNECTIONS OF TRANSFORMERS WITH DELTA PRIMARY AND DELTA SECONDARY ON 3-PHASE, 3-WIRE SYSTEM.

Line volts equals E. Transformer primary voltage equals E. Secondary voltage of transformers equals secondary line voltage required. If one transformer is injured, the remaining two will opeate in V or open delta connection with 58 per cent of the output of the three.

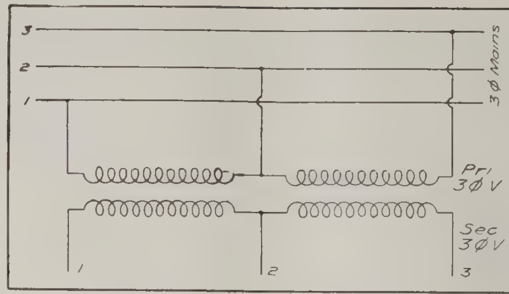


FIG. 3. CONNECTIONS FOR 3-PHASE V OR OPEN DELTA ARRANGEMENT OF TWO TRANSFORMERS.

Line volts equal E. Primary transformer volts equal E. Secondary transformer volts equals voltage of secondary mains.

the square of the current now equals 3.0 against a value of 1.0 in the original delta combination of three transformers. Aside from the copper losses of the two now being twice the copper loss of the three original transformers, the heating would be destructive. The open delta or V combination could operate with the same current in each transformer as in the original delta. However, in the original delta the power was (1.73 × E × I line). The transformer current was (I line ÷ 1.73). Now in order to keep the current in the transformer the same, the line current is reduced by the value (1 ÷ 1.73) since in the open delta, the line current is the same as the transformer current. The capacity of the combination is now (1 ÷ 1.73) times the capacity of the original delta or an open delta combination gives 58 per cent of the power of the three-phase delta using three transformers of the same rating. Thus in using two transformers instead of three we do not get ⅔ of the capacity or 66 per cent, but only 58 per cent of the original power capacity. This loss of capacity is one of the objections to using the V connection as an operative connection for three-phase transformation.

As seen above the current per transformer for a given power using a three-phase delta equals 1.0. If the same power is to be delivered by two transformers with an open delta connection, the current per transformer which is now the same as line current becomes 1.73. Thus the transformer rating single-phase is P = E × I. For the 3-phase delta connection in Fig. 2, each transformer's rating is E' × I with current = 1.0. Total capacity thus equals 3.0. For open delta, each transformer's rating is E' × I with current = 1.73. Total capacity = 3.46. The increase in capacity required therefore, for the open delta operation for a given power is 15.5 per cent above that re-

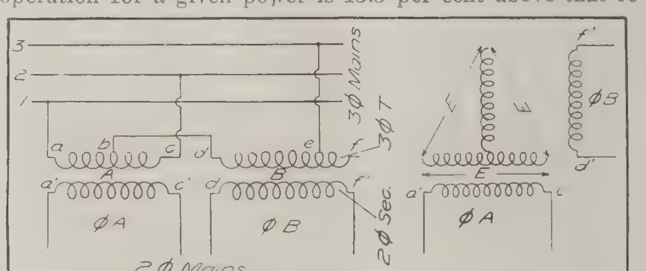


FIG. 4. CONNECTIONS FOR TRANSFORMATION FROM TWO-PHASE TO THREE-PHASE BY TWO TRANSFORMERS. VOLTAGE TRIANGLE OF 3-PHASE SHOWN AT RIGHT AND ALSO 2-PHASE RELATION OF SECONDARIES.

Three phase line volts equals E. Main winding (ac.) equals E Teaser winding (de) equals .865 E. ab equals bc equals .5 E. To be interchangeable. the winding of A must be the same as B for T connection. Secondary phases, (a' c') and (d' f') must be the same as the voltage required on the two phase mains.

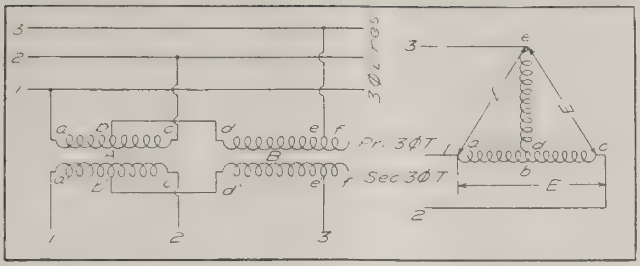


Fig. 5. Connections for 3-Phase T Arrangement of Two Transformers. Voltage Triangle for T Connection at Right.

A equals main transformer. B equals teaser transformer. Line volts equals E. Main transformer (ac) equals E. Teaser (de) equals .865 E. (ab) equals (dc) equals E/2. To be interchangeable A must be the same as B with taps for .865 E and .5 E. Primaries and secondaries have the same percentage of voltage taps. Two transformers required. In the voltage triangle for T connection, sides show voltages all equal. Teaser coil represented by perpendicular at middle of base equal to .865 E. Main transformer coil equals (base) equals E. Voltage triangle of secondary is the same as the primary. When desired a neutral can be brought out from the connecting point (bd).

quired for the 3-phase delta. While this is a very material reason for not using the open delta as a regular connection, the resultant unbalancing of secondary voltage with the *V* connection is the most objectionable feature.

T Connection of Transformers.

Since the increase in capacity required on the two transformers operated in *V* connection together with the unbalancing of voltages, render this method undesirable as a three-phase connection the *T* connection shown in Figs. 4 and 5 is most often used when only two transformers are desired. This *T* connection requires that each transformer have a lead brought out at the middle point of each winding and a lead at a point 86.6 per cent of the distance from one end of the winding to the other. Each transformer should be reversible, otherwise one transformer should have the half voltage tap from each winding while the other should have the 86.6 per cent tap. In making this connection (See Figs. 4 and 5) the 86.6 per cent tap of one transformer is connected to the 50 per cent tap of the same winding of the other transformer. If the 86 per cent winding is drawn in a vector diagram as a perpendicular at the middle point of the corresponding winding of the other transformer, it will be seen that the terminals as shown form an equilateral triangle with distances between points representing voltages and the triangle formed representing the phase relationship.

Referring to Fig. 5 it is seen that for a balanced three-phase transformation the transformer A has a rating E × I where I is the line current. The transformer with the 86.6 per cent tap will have a service rating of .866 E × I. The combined rating required for operation is 1.866 E I but if the transformers are to be interchangeable the capacity used to obtain the transformation is 2 E I. The T connection produces the transformation without appreciable phase distortion and has a balanced current and voltage. It also compares with the Y connection in giving a neutral point but requires that the transformers have special taps brought out.

In the next section of this article capacities of transformers for a given output will be discussed.

The Design of Steam Power Plants

(*Contributed Exclusively to* Electrical Engineering.)

BY EARL F. SCOTT, M. E., MEMBER A. S. M. E., MECHANICAL ENGINEER, ATLANTA, GA.

Section 5. Design of a Plant to Supply Lighting and Railway Service.

WITH this article the design of a new plant will be taken up. A lighting and a street railway load will be assumed and the design will be such as might be expected suitable for a small city of about 5,000 inhabitants, where 50 per cent of the houses are to be lighted. This assumption is further based on an average of five people to a family and that each house may be expected to have an average of 8 lights. Since the material to be presented in these articles is to be confined to the power house alone, this part of the work is assumed. Under actual conditions, however, the engineer would be required to make a study of the local conditions and from the data derived, work out his load curves.

With the above as an explanation, we will assume a load curve as follows:

Assumed lighting load curve:

7 A. M. to 6 P. M = 75 K. W.—Lights, elevators and small fans.

6 P. M. to 12 P. M. = 225 K. W.—Mainly lighting.

12 A. M. to 7 A. M. = 100 K. W.—Mainly Lighting.

Assumed railway load curve:

6 A. M. to 9 A. M. = 225 K. W.

9 A. M. to 12 M. = 175 K. W.

12 P. M. to 2 P. M. = 225 K. W.

2 P. M. to 5 P. M. = 200 K. W.

5 P. M. to 9 P. M. = 250 K. W.

9 P. M. to 12 A. M. = 150 K. W.

12 A. M. to 6 A. M. = 0 K. W.

Combination load curve:

6 A. M. to 9 A. M. = 225 Ry. + 75 Lts. = 300 K. W.
9 A. M. to 12 M. = 175 Ry. + 75 Lts. = 250 "
12 M. to 2 P. M. = 225 Ry. + 75 Lts. = 300 "
2 P. M. to 5 P. M. = 200 Ry. + 75 Lts. = 275 "
5 P. M. to 9 P. M. = 250 Ry. + 225 Lts. = 475 "
9 P. M. to 12 A. M. = 150 Ry. + 225 Lts = 375 "
12 A. M. to 6 A. M. = 0 Ry. + 100 Lts. = 100 "

Having thus determined the load curve, we may decide on the size units to install. From the hours of 6 A. M. to 5 P. M. we find the maximum load to be 300 K. W. composed mostly of a railway load, which necessarily will require direct current. We may serve this period to advantage therefore, with an engine direct connected to a direct current railway generator, and for the lighting load install a rotary converter, which would carry only 75 K. W. during this period.

From the hours of 5 P. M. to 6 A. M., we have a maximum load of 475 K. W. and a minimum load of 100 K. W. We may serve this load with a 400 K. W. machine, preferably an alternating current machine as the maximum load for the greater period of time is lights. Therefore we will have the combination of a 400 K. W. A. C. machine in connection with a rotary converter to serve the lighting load.

By a study of the load curve, we see that the maximum lighting load as well as the maximum railway load is about equal, that is 225 to 250, therefore, we will have to select a rotary converter of sufficient capacity to serve this load, when idle as a lighting unit running from the A. C. end. If we select the engine to serve the load only through the hours mentioned above, then we would not require more than 300 K. W. capacity, but if we arrange the units so that either may carry the load for the full 24 hours, then we would select an engine with not less than 400 K. W. capacity, which, with a 25 per cent overload for 2 hours, would carry the total plant load. Assume then that the above selections are made, and we will proceed now to see if these are the best selections.

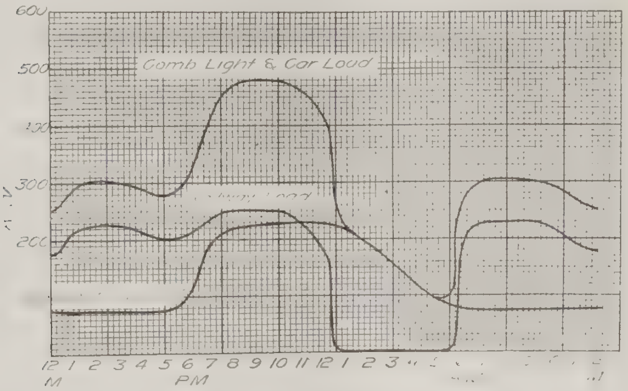


Fig. 3. Load Curve for Lighting and Railway Plant.

Each machine will not be loaded to its capacity but for a very short period, therefore, we may select a smaller unit in each case and depend on an overload for short periods, which would produce better efficiencies. From a study of the load curves, we find that it is possible to run a 300 K. W. A. C. machine to good advantage, full loaded during the whole period, while a 400 K. W. turbine would care for the overload from 6 P. M. to 12 P. M., but from 12 P.M. to 6 A.M. would be only partly loaded. During this last period we could use a small noncondensing engine to good advantage. We will now see if the difference between full load and running the turbine at such light load when compared to full load economies, will warrant purchasing the small unit.

On a 400 K. W. turbo-generator we may expect the following steam economies when running condensing: ¼ load 30 lbs.; ½ load 27 lbs.; ¾ load 24.6 lbs.; full load 22.5 lbs.; 1¼ load 23 lbs. To these values we will have to charge the cost of running the condensing machine as follows: ¼ load = 100 K. W. × 30 lbs. = 3,000 lbs. ½ load = 200 K. W. × 27 = 5,400 lbs., etc. The condenser will require about 60 times as much water as there is steam to be condensed, therefore at ¼ load we have 3,000 × 60 = 180,000 lbs. water per hour = 180,000 × .002 = 360 G. P. M. against a head of say 50 ft. (32 ft. due to vacuum on suction side of pump and 18 ft due to discharge including friction). Then this represents 360 × 8.33 × 50 = 150,000 ft. pounds per minute of work or 150,000 ÷ 33,000 = 4.6 brake horse power to run the condenser at this load. Assume the condenser pump to have an efficiency of 60 per cent and the turbine 85 per cent, then 4.6 ÷ (.6 × .85) = 9.00 I. H. P. Since the condenser turbine is only one quarter loaded necessarily it will use more steam per horse power say about 60 lbs. per I. H. P., then 9.00 × 60 = 540 lbs. steam per 100 K. W. or 5.4 lbs. per K. W. This amount must be added to the rate per K. W. in order to determine the total amount per K. W. at switch board. Thus we have 30 lbs. + 5.4 lbs. = 35.4 lbs. per K. W.

If our small noncondensing engine will show sufficiently better guarantees than this, to warrant our investing an additional amount for the engine, then it will pay to install the small unit, if not we will have to run the larger unit on the light load even tho it will be done at a loss.

We may expect the following from a 4-valve high speed engine running non condensing with a steam pressure of say 125 lbs. gauge pressure. At full load we should get about 22 lbs. per I. H. P. if we assume an engine at 90 per cent efficiency and generator at .85 per cent. Then 22 lbs. per I. H. P. is equal to [22 ÷ (.90 × 85) × 4/3] = 40.36 lbs. per K. W. at the switch board. Therefore we see that it is actually cheaper to run the 400 K. W. A. C. machine at ¼ load instead of going to the expense of installing a small unit which would cost between four and five thousand dollars installed.

With this settled we are now ready to decide just what machines we will require and prepare a specification for same. Going back to our load curve we find, as stated above, that a 400 K. W. A. C. turbo-generator and a 300 K. W. D. C. engine driven railway unit will best serve the requirements.

Since we will require 300 K. W. direct current at the switchboard we will require an engine as follows: Assume the generator to have an efficiency of 85 per cent, engine mechanical efficiency of 90 per cent. Then we will have (300/.85) × (4/3 × .90) = 526 I. H. P. For this size engine it would be best to select a compound engine of some type, and since the length of a tandem compound would require so much more room than a cross compound, it seems that the latter would be more desirable particularly in connection with a turbine unit. And for this size machine necessarily we would select a condensing type provided water conditions were favorable.

At this point it will be well to decide on the natural conditions which necessarily will exist. As we are not ready to discuss a cooling tower proposition, we will assume the plant site, or location, at a point where condensing water may be had in abundance. We next decide on what would not be called a natural condition, but one over which we have full control; that is the steam pressure and vacuum conditions. For a plant of this size and conditions, the writer believes steam at 150 lbs. gauge pressure without superheat and a vacuum on the turbine of say 27 in. at full load and 26 in. on the engine at full load about right.

It would be well to explain at this point why we would not specify the same vacuum for the engine as for the turbine, which condition can best be demonstrated by a diagram as follows:

From a study of the card taken from the low pressure cylinder as in Fig. 4, we see at the end of the stroke where we would begin to get the greatest advantage from high vacuum, the stroke has terminated and the piston started on the return, and the only gain we could secure from the additional vacuum say from 26 to 27 is shown in the upper area A C B, made by the expansion under the two conditions, and the small shaded area in the lower part of the card. If we think of the turbine as an engine with a very long cylinder, which is true as far as expansion goes, then we see from the diagram, the additional area that would be added to our card with the turbine. If we could imagine a perfect vacuum, absolute zero and a turbine that could expand down to this point, then our expansion curve A B would continue to infinity and become tangant to the absolute zero line at infinity. This of course is impossible from a mechanical point of view but is thrown in at this point to show the possibilities of the vacuum. The mechanical limitations of the reciprocating engine prevent us from tak-

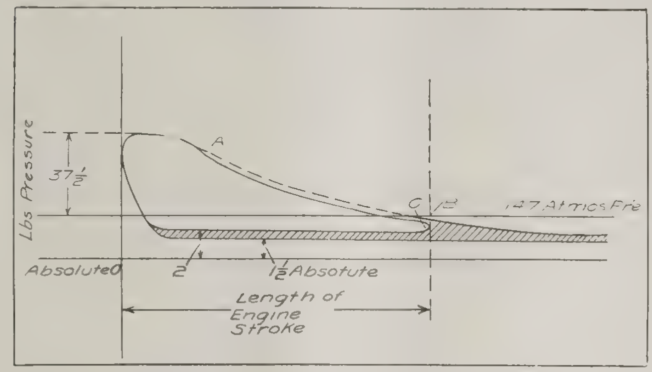


FIG. 4. DIAGRAM SHOWING COMPARISON OF ENGINE AND TURBINE EXPANSION OF STEAM.

ing advantage of this vacuum, from several angles, for instance: we see from the diagram that the piston starts on its return stroke just at the point of gain; second, very low vacuum temperatures cause cylinders to cool down, causing condensation when the fresh steam enters; third, it is extremely hard to keep stuffing boxes tight on reciprocating parts with high vacuum; fourth, it adds more expensive machinery, in first cost, and for operation where high vacuum is required, and the very small gain as shown on the diagram would not warrant it. In the turbine the conditions are all in favor of the high vacuum, for instance the expansions can be so arranged that it is equivalent to an engine with a stroke several feet in length, the stuffingboxes are easily kept tight as there are no pistons passing back and forth, and the cooling effect can be cared for easily. On account of the objections mentioned against high vacuum in engines, the writer believes that 26 in. as a maximum should be the limit in an engine and 25 in. will produce good results.

With this explanation we will decide on 26-in. vacuum for an engine unit We are now ready for a specification covering the two units. The turbine unit will be very similar to the previous specification in Section 1, but we will repeat it as there will be slight changes.

TURBINE SPECIFICATION.

There shall be furnished and delivered on foundations furnished by owners, one four hundred (400) K. W. normal rating turbo-generator—The generator shall be designed for 3-phase, 60 cycles, 2300 volts alternating current, and 80 per cent power factor. The turbine speed shall be 3600 R. P. M. The generator shall be capable of carrying a 25 per cent overload for 2 hours without undue heating.

The steam turbine shall be of horizontal pattern, either impulse or reaction type, designed to deliver the normal rated capacity of 400 K. W. at the switchboard, and with a 25 per cent overload capacity, under the following conditions: 150 lbs. steam pressure (gauge) at the throttle, no superheat, and 27-in vacuum beneath turbine Mercury column. (Barometer 30-in.). The turbine shall be fitted with governor that will control within 3 per cent speed, equipped with the necessary piping for oil and water for glands.

The manufacturer shall furnish a detail specification showing the full characteristics of the machine giving the steam consumption on the following loads per K. W.: ½, ¾, Full, 1¼, also show the mechanical efficiency of the machine. The machine shall be designed to furnish ¾ of its normal rated capacity when operating noncondensing (atmospheric pressure) and the consumption per K. W. for ¾ load shall be given. After contract is signed the manufacturer must furnish a detail working drawing of the machine proposed.

ENGINE SPECIFICATION.

The engine specification will be as follows: There shall be furnished one cross-compound condensing engine, direct connected to one 300 K. W. direct current generator. The piston speed of engine shall not exceed 700 ft. per minute. The engine shall develop sufficient power to deliver 300 K. W. at the switchboard under the following conditions: 150 lbs. saturated steam pressure at throttle and 26-in vacuum at point near low pressure cylinder of engine (30-in bar).

A detailed specification shall be furnished with the proposal giving in full every detail of importance regarding the engine, including bearing sizes, pin sizes, wearing surfaces, weights, etc. The steam rate per I. H. P. (indicated horse power) or economy of the engine shall be given for ½, ¾, full and 1¼ loads, based on corrected dry steam at throttle.

ROTARY CONVERTERS.

There shall be furnished two (2) rotary converters designed for 200 K. W. output at the switchboard. The machines shall be designed to start from either the A. C. or D. C. end, and shall have a 25 per cent overload capacity for 30 minutes without undue heating.

EXCITERS.

The exciters shall be furnished, one motor driven and one turbine driven exciter set. Each machine shall be large enough to excite the 400 K. W. A. C. generator. The motor driven set shall be driven by an induction motor and the steam driven machine by a non-condensing steam turbine.

We will next select the boilers. In order to determine the total size required, and the sizes of each unit best suited for the requirements, we will have to study the conditions. For instance the maximum capacity will be when the turbine is running at full load, or possibly on the peak loads, but this additional capacity may be cared for by the over capacity of the boilers, therefore we will take the normal rating of the machines as a basis, as follows:

400 K. W. at 22 lbs. per K. W. = 8800 lbs. of steam per hour. Add 10 per cent for the auxiliaries, we have 9680 lbs., say 9700 lbs. per hour.

Then 9700 ÷ 30 = 325 boiler H. P..

Refering again to the load curve, we find the following loads expressed in pounds of water per hour or boiler horse power.

From	To	K. W.	Pounds Water	B.H.P.
12 M.	5 P. M.	300	6600	220
5 P. M.	12 P. M.	475	10450	348
12 P. M.	5 A. M.	100	2200	73
5 A. M.	12 M.	300	6600	220

From this tabulation we see that the minimum boiler requirements occur for five hours, our maximum capacity for five hours also, and an average of 220 B. H. P. for the remaining time. Therefore we see that units of 125 horse power will divide so that we may always have the boilers running at or near rated capacity. Since it will require 3 units of this size for the maximum load and we should have one for "spare," we will select four 125 H. P. boilers for the plant.

There is good argument against selecting boiler units as small as these, but if we assume that this plant will not increase beyond its present capacity, or rather if we make this plant complete within itself, then the selection from the load is correct, but does not care for a future growth at all.

In the event we had selected units of larger capacity they would be run under light load a great period of the time which is not good engineering. To design a plant anticipating a load we have not assumed, would not bring out the best points for discussion in these articles.

The only difference in a specification for this plant and the previous one would be regarding the quality of steam, *i. e.*, in the previous plant we had superheated steam, while in this plant we have saturated steam.

BOILER SPECIFICATION.

There shall be four 125 horse power boilers, based on 30 lbs. of water evaporated from water at 70 degrees temperature to steam at 100 lbs. pressure, or 34½ lbs. from and at 212 degrees temperature. Each boiler shall be designed for a working pressure of 150 lbs gauge working pressure, saturated steam.

Grate surface shall be proportioned to burn "run of mine" bituminous coal, to best advantage. The heating surface shall be based on 10 square feet per horse power.

The boilers shall be of the water tube type, each unit shall be fitted with the required safety valves, water columns, gauge cocks, blow off valves and 12-in gauge. There shall be furnished two sets of firing tools for the total installation.

The price of the boilers shall be based on the manufacturer erecting them on foundations furnished by the purchaser, all common labor being furnished by purchaser. The manufacturer shall furnish a superintendent o rinspector to supervise the brick setting which shall be furnished by the purchaser.

The successful bidder shall furnish within a reasonable time a full set of drawings accurate to dimensions, from which the plant may be laid out.

BOILER FEED PUMPS.

The seelction of the boiler feed pumps will be similar to that in the last design, therefore we will say but little about it. From the table already given we see that the maximum amount of water or steam is 10450 lbs per hour, which is $10450 \times .002 = 20.9$ G. P. M. Therefore we will require a pump to handle say 21 gallons of water per minute at a temperature of 210 degrees. The pump should be selected large so that it may handle water of this temperature without "racing." For this reason we will specify a pump, or pumps as the installation should be in duplicate, as follows:

There shall be two duplex piston pattern boiler feed pumps designed to operate against 150 lbs. steam pressure, each capable of delivering 21 gallons of hot water per minute when running at a piston speed not to exceed 30 feet per minute. Each pump shall be brass fitted, and have valves suitable for hot water. Valve area in each pump must be large enough to allow a velocity of not to exceed 250 ft. per minute.

FEED WATER HEATER.

Since a feed water heater serves as a reservoir from which the pump may draw (open type) and since the rating of heaters is more or less a comparative proposition, we will specify a heater large enough to give sufficient water even if the plant should be over loaded. Referring back we find that 348 boiler horse power is the maximum requirements therefore we will select a heater of 500 H. P. capacity.

We will then have a machine sufficiently large to prevent the water from running thru the filter space or over the trays at such a high velocity as to prevent the absorption of the heat by the water. Our heater specification would be as follows:

The heaters shall be of the open type, of 500 horse power capacity or capable of heating 15,000 lbs of water from 70 degrees F to within 2 degrees of the steam when furnished with a sufficient amount of exhaust steam. The heater shall be fitted with oil separator, filter bed, regulator valve, gauge glass and overflow valves. A detail sketch shall accompany each bid giving full details of the heater, showing principal dimensions, giving storage capacity, filter area, etc. The heater body shall be cast iron and principal parts such as trays, etc., shall be cast iron or other noncorrosive metal.

CONDENSERS.

The latest designs in condenser engineering leads us to believe that the low lift jet type of condenser fitted with modern centrifugal machinery such as circulating and air pumps, is by far the simplest and most efficient condenser for the high vacuums required in turbine practice. This class of machinery necessarily is more expensive than the old style barometric condenser, or high lift jet type, and when a moderate vacuum is required as in the engine installation where the elevated apparatus is to be desired. Therefore for the turbine installation we will select the former type, the same machine as used in our preceding design. For the engine installation we will use the elevated type.

SPECIFICATIONS FOR TURBINE CONDENSER.

The condenser shall be large enough to condense 8800 lbs. of steam per hour and maintain 27-in. vacuum (Bar 30-in.) beneath turbine when furnished with sufficient condensing water at 80 degrees initial temperature. The condenser shall be of the low lift jet type and so designed that it may be placed at a lower elevation than the turbine outlet. The condenser shall be fitted with a centrifugal circulating pump of sufficient capacity to pump the required amount of water needed to maintain the above vacuum, with the velocity of water thru pump not to exceed 10 ft. per second.

A rotary air pump shall be furnished of sufficient capacity to handle the air and non-condensible vapors from the steam under conditions mentioned above. The air and circulating pump shall be driven by a steam turbine if on the same shaft; if separate, the circulating pump shall be driven by a steam turbine and the air pump may be driven by a motor.

The total lift on condenser (from level of water to suction inlet) will not exceed 15 ft. Therefore the circulating pump shall be designed to be primed under these conditions and shall discharge against a head of four (4) ft.

ENGINE CONDENSER.

There shall be furnished one barometric condenser head of sufficient capacity to produce 26-in. vacuum beneath engine when condensing 6900 lbs. of steam per hour.

A centrifugal circulating pump shall be furnished sufficiently large to circulate water for the above conditions with the velocity thru pump not to exceed 10 ft. per sec. The suction lift on pump will be 12 ft. and the discharge head 34 ft. for starting.

In the pipe arrangement we will discuss how this pump may be designed as a low lift pump, in order to get the highest efficiency under running conditions. It requires a greater head to start the pump than will be required for operating, therefore, if we can arrange to get the pump started as a low lift pump the operating conditions will be much less than would be required if we depended on running the pump under less than full load. The reason for this is due to the fact that after the vacuum is started in the pipe the syphon effect relieves the pump of most of the head.

This effect may be produced by cutting in a bypass valve between the injection pipe from pump to condenser and the tail pipe. With this valve we may relieve the pump of the maximum head until we get a vacuum started in the system, then close the bypass valve and the vacuum in the tail pipe will pull the water over thru the condenser. After the syphon is started it relieves the pump of this work.

Since the same argument, with reference to the purchase of the machinery, holds in this design as in the previous one we will not take up this phase. Therefore our next article will discuss the arrangement of the plant and the pipe design. Since our conditions have been changed we will have an entirely different pipe specification from the former plant.

In order to bring out the many different designs, as we proceed with this series of articles, we will use in this particular plant a unit stack system, where each boiler has its own steel stack. This method eliminates the breeching and necessarily does away with the friction losses caused from such, and also naturally makes a much cheaper stack proposition. This is particularly true where light steel would be used in the small stack.

Where the possibilities of a plant were such that it would outgrow itself in ten years, say, this construction would be good, but on the whole the writer does not advocate this type of construction, as the only real advantage that can be offered in its favor is that the initial cost would be reduced, and possibly the expansion feature would be in its favor, but beyond these, there could be very little said. With these few remarks we will progress in our design and in the following article we will discuss the layout of the plant.

When a man is no good to himself or to anybody else, he usually becomes a pessimistic agitator.

The difference between independence and impudence is about the same as the difference between the real article and a poor imitation.

Conditions, Practice and Developments in English Central Stations

(*Contributed Exclusively to* Electrical Engineering).
BY CECIL TOONE, AN ENGLISH CONSULTING ENGINEER.

Section 5. Cables and Distributing Systems in England.

The general tendencies in the design and application of switchgear are much the same in all countries, hence this section will be devoted to a consideration of cables and distributing systems as used in England. It has already been explained that the general tendency in this country is to adopt large turbo-driven, three-phase generators supplying feeders at 3,000 to 30,000 volts. Transformers are installed in sub-stations whence large power consumers are supplied with 500 to 2,000 volts, 3-phase current from cellular panels provided with the necessary switchgear and meters. Smaller consumers are supplied in groups from high or low tension distributors and traction and d.c. power and lighting feeders are run from d.c. generators or from converters, (in the most modern stations), in the central station and main substations. The improving load factors of stations are reducing the importance of idle and magnetizing losses in a.c. systems and, though the overall efficiency of few stations in England exceeds 20 to 25 per cent, groups of turbo-alternators in the more important industrial areas operate at 40 to 50 per cent load factor.

At the present day, roughly 75 per cent of English stations supply d.c. alone, 20 per cent a.c. alone, and 10 per cent both d.c. and a.c. Many stations employ more than one distributing system so that the average number of systems per station is 1.3. Fifteen per cent of our stations adopt single-phase, 3 per cent two-phase and 6 per cent three-phase distribution. Three-wire circuits are generally employed, though two-wire distribution is adopted in at least 20 per cent of the total number of undertakings.

The increasing use of overhead lines is again referred to in connection with cheapened distribution, (see later paragraphs). At the present time, underground cables are far preponderant and are likely to remain so for many years to come. The methods of laying cables may be broadly classified under the headings: (1) Direct—armored or unarmored; (2) Pipe or conduit systems; (3) Solid systems. The types of cables used are, (1) Circular core—single, twin or triple; (2) Sector core—twin or triple; (3) Concentric—twin or triple. The insulating materials employed include rubber, bitumen, (or other plastic substitute for rubber), paper, (in conjunction with lead or bitumen sheathing), and jute or other fibrous material impregnated with bitumen or various oils.

The following data as to the type of cables and methods of laying adopted in this country are compiled from returns from 360 undertakings. The information obtainable is, in many cases, incomplete, but the general conclusions to be drawn from these figures are unmistakable. Direct laid cables and cables drawn into earthenware conduits are each employed in about 155 cases but the most popular is the solid system used in about 202 towns, (generally in conjunction with wood troughing). These three systems are used with various materials—such as earthenware, cast iron and wrought iron pipes or conduits and iron, wood, fiber and asphalt troughing—and most undertakings have two or three types of cables and systems of laying in use. Bare copper cables stretched tight in culverts are used in (roughly) a dozen cases, but are steadily being replaced by overhead or insulated mains.

The solid system of cable laying is considered antiquated in America, but electrically and mechanically it is excellent and it is certainly a very flexible system to lay. Its cost is medium, (see Table 1), and an armored cable laid solid in 1-inch wood troughing with a minimum surround of 1-inch of bitumen and thoroughly bonded armoring and joint boxes, is hard to beat. The difference in cost between earthenware and wood troughing is comparatively small as also is that between Trinidad bitumen and a good pitch. Many engineers prefer to use the better materials, but pitch-filled wood troughing has been in satisfactory operation for a number of years in many parts of the country and there is no doubt that the cheaper construction is preferable in a number of cases. In Glasgow, excellent results have been obtained with a mixture of pitch and 8 to 10 gallons of asphalt oil per ton of pitch. The low melting point of such a mixture is advantageous as reducing the risk of damage to bitumen sheathing during filling but, in exceptional cases, it may lead to trouble by leakage and creeping of the pitch in lengths of inclined or strained troughing. At Manchester some years ago, cables drawn-in in cast iron pipes gave so much trouble that they were relaid in asphalt and have since given most satisfactory results.

Direct laying of cables is cheap and flexible and is even more popular on the Continent than in this country. For obvious reasons, cables laid direct should be armored and further protected by a strip of tarred wood or steel laid over the cable before filling in. The cable itself is laid in puddled clay or sand. It is worth while providing a well impregnated outer fibrous covering as this greatly protects the armoring.

Table 1 shows direct laying to be cheaper than the solid system, but in important mains the provision of a wrapping between lead and armor and of a thoroughly reliable

Table 1. Approximate Costs per Mile for Laying 3-Wire Cable by Various Methods.

System.	Street Boxes.	Trough or Pipe, etc.	Laying.	Total.*
Armored direct; wood guard board....	$ 72	$ 120	$ 96	$3720
Solid in wood troughing................	48	888	72	4000
Solid in asphalt.........................	48	935	72	4060
Drawn in—				
1-4″ earthenware pipe................	312	480	144	3950
1-4″ C. I. pipe	312	1220	144	4680
3 way 2″ earthenware pipe............	312	1060	144	4520
3-2″ w. i. pipes	312	624	144	4080
3-2″ earthenware pipes	312	845	144	4300
3-2″ fiber pipes in concrete...........	312	1160	144	4620

*Including $2160 per mile for cable and $435 per mile for armoring (case 1) and $850 for excavation.

waterproof and insulating cover over the armor makes the total cost of 5 to 10 per cent higher than that of the equivalent lead-sheathed cable laid solid. It is to be remembered, however, that the armored cable is *completed* by a highly skilled staff, whereas, the results obtained in service from any other system depend on the excellence of the laying processes —which are conducted by less skilled men and under less close supervision than are available in cable works.

Conduit systems enable the substitution of one cable for another or the laying of additional cables with minimum trouble, but are costly and inflexible to install and often involve great expenditure of time and trouble in effecting repairs. The life of the cable is certainly not extended by this system, as compared with the solid system, and the current capacity is considerably reduced in the case of a number of large cables laid in one nest of ducts. The conduit system also tends to confine feeders and distributors to a number of main routes irrespective of the best layout for security and economy of supply.

Where the conduit system is employed in this country, earthenware ducts are almost exclusively adopted. In 15 to 20 per cent of the total number of cases cast iron, and in about 6 per cent of the cases wrought iron pipes are used. The riveted sheet iron, cement-lined construction, considerably used in the States, is practically unused in this country. Cement blocks and reinforced steel constructions, (built *in situ*), have been used to a limited extent, but they are costly, cumbersome and tedious to install. The Brooke semi-solid system, using screwed wrought iron tubes filled in with a viscous oil liquid at 300° F. is employed in a few towns. If properly installed, the system is electrically satisfactory, but it is messy in practice. At Worcester the system has been in use on one route for many years past.

Callender's cables are most used in England, the British Insulated and Helsby make being the next most used. It is impracticable to obtain accurate statistics as to the various types in use in various undertakings and much less feasible to estimate the lengths of each in service. The immense popularity of the lead-sheathed, paper-insulated cable with or without steel armoring need hardly be mentioned, nor the extent to which vulcanized bitumen is now employed as a homogeneous waterproof insulating material, (as a substitute for rubber). Table 2 compares the size and cost of

TABLE 2. COMPARING SIZE AND COST OF VARIOUS TYPES OF CABLES.

Type		Copper Section. Sq. Ins.	Thickness Dielectric Ins.	Overall Diam. Ins.	$ per 1000 yds.
Single Condr. up to 660 v.	Class A		.13	2.0	5000
	B		.24	2.05	4900
	C	1.00	.13	2.16	5300
	D		.24	2.62	5600
	E		.24	2.59	6400
Twin cable (660 v.)	A		.11	2.65	5800
	F	0.5	.11	3.00	5320
Double Concentric 660 v.	A		.13	2.8	9780
	F	1.0	.13	3.1	9250
2200 v.	Aa		.14	1.85	3130
	Fa	0.25	.14	2.12	2900
Three core (660v.)	A		.11	2.82	8000
	C		.11	3.26	8550
	Da	0.5	.11	3.65	8300
	Ea		.11	3.62	9450
Triple Concentric (660 v.)	A	Inner and middle	.10	2.46	6580
	C	0.5	.10	2.90	7040
	F	Outer, 0.25	.10	2.73	6080

A = impregnated paper or jute; lead sheathed; impregnated jute yarn or braid taping. B = Yarn or paper separator on cable; vulc. bitumen; bitumen taped; impreg. jute yarn. C = paper or jute; lead; yarn; armor tape; jute yarn. D = yarn or paper separator; vulc. bitumen and bitumen tape; yarn; armor wires; yarn. E = Ditto but with lock coil armoring. F = Paper or jute; v. b. sheathing; bitumen tapes; yarn; impreg. braiding. Aa, Fa = A, F without alternative or jute in place of paper. Da = paper or jute; v. b. sheathing; bitumen tapes; yarn; armor wires; yarn. Ea = Ditto but with lock coil armoring.

various grades of cables employing various insulating materials and various systems of mechanical protection. Vulcanized bitumen insulation invariably makes a large cable but, in some cases, considerably reduces the cost; there is danger on overload of the conductors in a V. B. cable becoming decentralized and short-circuited.

Fibrous insulating materials, such as manilla paper, jute or cotton, impregnated with resin, resin oils or a compound of similar nature, and sheathed with lead or bitumen are cheap and serviceable. Their high dielectric strength and low specific capacity make them very suitable for high tension work and a high insulation resistance can be simultaneously secured by suitable impregnation. In addition to its high insulating resistance, paper possesses the ad-

TABLE 3. CAPITAL INVESTED IN CABLES, MAINS AND SERVICES. (AVERAGE DATA).

					Total Capital Expenditure.		Capital Expenditure on Cables.		
Kw. Station Generator Capacity.	Kw. Average Generator Capacity.	Sq. Miles Supply Area.	No. Consumers per Station.	Kw. Connected Load per Station.	1000's Total.	$ per Kw.	$ per Kw. Plant Capacity.	Per Cent of Total Capital Expenditures.	Miles of Cables per Station.*
0- 100	53	9	120	127	39	733	215	29.4	3-5
100- 250	163	2.5	230	310	107	650	245	37.3	9.0
250- 500	361	7	380	620	150	417	139	33.5	13
500- 1000	688	7.5	620	1150	270	394	139	35.5	22
1000- 2500	1682	6.5	1100	3500	534	316	109	34.4	41
2500- 5000	3445	9.0	2000	5600	1140	331	123	36.7	63
5000- 7500	6127	9.1	2260	9140	1400	229	86	37.4	107
7500-10000	8847	8.1	2400	10600	1810	216	64	31.2	80
10000-15000	11575	11.8	4200	16300	3820	331	85	25.8	150
15000-20000	16737	19.0	9100	23500	7470	445	172	38.7	150

*Limited data available.

vantage of not fraying like jute when it is cut. Its use provides a compact, serviceable and reasonably cheap cable, but one which must be carefully protected from the ingress of moisture.

Electrolytic corrosion is probably the most frequent cause of deterioration of lead cable sheaths in practice, and it is desirable to earth thoroughly the lead sheathing, (and armor if any), thus avoiding serious damage from stray currents and induced sheathing currents alike. Bitumen sheathing is immune from electrolysis and cannot become live through a fault, thus possibly causing arcing at a remote point. Armored cables are generally laid a few inches apart with brick or tiles between to prevent faults spreading.

The use of sector cores in multicore cables considerably reduces the cost and weight, and hence the cost of transport and laying, of the latter where low or medium supply pressures are concerned. The cost of manufacturing a sector core is only slightly greater than that of circular cores so that the former is apparently preferably up to very high working voltages. Actually, however, modern extra high tension cable construction penetrates far into the range of pressures where the circular core is the better. At very high working voltages, the thickness of insulation required rises much faster than the pressure; for instance, 40,000-volt cable needs, roughly, four times the thickness of insulation, which suffices for a 20,000-volt cable. Owing to the increased dielectric stress at the angles of the cores, a sector cable requires a greater thickness of insulation than a circular core cable for a given working pressure. For pressures up to 700 to 1,000 volts, sector cores offer real advantages, which are the greater the larger the percentage of copper section. The higher the working pressure and the smaller the copper area, the less favorable become sector cables and circular cores should certainly be used for high tension cables if the copper area per core is less than 35 square mm.

CAPITAL INVESTED IN CABLES AND LOSSES IN DISTRIBUTION.

Table 3 shows the average, actual and percentage capital outlay on cables, (including distributors and services), in groups of English electricity supply undertakings of various sizes. Few stations can show a lower expenditure than $60 per kw. on this item, while the proportional amount in small stations is from two to four times as great. Many of the largest undertakings now show very heavy expenditure on cables owing to the large amounts of energy distributed over considerable distances, sub-stations and consumers and owing to the large spare feeder capacity provided in a number of cases. This spare capacity will soon be called into service and the proportionate outlay on the cable system will then fall to a moderate value. The corresponding values of factors directly connected with the outlay on cables are also included in Table 3.

As to losses in distribution, all that can be done, in reviewing central stations as a whole, is to regard all units generated but not sold as being lost in distribution. Actually a considerable percentage of the difference between the output from the generator terminals and the input to the feeders, is required by the auxiliary machines attached to the generating equipment and should therefore be debited as generating losses. The true losses in distribution are those in transformers, batteries, switchgear, feeders and distributors, etc., but it is impossible to isolate these losses from the generating data published by supply stations. The ratio (units sold divided by units generated) is, however, closely related to the losses in distribution and, in the absence of a better criterion, its values for various groups of stations are given below:

LOSSES IN DISTRIBUTION IN CENTRAL STATION SYSTEMS.

Station Generator Capacity, Kws.	100 to 250	250 to 500	500 to 1000	1000 to 2500	2500 to 5000	5000 to 7500	7500 to 10000	10000 to 15000	15000 to 20000
Units Generated per Kw. per annum	1080	920	1140	1280	1340	1300	1180	1280	1140
Units Sold per Kw. per annum	750	720	920	1020	1100	1140	950	1070	830
Units Sold ÷ Units Generated	69.4	78.3	80.8	79.8	82.0	88.0	80.5	83.6	73.0
Difference (including Station Consumption; losses, meter errors, etc.)	30.6	21.7	19.2	20.2	18.0	12.0	19.5	16.4	27.0

These figures may be compared with some compiled many years ago, in the calculation of which, the actual mains input was compared with the units sold. (1) In d. c. undertakings with batteries, the percentage loss in distribution varied from 10 to 20 per cent and averaged 15 per cent. (2) In 7 a. c. undertakings with transformers, the distribution loss ranged from 10 to 40 per cent and averaged 25 per cent.

CHEAPENING DISTRIBUTION.

The generation and distribution of electrical energy is an industry which necessitates the locking up of huge amounts of capital and the latter is subject to comparatively rapid "wasting" by the depreciation and obsolescence of the equipment it provides. To improve the load factor of the supply station and thus increase the returns on the capital outlay, it is necessary to go into the by-ways and back waters of the supply area seeking every load which will justify the cost of its supply cable.

There are many classes of load, (particularly in poor class residential districts), which will hardly offer an adequate return on the capital cost of a standard distributing main and services and to meet such cases, many cheapened methods of distribution have been devised. Such methods, as applied to poor residential quarters, generally depend on the use of bare overhead supply mains and services or on the running of a common distributor through blocks of houses or tenements. In the supply of small or medium sized isolated power consumers, it is common to require a guarantee that the minimum annual payment shall cover the cost of laying and maintaining the supply mains, and unarmored, lead-sheathed cables laid direct are sometimes used for cheapness. In such classes of lighting or power demand, economical supply can frequently be effected through tramway trolley wires and the current density employed in the distributors is often pushed to very high limits. Lighting supply from traction distributors is unsatisfactory unless automatic regulators are employed. Bare overhead distributing mains are steadily becoming more popular in suburban and inter-urban districts but they are unsuitable for use in town areas and in industrial localities where the atmosphere is little more than a corrosive gas.

High current density may most safely be employed in small, single conductor lines and in overhead wires or paper-laid cables. Bitumen cables are soon damaged by overrunning. The load factor of the demand supply naturally determines the permissible current density. The higher the cost of current production the less profitable does it become to secure lighting loads at the cost of abnormal line loss.

Carrying a single distributor through a block of houses economizes service, cables and joints and places the latter under more favorable conditions. A less radical application of the same principle is the supply of two houses by a single service. In a number of cases, master meters have been installed on services, supplying a number of consumers who are then supplied at a certain fixed charge per lamp. Surface wiring on cleats—so largely used on the Continent, is gradually finding favor in this country and forms the final link in the cheapened distribution chain.

Something more regarding the problem of reducing the cost of supplying small consumers will be said in the next section dealing with meters and supply tariffs.

Design and Operation of Direct Current Commutating Pole Machines.

(*Contributed Exclusively to* ELECTRICAL ENGINEERING)

BY FRANK E. FISHER, E. E.

A Discussion of Operating Principles and Brush Adjustments for Commutating Pole Machines.

ECONOMY of floor space, increased efficiency, perfect commutation under all conditions of load and speed, large ranges in speed, close speed regulation in the case of a motor and close voltage regulation in the case of a generator, are some of the reasons for the development of commutating pole machines. Different companies use different names for this type of machine, one company calling them interpoles because they are placed between the main poles, another calling them regulating poles because they regulate speed or voltage, another company calling them commutating poles because they assure perfect communication. This latter is perhaps the most applicable name since the presence of perfect commutation is the most desirable feature of all.

The general arrangement of a four-pole commutating pole machine is shown in Fig. 1, where it will be noted that the commutating pole pieces are placed midway between the main poles. They have a narrow face and a winding of sufficient cross section to carry the full load current of the machine. The main pole windings are arranged and connected in the same manner as in a machine not equipped with commutating poles. The commutating pole winding is connected in series with the armature and bears definite relation to it. When the connection between armature and commutating pole winding is once determined this should never be altered.

A machine without commutating poles can be reversed by moving the rocker ring a full pole pitch which reverses the armature with respect to the main field winding. In the instance of a commutating pole machine this must never be done, for in so doing the correct polarity relation between the commutating pole and the armature is destroyed. Figs. 1 and 2 show the correct relation of the commutating poles with respect to the main pole pieces. The main pole and the commutating pole following in the direction of rotation should be of the same polarity in the case of a motor and of opposite polarity in the case of a generator.

Now in order to reverse the commutating pole machine, one of two methods should be used. Either reverse the field windings of the main poles, which may be either shunt, series or compound wound, or reverse the two connections, one of which goes to the armature and the other to the end of commutating pole winding. Often times the brushes are adjusted for one direction of rotation only. In the case of a machine of this kind when it is reversed, it may be necessary to shift the brushes a very slight amount in the direction of rotation, that is, give them a slight generator lead. By generator lead is meant moving the brushes in the direction of rotation.

The correct method of reversing a shunt wound commutating pole machine is shown in Fig. 5. A and B are the leads from the shunt field, and in the upper part of the diagram, B is connected to the line of a certain direction of

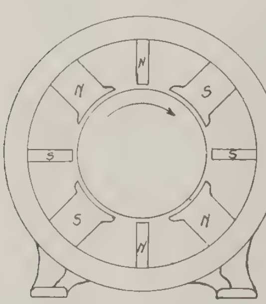


FIG. 1 MOTOR CLOCKWISE ROTATION

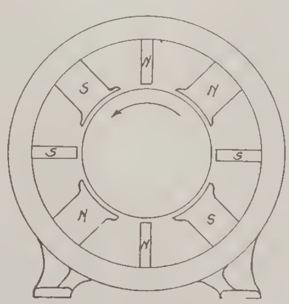


FIG. 2 MOTOR COUNTERCLOCK ROTATION

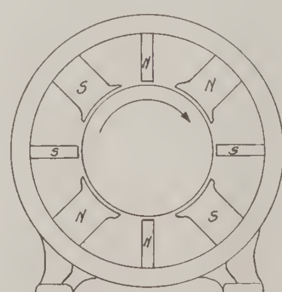


FIG. 3 GENERATOR CLOCKWISE ROTATION

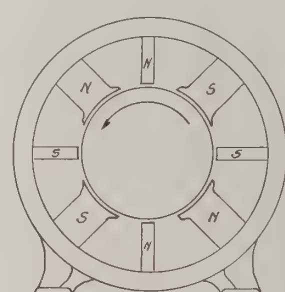


FIG. 4 GENERATOR COUNTERCLOCK ROTATION

FIG. 1. COMMUTATING POLE MOTOR—CLOCKWISE ROTATION. FIG. 2. COMMUTATING POLE MOTOR—COUNTER CLOCKWISE ROTATION.

FIG. 3. COMMUTATING POLE GENERATOR—CLOCKWISE ROTATION. FIG. 4. COMMUTATING POLE GENERATOR—COUNTER CLOCKWISE ROTATION.

rotation. To reverse the machine A is connected to the line and B is brought out as a terminal.

In the case of a generator, the polarity of the main poles with respect to commutating poles are just reversed, that is, the main pole and the commutating pole proceeding in the direction of rotation are of the same polarity. Figs. 3 and 4 show the correct polarity for clockwise and counter clockwise rotation when facing the commutator or front end of the machine.

The commutating pole winding is connected in series with the armature and has a number of turns per pole sufficient to give a magnetic strength that will not only counteract armature reaction, but will actually reverse the current in the coil when it is in the commutating zone. If we calculate the total number of ampere turns per pole on the armature, the number of ampere turns on the commutating pole should be about 20 per cent more than those on the armature.

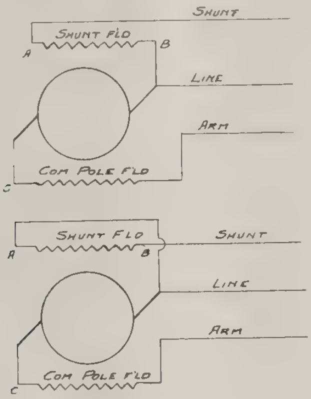


Fig. 5. Method of Reversing Shunt Wound Commutating Pole Machine.

For mechanical reasons in the case of machines carrying larger currents, it is often times impossible to obtain just the proper commutating pole strength in ampere turns. For instance, you cannot wind six turns per coil and get a suitable arrangement of connections, but you must have either 5½ or 6½ turns. If you use 5½ turns the strength of the commutating pole will be too weak and the effects will be similar to that of a machine not equipped with commutating poles. If you use 6½ turns on the commutating poles, its magnetic strength will be too great and in the case of a motor you may have racing or surging, and in the case of a generator a heavy over-compounding. To take care of this mechanical difficulty, a shunt is connected to the terminals of the commutating winding, which takes up part of the current, thus reducing the number of ampere turns, and as a result the magnetic strength to the proper value. This shunt is made up in a permanent form and is adjusted at the factory before the machine is shipped to the customer, being placed inside the machine or under the terminal boards as the case may be, and properly insulated from grounds.

By means of a double scale, low reading volt-meter having an approximate range of zero to 5 in each direction, or by means of a single scale volt-meter having a range from zero to 15, one can readily check the strength of a commutating pole winding. Attach to the terminals of the low scale of the volt-meter a pair of leads, the opposite end of which carries two pieces of German silver wire of approximately No. 15 gauge. These two ends should be separated at a small distance by a piece of insulating material, either wood or fiber, and the two leads should be tied together with tape or other insulating material forming what is known as a double pilot brush or explorer. If this explorer is placed on the commutator while machine is running and is moved back and forth along the surface of commutator the place of no voltage or the neutral point can be found. If the explorer is moved away from the neutral the volt-meter will read to the right, the amount increasing as it moves farther from the neutral point. If the explorer moves to the left the volt-meter reads in the opposite direction.

On a motor equipped with commutating poles there will be one no load neutral and the brushes on the machine should be set so that this comes approximately under the center of the brush. This is a different setting from that in the case of a machine not equipped with commutating poles, the full load neutral moves across the brush or is near the toe of the brush. The same effect occurs if the commutating pole winding is too weak. The position of neutrals having a weak commutating pole winding is shown in Fig. 6. The reverse occurs if the commutating pole winding is too strong. The neutral goes toward the heel of the brush or gives the brush a motor lead under full load conditions. If the commutating pole winding is just exactly the right strength the neutral will not move from full load to no load. This condition is illustrated in Fig. 6.

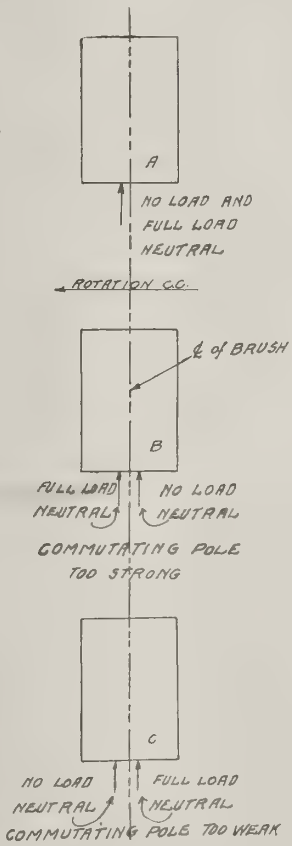


FIG 6

Fig. 6. Positions of Neutrals for Commutating Pole Winding.

It has been found that if the brush is given a very slight motor lead as indicated at *A* Fig. 6, the operation in general is improved. On account of counteracting effects, a commutating pole machine of this type can be built with much weaker fields than in the case of a machine not equipped with commutating poles. Taking advantage of this fact, the armatures are made with a large number of face conductors, as a result of which the dimensions of the magnetic circuit are reduced; thereby giving a small machine and one of light weight.

If the commutating poles are of the proper strength they keep the electrical neutral from shifting under load, the brushes having the same relative position at no load and full load. The no load or light load current is small, resulting in an increased efficiency. As an example, a machine without commutating pole, having a certain rating will have a weight of approximately 850 pounds and efficiencies at various loads as follows: 1/4 load 67 per cent; 1/2 load 78 per cent; 3/4 load 82 per cent; full load 83 per cent; 1 1/2 load 83 per cent.

A commutating pole machine for the same rating will weigh approximately 735 pounds and have efficiencies as follows: 1/4 load 75 per cent; 1/2 load 81 per cent; 3/4 load 84 per cent; full load 85 per cent; 1 1/4 load 84.8 per cent. It will be noted that the efficiency of the commutating pole machine holds up considerably better on the light loads which is due to the fact that a large part of the losses on the commutating pole type are copper losses.

Taking advantage of the fact that commutating pole machines can run on weak fields, large ranges in speed can be obtained, and we have what are known as adjustable speed motors. The machine is designed with a very strong field when running at slow speed and resistance is inserted in the field, thereby weakening its strength and causing the speed of the motor to increase.

If the value of the field is reduced until the number of ampere turns on the main field is approximately one-half of that of the armature ampere-turns, successful operation may be expected. If, however, under these conditions the commutating pole winding is a little too strong, "racing" may be encountered. By "racing" is meant surging of the speed back and forth from low to a high speed, and a large increase in the current consumption at every surge.

A large motor lead on the brush when in a weak field condition will often cause the same effect as too strong a commutating pole. The first thing to do, therefore, with a machine that races at weak field is to move the brushes a slight amount in the direction of rotation, as it may be assumed that the commutating pole has been properly adjusted at the factory. If this fails to correct the racing trouble, a small shunt may be put across the terminals of the commutating pole. If the shunt is too large, that is, if it shunts out too much current from the commutating pole, the brushes will spark badly. If it shunts out too little current the racing effect will still be noticeable. The speed regulation of a commutating pole motor can be made very close, that is, a full load speed of a certain machine having a speed range of from 400 to 1600 may be 1600 rpm at full load and 1632 rpm at no load, or a change in speed only 2 per cent from no load to full load. As a matter of fact this can often times be made "flat," that is, 1600 rpm full load and 1600 rpm no load, but under these conditions unless the machine is large so that the field strength is large in proportion to the armature, the machine is liable to be unstable, or will race. Some machines may, however, have a rising characteristic, that is, the speed may rise as the load comes on giving us a full load speed 1600 no load speed of 1680, and still have no racing effect. This is probably due to brush setting, a strong field and a commutating pole winding that is slightly weak. In the case of a generator a commutating pole winding that is too strong will give an over-compounding effect. If designed especially for voltage regulation, a shunt wound commutating pole machine can be made to operate almost exactly as a compound wound generator, not equipped with commutating poles.

Commutating pole machines are very sensitive to the following adjustments:

(a) The armature must be in the center of the magnetic field. On engine type machines where the air gap is large, a displacement of 1/32-inch may put a strain on the shaft and bearings equal to approximately the weight of the armature. This de-centering of the armature will cause an unbalanced magnetic circuit, and may produce bad commutation, poor speed regulation, or a large falling off in voltage under load.

(b) Brush Spacing. It is absolutely necessary that the brushes on a commutating pole machine be equal around the periphery of the commutator. In the case of a four-pole machine brush spacing can be very easily checked by placing a strip of paper around the commutator and dividing it into four equal parts. The toe of each brush should come exactly on this mark. A brush which is 1/32-inch out of space will cause very bad effects on the commutation or regulation of the machine. Sometimes sparking will occur at this one brush or at different brushes.

(c) Brush Setting. A commutating pole machine is very sensitive to brush position. In the case of an adjustable speed motor, for a range in speed of about 4 to 1, a movement of the brushes 1/32-inch in the direction to give motor lead may cause the machine to race. It will certainly cause it to increase in speed by a larger amount than is ordinarily expected. For instance, in the case of a 10 horsepower motor running from 400 to 1600 rpm, 1/32-inch increase in motor lead causes the full field speed to raise from 400 to 405, while at the high speed, the increase in speed is much greater. With the same field strength, the speed raises from 1600 to 1750, and the machine is not stable.

(d) Brush Fit. Brushes on commutating pole machines should be sanded in carefully, and be sure that they fit the commutator surface entirely across the face. Never use emery paper on a commutator or on brushes. The sand paper should be drawn in the direction of rotation and a pressure should be exerted on the brush with the hand until approximate fit is obtained. Two or three finishing strokes of the sand paper should be given with no pressure other than the normal brush tension, care being taken to keep the sand paper close to the surface of the commutator.

(e) Pole Space. Main pole pieces and commutating pole pieces should be very carefully spaced around the periphery of the commutator. A twisted pole or a pole that is 1/16-inch out of mechanical space will cause bad commutation or cause heating.

(f) Too Light Brush Tension. A good value of the tension on a brush is about 1 1/4 to 1 1/2 pounds per square inch, that is, on a brush one inch square, a spring balance should record about 1 1/4 pounds, while under a brush having cross section of 1 x 1/2-inch the balance should record one-half of this amount, or about 10 ounces.

(g) Brush Binding in the Holder. Sometimes the wrong grade of brush or an overload will cause the composition of the brushes to be impaired and some of the binder will come out of the brush and cause it to stick in the holder. Such cases should be carefully investigated and the brush cleaned and ground off slightly on the side if it is found that it is simply a swelling of the brush and not a loosening of the binder.

(h) Dirty Commutator. This may be due to the binder in the brush or the grade of the brush being such that the brush is picking up copper and that it does not fit the commutator properly.

(i) Rough Commutator. This can be noted by holding a pencil on the brush while machine is running. If slightly rough use a piece of coarse sandpaper and a block of wood to smooth it up. If this does not correct the roughness use a piece of sand stone. As a last resort take the armature out of the frame and take a light cut over the commutator with a fine feed, using a diamond point tool and running at such a speed that the copper does not drag over from bar to bar. Finish commutator surface with sand paper, being sure it is running true in the lathe so that the commutator will not run eccentric when turning in its own bearings. Never use emery paper.

(j) High Mica. Often times the mica between the bars of a commutator will be hard or have hard spots in it so that it does not wear away even with the copper. Sometimes this can be reduced by sanding. On a high speed machine it is often advisable to undercut the mica between the bars about 1/64-inch. The space formed by the under cutting should be cleaned out frequently.

(k) Broken Commutating Pole Shunt. If for any reason the shunt to a commutating pole winding is broken or short circuited a motor may race or a generator may be compounded more than the specified amount.

(l) Grounds in the armature, commutating pole, or main pole winding may produce bad commutation. Grounds can be located in the usual way by means of a lamp or magneto by trying each circuit out separately.

Until recently no one would have thought of building a 125 horsepower motor for a range of speed of from 600 to 1800. Yet such a motor has been built and is in successful operation in a pump factory operating at various speeds for testing pumps. This particular machine has a very close speed regulation for a speed of 1800 rpm with a 125 horsepower load and a no load speed of 1810 rpm. The customer desired this very close speed regulation and on account of the nature of work would not require a reversible motor. When the machine is operating in the reverse direction the brushes have to be moved about a bar and one-half on the commutator in direction of rotation. In order to obtain this close speed regulation and to prevent machine from racing, the machine is designed with a slightly strong commutating pole winding and it is understood from the customer that it will never be loaded beyond 135 horsepower at weak field, which corresponds to a speed of 1800.

Ratings of 10 horsepower, 600 to 2400 rpm; 40 horsepower 500 to 1500 rpm; 50 horsepower 500 to 1000 rpm; 100 horsepower 500 to 1000 rpm, etc., are now quite common.

Another field for commutating pole motors is that of high speed machines having no variation in speed, such as motors for driving centrifugal pumps, turbine blowers, etc. Machines running at 100 horsepower 1800 rpm; 75 horsepower 3000 rpm; 10 horsepower 4000 rpm; 15 horsepower 3500 rpm, to 4000 rpm, etc., are not exceptional cases, but are quite frequently found at present. In these machines the iron losses or the losses in the armature due to hysterisis and eddy currents are the losses that give the most trouble. The fact that a commutating pole machine can work on a very weak field, thereby reducing the magnetism that must go through the armature, affords an advantage that is obvious. Another field for this type of machine is elevator work. An elevator motor is subject to very sudden and severe overloads. If the commutating pole winding is properly proportioned in design, it is almost impossible to make the machine commutate badly. Often times elevator motors are thrown directly on the line and the controllers are set to operate very rapidly, producing a large inrush of initial current, which on an ordinary machine would cause vicious sparking. The writer has thrown a 10 horsepower 1000 rpm shunt wound machine equipped with commutating pole windings directly on a 500 volt line. The initial inrush of current was equivalent to 40 horsepower and there was no sign of sparking or evidence of distress of any kind in the motor.

Along this same line this type of machine is used for crane and hoist work where the load is sometimes sufficient to stall the machines.

Commutating poles are used to great advantage in the case of turbo-generators. The high speeds that are necessary to produce the great economy claimed by turbine manufacturers has made the problem of direct current turbo-generators very difficult. The high speeds causing the commutator to run out of true have made necessary the addition of steel shrink rings. The high frequency of commutation and the resultant high reaction voltage makes commutation very difficult.

As the commutating pole machine has practically solved commutating troubles and mechanical difficulties have been greatly overcome, turbo-generators having a rating of 300 kilowatts at 1500 rpm are in successful operation. Three-wire types of turbo-generators having ratings of 35 kilowatt at 2500 and 25 kilowatt at 3500 rpm are now quite common.

Philadelphia to Install Large Tubo-Alternators.

President J. B. McCall of the Philadelphia Electric Company, has recently ordered two huge turbo-alternators to take care of the rapid increase in the business of his company. The capacity of the generators will be respectively 35,000 and 30,000 kilovolt-amperes. The largest unit has an equivalent capacity of 46,666 horsepower. The details of each of these turbines are approximately the same—length 65 feet and net weight 1,200,000 pounds (about 600 tons).

It is interesting to note that the total station capacity of the company ten years ago was not as great as the capacity of this largest machine. 35,000 kilowatts represents, roughly, the capacity sufficient to furnish service to a connected load of over a million lamps, which is a larger electrical demand than is found, at the present time, in all but a few of the largest cities in the country. The performance of these huge turbines will be viewed with a great deal of interest by the electrical industry throughout the country.

It will be necessary to construct a new generating station joining the present main generating station of the company located at Christian street and the Schuylkill River.

Inspections and Tests on Electrical Machinery

(*Contributed Exclusively to* Electrical Engineering).

BY HUGH T. WREAKS AND R. L. SHEARER, OF T. E. I. BUREAU.

Section 4. Tests on Induction Motors.

INDUCTION motor tests consist of excitation, impedance, torque, normal and overload heat runs. Both excitation and impedance are important tests on induction motors.

EXCITATION TEST.

After wiring the machine and ready to start the test, close all switches and with the exciter of the generator from which the motor receives its supply, bring voltage up slowly until the motor starts and reaches normal speed. The amperes and volts in the different phases should be read and any unbalancing discovered. The end-play of the motor should be inspected as a slight pressure against one side will change the friction load and give an incorrect value to the core loss. The motor should be run for some time before this test is made to reduce friction loss.

The speed of alternator from which motor receives its source of supply must be held constant during this test. Two wattmeters are used, the current leads and voltage leads being brought up to meters. In a three-phase motor, phase (1) would be connected on the current coil of wattmeter and the pressure (voltage) coil of wattmeter across (1) and (2). On the other wattmeter the current coil is on phase (3) and its pressure coil between (2) and (3). With both meters reading in a positive direction, open one of the phases containing the current coil of the wattmeter and observe the other wattmeter. If the needle drops below zero on the scale, the meter reads negative. If the needle drops to some value above zero the meter reads positive. Repeat this to determine the readings of the other wattmeter. About 125 per cent normal voltage should be used for the first reading. Volts, amperes, watts and speed of generator and motor should be read. The volts should then be decreased in steps so as to obtain about 25 readings down to 15 per cent of normal volts. Here the conditions are no longer stable. The wattmeter with a negative sign will read less than the other and become still less until it reaches zero, when the sign changes. When it becomes positive the current leads must be changed.

Two important points on an excitation curve are the watts at normal voltage and friction watts. These points determine the per cent core loss of the motor. Several readings, a few volts apart, should be taken on each side of normal voltage. In plotting the curve use volts as abscissa and the algebraic sum of watts as ordinates. As the lower points on the curve or friction readings are approached many readings should be taken.

IMPEDANCE TEST.

The rotor is blocked in a certain position, say mark (1). Switches are then closed and the impressed voltage increased gradually until normal amperes are obtained. Read volts and amperes on all phases, to be sure that no unbalancing occurs. Hol dthe same voltage as at position (1); and move rotor to a position (2) and read amperes. This is repeated for at least eight different positions. The rotor is then blocked at the position that gives average value of current. Amperes are then increased until at least 150 per cent normal amperes are obtained. Read amperes, volts and watts; about eight readings should be taken between zero and 150 per cent normal current. In plotting the curve use volts as abscissa, and amperes and the algebraic sum of watts as ordinates.

TORQUE TEST.

Torque is usually taken with a spring balance, a break lever being clamped around shaft or pulley. The size and length of lever used depends on the size of motor; that length is selected which will give a maximum reading at one-half the full capacity of the spring balance used. Let the point of attachment of spring balance to lever arm be *A*. Then the length of the lever arm is the distance from center of shaft to *A*. On the frame of the motor should be a mark *B*, and on the brake, just over the shaft a pointer *C*. The lever arm is then raised until *A* is the same distance from the floor as the center of the shaft of motor, and *C* is on mark *B*. If the weight of the lever arm is not sufficient to overcome the friction of the bearings and turn the rotor around until the end of the lever touches the floor, add a weight to lever arm below *A*, calling this weight X. Pull the spring balance up until *C* is on mark *B*, when a line from the center of shaft to *A* is parallel to the floor on which motor stands and the point *A*, which is the lower extremity of the spring balance makes an angle of 90 degrees with the center of the shaft. All readings should be taken with lever arm in this position. Raise the lever arm by pulling vertically on the spring balance till *C* passes the mark *B*, at the instant of passing take a reading of spring balance. Call this reading *X* plus *Y*. Let the lever be raised until the pointer is some distance beyond mark *B*. Then lower the spring balance and let the lever fall to the floor, reading the balance when *C* again passes the mark *B*. Call this reading X-Y. The lever arm should be moved slowly and three or four readings should be taken.

Now close line switches and increase the amperes to twice the normal and take readings as just described. Also read volts and amperes. Call *X* plus *Y* plus *Z* the reading obtained as *C* passes mark *B* as the lever goes up and that as it comes down with current released *X-Y* plus *Z*. Z represents the torque.

The torque at one foot radius at normal voltage equals normal voltage squared divided by volts read, times torque *Z* times length of lever arm.

Normal load heat run consists of running a motor at normal voltage and current until temperatures on the motor are constant, then shutting down and placing thermometers on the various parts of motor revolving parts, etc., so as to get the final temperatures. Overload heat run is the same as normal load heat run except that the current of motor is above normal and test is run usually for two hours before being shut down and temperatures are taken.

We have now covered the usual tests on A. C. and D. C. transmission machinery with the exception of transformers, which we will take up in a later article.

Convention of the Southeastern Section of N. E. L. A.

On Thursday morning, August 14, a large delegation of Southern central station men assembled at Macon, Ga., and formally opened the first convention of the Southeastern Section of the N. E. L. A., organized last February. As already explained in detail in past issues of ELECTRICAL ENGINEERING, this section is an expansion of the old Georgia State Section, representing the central station interests of the states of North and South Carolina, Georgia, Florida and Alabama. Each of these states was well represented at the convention and telegrams from other members showed a special interest in the work, some being prevented from attending at the last minute and others hindered by some other good reason. As it was the attendance included nearly 200 members and guests, 150 of which number were employed by central stations or directly interested in the work. From the standpoint of actual work done, interest taken in the subjects discussed and attendance at the sessions, the meeting earned the name of a "working convention" and clearly showed that the organization now has a very bright future. Presided over as it was by President Deal, a vice-president of the National organization and honored by the presence of the National Secretary, Mr. T. C. Martin, the work of the first convention of the Southeastern Section, the largest territorial division of the parent body, was ushered into the pages of association history in no ordinary manner.

First Session—Technical.

The Thursday morning session was called to order at 10 o'clock and the members welcomed to the city by Judge Augustin Daly speaking for Mayor John T. Moore, of Macon. This address was followed by the address of the president, E. C. Deal, vice-president of the Augusta-Aiken Railway and Electric Corporation, an abstract of which is found elsewhere in this issue. Following this address the report of the membership and finance committee was presented by T. W. Peters, of Columbus, Ga. This report showed a section membership of 220 as follows: Class A 58; class B 134; class D 2; and class E 26. The finances were reported in excellent condition with a balance over the expenses of the convention of about $300.

President Deal's Address.

President Deal prefaced the remarks of his address by an appropriate review of the formation of the Georgia section and its expansion into the Southeastern section, covering the states of North and South Carolina, Georgia, Florida and Alabama, mentioning the fact that this territory is in many respects second to no other section of the country in the development of electrical business. He showed how consolidations, construction, reconstruction, and reorganization of new and old properties has been so rapid as to emphasize the necessity of an organization to aid in securing proper legislation and promote intelligent public policies.

The address was made up of a number of carefully framed constructive suggestions for the beneficial development of association work and the overcoming of duplication of effort in cases where member companies are also members of other organizations, mentioning the work of the national association. These suggestions included the appointment of a committee to take up the matter of determining the work of the Southeastern Section, special consideration being given to a possible section to handle electric railway affairs, perhaps working in conjunction with a proposed Southern Section of the American Electric Railway Association.

President Deal quoted a prediction of a president of the N. E. L. A. of 10 years ago, in which it was stated that the importance to be placed on commercial matters would in 5 years equal engineering considerations. He showed how this has in a large measure come true and the part played by the N. E. L. A. in furthering the cooperation of central stations and electrical manufacturing companies. He believes that affairs relating to matters of legislation, labor problems, rate making and public policy can be standardized through association work if the proper spirit of responsibility for the Southeastern Section progress is exhibited by all Southern companies. The benefits of association work, he pointed out, are much greater for the small than for the large company, and their affiliation should be encouraged for the upbuilding of the industry.

E. C. DEAL, RETIRING PRESIDENT OF SOUTHEASTERN SECTION, N. E. L. A.

The subject of legislation, President Deal discussed, showing how laws in one state, detrimental to the public and company, should interest companies in neighboring states. In this connection he referred to labor agitators, stating that often unfavorable legislation can be prevented through association efforts, an effort due the public, labor and member companies. Laws regarding commissions should likewise be considered and framed to conform to some standard fair both to the industry and the public. At this point he said: "For one state to grant only very limited term franchises under burdensome restrictions and another, possibly a neighboring state, to grant a perpetual franchise without restrictions; for one state to reserve the right to fix and change the rate of charge for service rendered and for another state to empower another municipality to make any rate it may see fit and to change same when and as it pleases, cannot but injuriously effect the stability of the industry from the standpoint of the investing public." A committee on legislation was Mr. Deal's suggestion, composed of a member from each state, to gather and disseminate data on legislative matters in the territory to the member companies. By a prompt refutation of unwarranted charges by newspapers, by voluntary publication of facts, by fair rates and by straightforward dealings, much unfavorable publicity can be avoided. In this regard President Deal suggested a newspaper committee to receive newspaper clippings from member companies of special interest to the industry or any member company, this information to be held available for reference.

In regard to municipal agitation, Mr. Deal called attention to the unsuccessful nature of most schemes, especially those backed by the so-called reformer.

On the subject of rates for light and power, mention was made of the gradual downward trend in spite of the fact that wages and cost of supplies to the companies are increasing. President Deal emphasized the necessity of a wise consideration of the effect of rate changes on neighboring companies. He recommended the appointment of a committee on rates to investigate new rate methods, gather data on rates in the South and make recommendations toward standardization of same.

In concluding his address, Mr. Deal emphasized the need of adopting a broad, liberal and cooperative policy in regard to the labor situation, a perplexing problem confronting the industry at all times. With a view to this end he recommended appointment of a committee on labor conditions to report at the next convention.

The first paper of the Thursday morning session on "Outdoor Transformers," by A. D. Fishel, of the Westinghouse Electric and Mfg. Co., was read by E. A. Thornwell, of the Atlanta office of the same company. An abstract follows:

OUT-DOOR TYPE TRANSFORMERS FOR LIGHT AND POWER DISTRIBUTION.

In a paper on this subject conditions and requirements of present day distribution systems were taken up and the characteristics of the types of transformers developed for this service. Safety, reliability of operation, high economy of operation and durability of distributing transformers were named as prime requisites, it being essential that types up to 22,000 volts now in the distribution class, be designed for the same service as formerly expected of the 2,200-volt class. Among other transformer characteristics that are given more attention at the present time, are the copper losses because of the higher average load factor on distributing systems, due to advanced central station engineering, as well as to the improved load factor caused by the rapid growth in heating appliances and motor driven devices in residence communities; the importance of low exciting currents in distributing transformers in determining the lower cost of distribution, better feeder regulation and permitting maintainance of higher feeder power factors; points of mechanical design and construction as for example, the obtaining of light weight transformers so built that they can be handled most economically and to best advantage by the linemen as well as impose minimum strain upon the poles.

The 2,200-volt class distributing transformers still form the major portion of outdoor transformer installations. In the general design of the single-phase transformer for this service some modifications have been incorporated into the distributed shell type of construction tending towards further development of characteristics. These improvements have been especially with regard to the materials and methods used in winding and insulating the coils. The insulation of this type consists of the insulation between turns and layers of the winding, between high and low tension windings and between windings and metallic parts of the transformer. The insulation between turns is relatively easy because the normal stress between turns is very low, usually not more than three or four volts. Care must be used to protect against abnormal electrical stresses as well as the mechanical stresses of winding, and as a result the insulation strength between turns is usually several thousand times the normal voltage stress and many times the maximum commercial test that can be applied after the transformer is assembled. With regard to the insulation between layers of the winding a sufficient number of coils is provided so as to keep down the voltage stress between layers to a very low figure.

The insulation between the high and low tension windings is of prime importance in a distributing transformer in order to obtain a sufficient factor of safety as well as proper durability. Unless the low tension system is thoroughly grounded, a breakdown between the high and low tension windings of such a transformer may result in serious damage to the property of the consumer as well as to that of the central station in addition to the life hazard that is imposed. As an advancement over the hand-wound mica shield with its resultant lap joint, there have been developed for this service, continuous insulating tubes of high dielectric strength, which take up a very small amount of space and have considerable mechanical strength. This insulating material is called micarta and a solid barrier of this type provides insulation as effective mechanically as electrically, at the corners as along the straight parts of the winding and one that gives uniform appearance to the coils and maintains them in the proper relative position without warping.

As insulation between the high tension winding and the ground, channels of micarta insulation are provided over the ends of the high tension coils where they pass under the iron of the distributed shell type magnetic circuit. The insulation from the inner low tension winding to the ground is by the use of a micarta tube, made without mica, which encloses the middle leg of the magnetic circuit and which results in uniform insulation as well as permits proper inspection of the coil insulation when it is removed from the winding form or mould.

To permit the modern distributing transformer to carry a liberal overload as well as make it more weatherproof, the complete transformer unit consisting of the coils, magnetic circuit and end frames, is impregnated with a moisture-repelling, oil-proofed, insulating compound.

The distributing transformers for the higher voltages necessarily present some constructional differences from those of the standard 2,200-volt pole type transformers, but in general the materials and methods that have been proved to give safety and durability in the 2,200-volt class, have been adapted for the higher voltages. The coils of these higher voltage, single-phase transformers are of the core type with proportions especially suitable for high voltage transformers of relatively small capacity.

Transformers of the types referred to above are now built in sizes to include 100 Kva units, for the use of relatively larger size distributing transformers has increased considerably so that during the past few years, a very large number of transformers of the 75 and 100 Kva sizes for all voltage classes have been installed. These transformers have the same general construction as the smaller size, pole type, distributing transformers except that they are normally mounted in corrugated sheet-iron, cast-in tanks, so that a sufficiently large radiating surface is obtained together with the light weight per unit of capacity essential with such larger capacity transformers if they are to be installed on cross-arms or readily mounted upon platforms.

With small capacity, high voltage transformers, the three-phase transformer may show up considerably better from the standpoint of price and performance as compared to three single-phase transformers of the same total capacity. On the other hand, the single-phase transformer may have a lower initial cost in that only one unit may be furnished at the start and then additional units for polyphase connection added when the load is built up in the new territory, so that in this respect the single-phase transformer is more flexible. Again, three-phase power can be furnished with two single-phase transformers connected in open delta and the third transformer may be added to close the delta when the load increases. On the standard voltage classes, three-phase transformers of small capacity do not represent much saving over the single-phase because of the advanced stage of development of the single-phase 2,200-volt class and other transformers, due to their extensive use. However, the determining feature will usually be the question of flexibility, which is distinctly in favor of the single-phase transformer except in the standard voltage classes for larger central stations where there are a sufficient number of transformers carried in stock and large enough variety in power consumers to offset the advantage in the flexibility of the single-phase transformer. This may be true for the average central station serving an urban population of over 100,000.

The first paper was discussed by H. L. Wills, transmission engineer Georgia Railway & Power Company, Atlanta, Ga.; E. P. Peck, Asst. Electrical Engineer of same company; C. M. Young, Columbus Power Co., Columbus, Ga.; J. O. Hardin, Georgia Railway and Power Co., Atlanta, Ga..; and L. A. Magraw, Central Georgia Power Co., Macon, Ga.

Mr. H. L. Wills mentioned the increasing use of voltages higher than 2200 in distribution systems enlarging the radius economically served and permitting use of small transformers for local loads. He mentioned 20 miles as a radius from a distribution center that can be served by a 22,000 volt system of feeders. He said that the 2200-volt transformer is fairly well protected from lightning by the use of standard types of arresters now available, however, the problem is not yet solved for these low voltages. With increase of voltage the troubles do not seem to increase and proper precautions and arrangements provide satisfactory lightning protection at the higher voltages. The most annoying troubles in regard to transformer protection seem to be high frequency disturbances. For pole top mounting for small customers, Mr. Wills suggested a 3-phase transformer with wattmeter transformers all self-contained.

E. P. Peck, of Atlanta, Ga., in discussing design of distributing transformers emphasized the insulation protection against break-down from primary to secondary, thus avoiding accidents and fires. Next in importance he placed ability to stand rated load continuously and in addition considerable abuse from overload before destruction and interrupting service. Even when records of loads on individual transformers are kept an overload must be carried until time permits relief after discovery. Efficiency and reduced losses were next mentioned, high efficiency and low losses making available salable power. Importance of regulation at times of heavy load was also mentioned. Mr. Peck believes some changes should be made in present transformers to enable them to withstand high frequency strains, stating that present designs have an internal insulation to withstand a voltage sufficiently high to jump from the leads to case only when such is of normal frequency. He mentioned unusual cases of damage to instruments on systems with grounded secondaries, due to lightning, and has under investigation conditions causing same.

C. M. Young, of Columbus, took up the question of transformer regulating taps suggesting a standardization of same, both as to number and percentages of voltages possible through their use. He referred to the numerous grades of oils specified by manufacturers for different apparatus, stating that facilities were not usually provided in the average station for handling such to advantage and suggesting that one or two grades would facilitate storage of oils. He referred to lightning troubles in his section, emphasizing the need of cheap but efficient lightning protection for cheap loads.

J. O. Hardin, in referring to lightning troubles and transformer protection, explained the low electrostatic capacity of small 22,000-volt transformers, and the high electrostatic capacity of the shell types. He said that choke coils tend to increase the danger of a transformer destroying itself when hunting within the transformer takes place. He recommended horn gaps as protection against high voltage transients and urged the development of protection against low voltage high frequency disturbances. He also suggested use of the compression chamber type of lightning arrester for connection at distributing transformers of 2300 volts.

The next paper on "Regulation of Hydro-Electric Transmission Lines," was read by the author, E. P. Peck, of Georgia Railway & Power Company, Atlanta, Ga. An abstract of this paper follows:

REGULATION OF HYDRO-ELECTRIC TRANSMISSION LINES.

The paper on the above subject took up the regulation of transmission lines and feeders, the author pointing out that the regulation of a high voltage line is dependent on the resistance, reactance and capacity of the line, and that these factors vary with the length of the line, the size of the wire, material of the wire, and the spacing between lines. The resistance and reactance both cause the voltage drop to increase with the load. The capacity of the line tends to enutralize the reactance, and make the voltage higher at the receiver than it would be if capacity was not present. In long high voltage lines, voltage at the receiver may be several thousand volts higher than at the generator if there is no load on the line. This is because the capacity of a long line at high voltage allows a charging current which leads the generator voltage, the effect of the leading current being to raise the voltage along the line exactly opposite to the effect of a lagging current which lowers the voltage along the line.

There are several methods of calculating these problems, the most common of which are probably the trigonometric and the convergent series. In making these calculations it is necessary to assume a temperature for the wire and the power factor of the load. The change in power factor from that assumed is liable to make a considerable error in the result. This being the case, exact calculations are seldom worth while, and any formula giving close approximations may be used with good results. The power loss on a transmission line may be very different from the voltage loss. With some sizes of wire, and low power factors, the power loss may be a larger per cent than the voltage drop. Power loss calculations are comparatively simple to make, and for this reason they are often used in place of the voltage drop calculations, although the difference between the two may amount to several per cent.

If several sub-stations are fed from widely distant points, on a long line, quite a problem is presented in keeping a given constant voltage on feeders from these sub-stations all along the line. Regulators of the Tirrill type or their equivalent are advisable in the plant. These may be set to keep either a constant bus-bar voltage or a constant voltage near the main sub-station. The transformers in the sub-stations should have voltage taps which should be connected to give the required secondary voltage, when the primary voltage is at its average value. Feeder regulators with automatic contact and rapid moving parts may be used on the out-going lines to take care of both variations on the high voltage line and drop in the feeders. The apparatus is adequate if conditions are not very severe, but in many cases the capacity effect of a line is so great that it must be very largely neutralized before any approximation to constant voltage can be obtained. This is best done by installing large synchronous condensers at the receiving end of a line, which are equipped with Tirrill regulators set to keep a constant voltage at that point. The condenser will supply either a lagging or a leading current to the line, and will supply its current in just the proper manner to maintain a constant voltage.

The question of lightning arrester protection was mentioned in the paper since the discharge of lightning arresters has an effect on the line voltage. The author stated that the aluminum lightning arrester, as now made with charging resistance, will operate with a small line disturbance, and that the horn gap arrester with series resistance is more or less effective, but it will sometimes cause a dip in voltage when discharging. The dead grounded horn gap arrester is undoubtedly effective at times, but disturbances produced in the line voltage are very often extremely severe.

The discussion on Mr. Peck's paper was taken part in by C. M. Young, Columbus Power Co., Columbus, Ga.; L. A. Magraw, Central Georgia Power Co., Macon, Ga.; O. H. Caldwell, *Electrical World*, N. Y.; G. K. Hutchins, Columbus Power Co., Columbus, Ga., E. H. Bussey, General Electric Co., Atlanta, Ga.; and H. L. Wills, Georgia Railway & Power Co., Atlanta, Ga.

C. M. Young, of Columbus, Ga., explained a possibility of the interconnection of the hydroelectric systems of the South and the consequent need of good regulation and communication facilities for the transmission systems. He explained a system of recording line insulator troubles and localizing of same through marking the particular towers effected on a map of the system and further noting by a simple scheme the particular insulators broken.

L. A. Magraw, of Macon, Ga., took up the regulation at points of distribution and the use of the synchronous condenser. He believes that station protection is now well provided for and that greater line protection is needed.

E. P. Peck, of Atlanta, Ga., referred to the use of horn gaps in series with graded concrete resistance columns, the horn gaps set to take the dangerous voltage and the concrete resistance to limit the power current.

G. K. Hutchins took up protection from standpoint of customer emphasizing need of adequate line protection and against the interruption of service.

H. L. Wills discussed transformer taps, stating that they were not especially good except under certain known conditions. He made the point that transformer oil should stand a break-down test of 50,000 volts. Wireless communication between generating and substations was also suggested.

H. E. Bussey, in discussing transmission regulation, mentioned the use of feeder regulators for lighting service, stating that size and relative cost depend on constancy of voltage to be maintained. Voltage variation on operation of induction motors shows up in the torque, efficiency, the heating and speed. Mr. Bussey regards 10 per cent variation in voltage at no load and full load the maximum for transmission lines. For transmission lines of from 50 to 150 thousand volts, over long distances, the use of synchronous condensers at the receiving end of the line, equipped with Tirrill regulators, is important and necessary for constant voltage.

Second Session—Address by T. C. Martin.

At the evening session on Thursday at 8:30 o'clock, T. C. Martin, executive secretary of the National Electric Light Association of New York City, gave an address on, "Advantages of Membership in the N. E. L. A." Mr. Martin prefaced the remarks on his subject by a brief review of the conditions at Dayton, Ohio, after the flood during the past spring, stating the central station now has connected a larger load than before the flood due to the connection of a large number of customers previously operating isolated plants, which plants were damaged beyond recovery by the water and fire.

In regard to the condition of the industry and the progress of certain sections, Mr. Martin's remarks were replete with facts and data, characteristic of his annual N. E. L. A. progress report, now considered a masterpiece of literature referring to the electrical business. He referred to the N. E L. A. as having around 13,000 members, located in the United States and Canada. There are now three large territorial sections, 18 state and 45 company sections with a membership of 9,000 officers and engineers. At present the N. E. L. A. membership represents 90 per cent of the capital invested in the industry totaling some 2.5 billion dollars on which is annually earned 450 million dollars. Thus 10 per cent of the capital invested in the lighting and power industry is represented by municipal plants, and says Mr. Martin, good authorities believe the data of the next census will show this figure dropped to not more than 5 per cent.

Mr. Martin took up the work of the association in investigating rates, mentioning the publication of the rate research bulletin by the Rate Research Committee. The value of the question box was also explained and the help the small company can secure from it. A Lecture Bureau is now established with some 50 lectures with lantern slides available, discussing educational topics.

The association is doing much for the betterment of the entire industry along broad lines, it is cooperating with other associations and engineering bodies, with the A. I. E. E. in the investigation of electrolysis and the National Electric Code. It is having a good influence on the labor situation through its welfare work, sick benefit and pension systems and profit sharing schemes.

Looking into the future of the work Mr. Martin sees a great National Public Utility Association representing the interests of all public utility properties and exerting a tremendous influence for good from points of development, operation and regulation. Along this line he referred to growing proportions of annual conventions and the necessity for devising means to handle the work in the very near future. The suggestion of section meetings at centers of interest has come up, namely, that the commercial section meet in one section, the hydroelectric section in another, the accounting in another, etc. These are matters now troubling the officials of the organization.

In concluding his remarks, Mr. Martin made an earnest plea for cooperation among members and companies, and the building of the industry along broad lines cultivating the good will of the public at all times.

After Mr. Martin's address, the paper on "Load Builders," by Milt Saul, of the Georgia Railway & Power Co., of Atlanta, scheduled for Saturday morning, was presented to relieve a crowded program at that time. This paper was presented by W. Rawson Collier, of the Georgia Railway & Power Company, an abstract of which follows:

LOAD BUILDERS.

The subject of this paper was presented from the viewpoint of the central station advertising managers. Mr. Saul, besides outlining the essential features and good results of advertising, took up the experience of the Georgia Railway and Power Company, in a recent campaign in which daily papers were used to advertise conspicuous institutions using central station service in Atlanta. This campaign was based on the assumption that prospective customers would be impressed wit hthe information that the larger enterprises, notable for their success in the commercial world, had found this current the most economical and reliable method of obtaining power and light. The results obtained more than justified the expenditures, for the first full page had scarcely appeared in the daily papers when several prospective customers of desirable load building quality asked to open negotiations, and by the time the campaign was well under way the contract department had not only signed contracts with these. but had awakened similar desires in several enterprises that had theretofore appeared absolutely hopeless as prospective customers. These also finally entered into contracts for this current. It cannot be claimed, however, that these conspicuous examples were signed up solely as the result of this newspaper advertising. To the ability and cleverness of the contract department the accomplishment is principally due. The advertising merely fertilized the field, as it were, and in its final analysis this is about all that can be expected of any advertising.

In advertising electrical appliances, the effort is made to keep the expenditure for newspaper space as nearly as possible in proportion to the importance of the appliance as a load builder Appliance sales have been accelerated, perhaps, more by the use of the mails for circulars and descriptive pamphlets than by the use of newspapers. It has been found more effective, for instance, to mail out to a selected list 2,500 attractively illustrated pamphlets describing household appliances than to advertise these appliances in the newspaper space that could be purchased for the cost of the pamphlets plus the postage and labor necessary to the mailing method.

Mr. Saul concluded his paper with the following statement: As a load-builder, the advertising department is merely nominal when considered as an institution separate from the other departments. With intelligent and enthusiastic cooperation with the other departments it may become as a mighty pipe-organ voicing the compositions of the genius within the enterprise—the spirit that evolves principles of fair dealing upon which the business is founded, and which moves every man connected with it to put his shoulder to his wheel, proud of his position.

The paper on "Load Builders" was discussed by the following: G. K. Dustin, Columbia Railway, Gas & Electric Co., Columbia, S. C.; T. J. McGill, Atlanta office, Westinghouse Electric & Mfg. Co., W. Rawson Collier, Georgia Railway & Power Co., Atlanta, Ga.; G. K. Hutchins, Columbus Power Company, Columbus, Ga.; R. L. Rand, Anniston Electric & Gas Company, Anniston, Ala.; T. W. Peters, Columbus Railroad Company, Columbus, Ga.; and W. A. Belcher, Cordele Electric Co., Cordele, Ga.

Mr. Dustin, of Columbia, S. C., emphasized the importance of preaching good service and the connection of profitable loads through advertising. In Columbia essentially an off peak night service is solicited by this means.

Mr. McGill, of Atlanta, raised the question as to benefit of Campbell dolls and special moving picture shows, and drew out expressions of the profitable use of same from Mr. Dustin, of Columbia, S. C., and Mr. Hendee, of Augusta, Ga.

Mr. Collier, of Atlanta, Ga., mentioned the use of pamphlet mail matter furnished by electrical manufacturers and pointed out the disadvantage of mailing with bills on account of loss of bills resulting.

Mr. Rand, of Anniston, Ala., explained the use of a card system in circularizing his field, appealing directly to needs and possible service shown by the cards. He has secured excellent results.

Mr. Peters, of Columbus, Ga., outlined a scheme of using advertising space in Sunday newspapers cooperatively with electrical contractors, in which the company uses the slogan, "Make Electricity Your Willing Servant," as border for the advertising space used by the contractors.

Mr. Belcher, of Cordele, Ga., mentioned successful use of advertising to individual classes where customers are made up of foreign elements, addressing in their native tongue.

Third Session—Commercial.

The Friday morning session was devoted to commercial matters and called at 10 o'clock. The first paper was presented by Albert Milmow, of the Alabama Power Company, Birmingham, Ala., and took up a discussion of the horsepower from the viewpoint of the commercial man. An abstract of this paper follows:

WHAT IS A HORSE POWER?

The author of this paper emphasized the liability of creating confusion in the mind of the business man by too careless use of the terms horsepower and kilowatt-hour on the part of the engineer and commercial solicitor. He suggested that the following clause can be used to advantage in contracts: "The price of power delivered shall be so many cents per kilowatt-hour, said rate being equivalent to so many dollars per horsepower per year based on the operation of the plant of the customer for so many hours per day and so many days per year."

The importance of a commercial interpretation of an engineering analysis of any possible sale of power to a customer was stressed, referring to the conditions met in studying the electrical equipment of cotton mills for a comparison with steam power so as to place the data before the manager of the mill on a definite and understandable basis. His comments referred to design of plant, cost of equipment, subdivision of drive, design of mill, speed of machinery, etc., all these considerations, when carefully analyzed, helping the power salesman to present the cost of power on a simple basis, and establish the electrical horsepower as a unit for the measurement of the manufactured articles produced. In closing this paper the author referred to the importance of simple rates expressed as some unit times dollars or cents; and that the customer should always be satisfied, know his power consumption and use it as an index to his operating conditions.

The paper on, "What is a Horse Power?" was discussed by J. S. Bleecker, Columbus Power Company, Columbus, Ga.; W. R. Collier, Georgia Railway & Power Company, Atlanta, Ga.; G. K. Hutchins, Columbus Power Company, and A. H. Sikes, Athens Railway & Electric Company, Athens, Ga.

Mr. Bleecker stated that the most satisfactory rate unit, and one best understood by cotton mill men, is the Kw.-hr. times cents. Mr. Collier, of Atlanta, further mentioned in regard to rates, that load factor be given careful consideration and its variation from year to year.

Mr. Hutchins, of Columbus, said that experience in Columbus mills with the graphic wattmeter had shown $18.60 per horsepower year, a fair rate for cotton mill business, and to compare with $23.35 per horsepower year from a steam plant.

The next paper, entitled, "The Hotel Load," was read by C. A. Collier, assistant contract agent of Georgia Railway & Power Company, Atlanta, Ga. An abstract follows:

THE HOTEL LOAD.

Under the heading of desirability of the hotel load, the author of this paper made the following statement: There is probably no other type of customer that offers to the central station a larger revenue from the sale of current, or affords a more advantageous subject for advertising."Looking at the hotel only as a consumer of current, it is found that very few types of commercial business, some industrial plants excepted, consume as much energy per K. W. connected as does the modern hotel. For instance, the combined average load factor of two hotels, data on which is given in this article, is approximately 20 per cent, whereas, the load factors of the other types of business are only as follows: Office buildings, 7 to 15 per cent; department stores, 8 to 10 per cent; newspaper publishers, 8 to 14 per cent. In other words, the ability of a hotel to absorb current is almost double that of any other large commercial consumer.

A factor certainly to be considered in connection with this comparison, is the relatively small peak of a hotel load, and the absence, in comparison with other types of business, of the large "valleys," representing the hours of the day when little or no current is used. In fact, the hotel, during every hour of the day, is a considerable user of current and especially is this true if the hostelry operates a machine for refrigeration and ice making, as the ice making is largely done during the night hours. The fluctuation due to the change in seasons is also less than for almost any other type of business

The following table shows data on loads of four hotels in Atlanta:

	Hotel A	Hotel B	Hotel C	Hotel D
Connected Lighting Load in 50 Watt Equiv.........	3,200	2,600	454	2,500
Connected power load in Hp.	150	128	20	160
Connected Heating Load in Sq, Ft. Radiation.........	16,000	12,000	3,963	12,000
Yearly Consumption (Light) —Kw. Hrs.	307,000	334,000	19,288	118,500
Yearly Consumption (Power) —Kw. Hrs.	153,000	177,000	3,056	183,000
Yearly Consumption (Steam Heat)—Lbs. Steam	6,400.000	4,800,000	1,565,000	4,880,000
Kw. Hrs. per 50 Watt Equiv. per Yr. (Light)	96	128	43	95
Kw. Hrs. per Hp. per year..	1.020	1,383	152	1.045
Condensation in Lbs. per Sq. Ft. Radiation per Season..	400	——	398	400
Load Factor (Light) in per cent.	22	29	9	21
Load Factor (Power) in per cent.	16	21	2.5	17
Maximum Monthly Consumption—Kw. Hrs.	45.000	51,300	2,840	
Minimum Monthly Consumption—Kw. Hrs.	27,700	36,000	1,240	

Particular attention is called to the yearly consumption of Hotels "A," "B" and "C," as these three hotels represent distinct types of loads as follows: Hotel "A" is a modern large building, thoroughly equipped with motors throughout, but having no ice machine. Hotel "B" has the same general characteristics as "A," with the addition of a 10-ton ice machine. Hotel "C" is a small hostelry, with no power other than one elevator, and Hotel "D" is equipped with individual motor drive and is most modern.

The greatest talking point of the advocate of the isolated plant is the claim that if engines are installed, the steam heating will cost nothing. As a matter of fact, not over 30 per cent of the steam necessary for building heating in this section is available as exhaust steam. And of the available 100 per cent of exhaust steam, not over 30 per cent of it can actually be used for heating during the heating season. As an illustration, Hotel "A" has installed 16,000 square feet of radiation. This radiation condenses during the heating season, approximately 5,600,000 pounds of steam, of which over 60 per cent is condensed during the months of January and February, leaving only 2,240,000 pounds of steam to be condensed in November, December, March and April. The Kw.-Hrs. consumption during the four months, November, December, March and April was 169,000. Taking the figure arrived at by the committee on steam heating of the N. E. L. A., i. e.: 60 pounds steam per Kw.-Hr., we find that the exhaust steam available during the above mentioned four months is 10,140,000 pounds, or practically five times the steam heating demand. Despite even this large excess, actual running tests show that the steam heating demand in the early morning hours is so great that it exceeds the output of exhaust steam available, resulting in live steam having to be supplied to the heating system.

In connection with the using of exhaust steam for heating, it must be remembered that there are few systems, indeed, that show no back pressure. This back pressure directly effects the operation and economy of the engine, due to the fact that not only is the horse power of the engine greatly reduced but the steam consumption per Kw.-Hr. output due to the cylinder condensation is greatly increased. Therefore, the net result shows very little gain in the direction of economy. In fact, Hotel "A" can be heated from low pressure boilers at a total over all cost of $2,500.00 per annum. This $2,500.00 per annum would be reduced to a maximum of only 30 per cent of $2,500.00 or $750.00 by the use of exhaust steam from the engines. This $750.00 is offset several times by the saving in the purchase of current from the central station.

Assuming that a plant of the proper size, type, etc., were installed to supply these buildings, each individually, and crediting each plant with one engineer and two firemen, and the additional coal, etc., which are directly chargeable to the steam heating, we find the cost of manufacturing per unit of current to be very close to 4 cents per Kw.-Hr., including all charges. The remaining credit for exhaust steam for heating being very small, it will hardly affect the cost per Kw-hr.

The purchase of steam for building heating, offers little or no saving to the hotel company, but the big saving is realized by the purchase of electric current. For the purpose of furnishing steam for cooking and hot water heating in Hotel "D," there are installed two 40-Hp. internally fired Scotch Marine boilers. The boilers operate at approximately 40 pounds pressure supplying steam for soup kettles, boilers, hot plates, chafing dishes, coffee and tea urns, and other similar cooking devices, and to the heaters used for supplying hot water to the various parts of the hotel. Likewise, exhaust steam from the cooking apparatus and boiler feed pump, supplies such distilled water as is necessary for the purpose of ice making, it rarely being necessary to furnish live steam for this purpose. No steam for building heat is supplied from these boilers but this service is purchased from the central station.

The paper was discussed by W. L. Southwell, Macon Railway & Light Co., Macon, Ga.; E. S. Roberts, Savannah Electric Co., Savannah, Ga.; W. R. Collier, Georgia Railway & Power Co., Atlanta, Ga.; H. C. Adams, Southern Utilities Co., Jacksonville, Fla.; M. Webb Offutt, Alabama Power Co., Birmingham, Ala., and M. H. Hendee, Augusta-Aiken Railway & Electric Corporation, Augusta, Ga.

Mr. Roberts mentioned the fact that in most Southern cities the hotels operate at greatest load during winter months when the station has the largest demand on its capacity, while during the summer when the load would be most favorable, it is very small, and not very profitable except at a high rate.

Mr. Collier spoke against making a flat rate to hotels, believing that the rate should be based upon yearly conditions and be referred to a maximum demand and a minimum or a Kw-hr rate on a sliding scale.

Mr. Offutt, of Birmingham, Ala., presented results of a government test on a small isolated plant at Fort Monroe of 150 Kw capacity, which showed a power cost of 4.33 cents per Kw-Hr. Mr. Adams stated that he did not consider it profitable to take hotel business in Florida, based on a 3 months maximum service, unless 8 cents per Kw-Hr could be secured.

Mr. Collier mentioned the disadvantage of installing motor generator sets for elevator service in hotels, due to the losses ranging from 18 to 35 per cent, these losses being chargeable to the electric system when figuring on same. He mentioned successful use of A.C. elevator systems in Atlanta.

Mr. Hendee, of Augusta, did not consider the tourists' hotels connected to his system in Augusta and operating three months in winter specially profitable at rate now secured and made some time ago to promote the enterprise.

The next paper, "Sale of Current on a Flat Rate by Means of a Current Limiting Device," was presented by A. T. Holbrook, of Excess Indicator Co., Pittsburg, Pa. An abstract follows:

SALE OF CURRENT ON A FLAT RATE BY MEANS OF A CURRENT LIMITING DEVICE.

In this paper the author set forth the possibilities of securing a large number of small customers, who, on account of the indefinite cost of lighting on a measured service basis, cannot be reached by it but can be secured on a flat rate basis. He referred to the campaign of the Augusta-Aiken Railway and Electric Corporation, of Augusta, Ga., where a campaign of wiring small houses was started in Sept., 1912, and has continued with decided success. In this campaign the current limiting device was used and a rate of one cent per watt per month made. The result of the campaign up to May 1st, 1913, was 1,200 contracts accepted and installed, with 778 contracts for wiring houses. In addition, 332 gas arcs were replaced.

Subsequent to the starting of this campaign and approximating November 15th, a similar campaign was undertaken in Raleigh, Oxford, Henderson, Sanford, Jonesboro, Hamlet, Rockingham, Wadesboro and Goldsboro, North Carolina, and Cheraw, South Carolina, all being under the control of the Carolina Power & Light Company, Raleigh, North Carolina. These towns were from 6 miles to 55 miles apart and made it necessary to keep local solicitors permanently employed. At the time the campaign was started there were 1,050 electric residence consumers in Releigh and 600 consumers using gas for lighting which were barred from solicitation by the solicitors furnished for this campaign work. The solicitors did not solicit from new houses until after they were occupied and without making application for service at the office.

Up to April 1st the net result of the campaign has been to secure 930 new customers. The company reports that their revenue has been increased from these customers $14,784 a year by means of this campaign, which revenue could not have been obtained by any other method. This list includes a large number of mill houses and shacks, and all the business was taken from customers who had been approached from time to time without result.

Among those discussing the above paper were the following: J. E. Bigham, Tampa Electric Co., Tampa, Fla.; T. W. Peters, Columbus Railroad Co., Columbus, Ga.; G. K. Hutchins, Columbus Power Co., Columbus, Ga.; M. Webb Offutt, Alabama Power Co., Birmingham, Ala.; W. A. Belcher, Cordele Electric Co., Cordele, Ga.; H. C. Adams, Southern Utilities Co., Jacksonville, Fla.; E. C. Deal and M. H. Hendee, Augusta-Aiken Railway & Electric Corporation, Augusta, Ga.

Mr. Bigham, Tampa, Fla., recognized the field of the flat rate but questioned the current limiting device campaign on the following points: Method of solicitation where outside solicitors are used in the campaign; special inducements to get property-owners to wire houses, where change of tenants is frequent and the necessity of making a new contract for both light and wiring if contract has not expired. Mr. Bigham also brought up the question of discrimination against meter customers where the two systems were in use, and asked if public service commissions regarded it as such. To this Mr. Holbrook replied that no commission had ever questioned the flat rate with current limiting device if made optional.

Mr. Peters said that with prepayment meters in Columbus, his company was receiving an average of 9.5 cents per Kw-hr and $21 as an average revenue per customer. He contended that the loss on a flat rate was larger than with prepayment meters, and stated that the cost of securing the business was 20 per cent against 40 per cent with the flat rate and current limiting device. He gave 3.4 hours as the average service demand of a 3-lamp customer in Columbus.

Mr. Offutt referred to a flat rate campaign with current limiting devices in Hartford, Conn., which had been successful and shows practically no additional demand on the plant capacity.

Mr. Belcher, Cordele, Ga., referred to a campaign in Gardner, Mass., where between October, 1911, and January, 13, 1912, 201 contracts were signed with a maximum demand of 24.5 Kw and a total revenue of $3,215.98, making an average per customer of $16 per year at the rate of $131 per year per kilowatt of maximum demand. Up to March

15, 1912, 375 customers were secured, and $3,592.35 of wiring was sold these customers.

Mr. Hendee gave the following results of a house wiring and flat rate residence lighting campaign conducted between September 1912, and August, 1913, using the Excess Indicator. Contracts taken, 1357: number taken out of service (including 145 contracts proving bad credit customers and 39 changing to meters) was 372 leaving 985 customers connected representing a monthly revenue of $2,227.05, or a revenue of $2.35 per customer. During the campaign 801 houses were wired. Three solicitors were used during the campaign most of the time.

A number of meters used to check the consumption of the flat rate customers shows an average rate for the service of 9 cents per Kw-hr against 10.7 cents which customers are paying on regular meter rates. The flat rate appeals to the man of small means in Augusta and seems to provide reasonably profitable new business impossible to secure on a meter basis.

Mr. Deal, in referring further to the situation in Augusta, said that a large number of customers have been secured from a laboring section where two years ago few could be secured. He believes under the present system 66 per cent are possible customers. The campaign has not affected the demand on the station.

Mr. Dustin of Columbia, believes that a campaign to educate customers and prospects in reading meters and control of lights will make the current limiting device unnecessary.

Fourth Session—Public Policy.

On account of the unavoidable absence of P. S. Arkwright, president of the Georgia Railway & Power Company, who was scheduled to address the convention on public policy matters, the paper entitled, "Why?" by John S. Bleecker, of Columbus Railroad Company, Columbus, Ga., was presented at the Friday evening session.

WHY?

This paper dealt largely with questions of a public policy nature, some of the points touched upon being expressed in the following questions: "Why should there be any difficulty between a good public service utility and a reasonable public? Why should there be any difficulty in a public service corporation earning a reasonable profit in its business? Why should there be any difficulty in an intelligent consumer securing reasonable rates and service? Why should not a reasonable consumer be willing to pay such reasonable rates for reasonable service as will give the utility a reasonable return."

Each of these questions were taken up, explaining the logical answer both from the standpoint of utility and consumer and concluding with the following paragraph: "Public utility monopolies must recognize that they are public utilities, the servants not the masters; they must remember that they are monopolies and not discriminate; they must give good service; they must not expect unreasonably high returns; they must encourage and assist the properly selected bodies that represent that average individual they wish to reach; they must not be over sensitive nor overbearing; they must be frank, fair and efficient, and they must look for the bright side of that dark cloud. It is beginning to show. They can help turn its smiling countenance to the light by remaining white sheep by continuing to produce more wool than the black ones and by telling the public who they are, and what they are and WHY."

Mr. Bleecker's paper was briefly discussed by M. Webb Offutt, of the Alabama Power Company, of Birmingham, Ala. He reviewed the good of the association work and close cooperation of member companies, emphasizing the need of educational methods to cause the public to appreciate equitable rates. He also referred to the labor situation stating that utilities are now recognizing that to get the greatest benefit of labor, labor must be treated best.

Following this paper, the one on "Electric Truck Sales to Merchants by Central Stations," by H. W. Hillman, of the General Vehicle Company, of Long Island City, N. Y., was read by G. K. Dustin, in the absence of the author. An abstract follows:

ELECTRIC TRUCK SALES TO MERCHANTS BY CENTRAL STATIONS.

Mr. Hillman opened his paper by referring to the success of the Hartford (Conn.), central station in selling trucks, stating that for the month of May an electric truck was sold to a merchant every three days. Eighty-two per cent of the merchants sold have previously operated gasoline trucks and changed to electric. In Baltimore, Md., he stated that upwards of 100 trucks are in operation by seven classes of business, with opportunities for sales to 52 other classes. One truck per thousand people was given as a measure of possible business for the larger cities, and that an annual output of 600,000 horsepower hours represents the load of 50 trucks.

The author further explained the advantages in central stations making an effort to sell trucks to merchants, cultivating their confidence in doing things electrically and cooperating with them in trade relations.

The following table gives data taken from the electric vehicle research bulletin of the Massachusetts Institute of Technology, representing results secured by means of curve drawing instruments applied to 60 gas, electric and horse drawn wagons.

COST OF OPERATION, ELECTRIC COMMERCIAL VEHICLES.

Two ton rating.

Estimate for furniture delivery:

Average max. load, approx.	4,000 lbs.	Hours per trip for loading	0.7
Mileage per trip	12	Minutes per call	6.
Calls per mile	1	Hours working per day	9.

VEHICLE	4,000 lb. Electric	4,000 lb. Gasoline	Two-horse wagon; one extra horse
Average running speed, miles per hour	8	9	5
Hours per trip, standing	1.9	1.9	1.9
Hours per trip, moving	1 5	1.4	2.4
Hours per trip, total	3.4	3.30	4.3
Average number trips per 9 hour day	2.65	2.75	2.1
Miles per day	32	33	25
Calls per day	32	33	25
Days used per year	285	270	285
Vehicles mills per year	9,100	9,000	7,150
Calls per year	9,100	9,000	7,150
Expense, Annual:			
Tires or shoeing, etc	$ 225	$ 270	$ 108
Repairs	260	550	125
Battery	270		
Veterinary	....	....	18
Lubricants	15	50	
Electricity at 3 cents per kwhr	200	....	....
Gasoline at 16 cents per gal	....	285	....
Feed	....	....	570
Garage or stable	220	220	220
Driver and helper	1,140	1,215	1,140
Depreciation	240	500	210
Interest	84	96	31
Insurance	140	180	35
Total annual expense	$2,794	$3,366	$2,457
Cost per day	9.75	12.50	8 60
Cost per call	.31	38	.35
Cost per mile	.31	.38	.35

SUMMARY.

(Values in Cents per Mile)	Electric	Gasoline	Horse
Electricity, gasoline or feed	2.2	3.2	8.0
Maintenance	8.5	9.7	3.5
Storage, driver and helper	14.9	15.9	19.1
Overhead charges	5.1	8.6	4.0
Total	30.7	37.4	34.6

The following members discussed the paper on trucks: J. S. Bleecker, Columbus Railroad Co., Columbus, Ga.; M. Webb Offutt, Alabama Power Co., Birmingham, Ala.; A. N. Bentley, Electric Storage Battery Co., Atlanta, Ga.; W. R. Collier, Georgia Railway & Power Co., Atlanta, Ga.; E. C. Deal, Augusta-Aiken Railway & Electric Corporation, Augusta, Ga.; J. L. Hart, Baker Electric Co., Atlanta, Ga.; C. M. Young, Columbus Power Co., Columbus, Ga.; R. S. Linsey, Durham Traction Co., Durham, N. C., and E. D.

Craig, Savannah Electric Garage & Tire Co., Savannah, Ga.

Mr. Bleecker outlined a failure to sell pleasure electrics in Columbus on account of mechanical defects of a demonstration car.

Mr. Offutt explained the successful handling of small trucks among merchants by placing them at disposal of merchants for trial. Mr. Bentley outlined some of the hindrances in promoting sales by central stations, agreeing with some central station managers that the conditions of sales to the central station of 25 per cent of cost in advance and balance on delivery works a hardship. He believed that sales can best be handled by the representatives of manufacturing companies, cooperating with commercial departments of central stations, the latter finding the prospect and the former closing the sale. He referred to the Memphis situation where some 200 electrics have been placed in use.

Mr. Collier, of Atlanta, stated that it was unfair for truck manufacturers to ask central stations to sell trucks or to refer to them as making excuses for not selling them. While he does what he can to secure the load they represent, he does not feel that under present sales arrangements their promotion by the central station can be done with profit when the cost of placing the truck in service is considered. He referred to the successful use of an electric in his meter department, having been operated 25,000 miles with no repair cost and one set of batteries.

Mr. Hart, of Atlanta, gave considerable information on the methods for sales of trucks by small stations, showing that the latest types climb hills satisfactorily and have ample mileage.

Mr. Linsey, of Durham, N. C., explained the successful use of electric trucks in the ice business of his company. He stated that one three-ton truck does the work of about 4 single-horse wagons.

Mr. E. D. Craig, of Savannah, mentioned the hindrances in selling electric trucks, due to manufacturers demanding 10 to 25 per cent on signing an order and the balance on sight draft attached to bill of lading. He further did not favor handling of one line of vehicles only until field is further developed. To sell electric vehicles, Mr. Craig said, it is necessary to figure with a merchant on his basis of permissible expenditure, maintaining them on a guarantee basis covering repairs, garaging, new tires, batteries, etc., for a period of from three to ten years. This his company is doing in Savannah.

Following the discussion of the paper on electric trucks, T. H. Birch, of the Griscom-Russell Company, New York City, gave a talk on manufacturing ice.

ELECTRICALLY DRIVEN ICE PLANTS.

The author of this paper took up the use of evaporators for providing distilled water in electrically driven ice plants. presenting data on operation and efficiency. He stated that with several evaporators connected in series, it is possible to secure 6 lbs. of distilled water per pound of steam furnished the high pressure evaporator or a maximum of 42 tons of distilled water per ton of coal is possible if evaporating 7 lbs. steam per one lb. of fuel. For a 20-ton ice plant the following data was given, assuming coal at $3.00 per ton, boiler evaporation as 7 to 1 and production of one ton of ice per 2½ I. H. P. of steam engine driving compressor. A 20 ton plant requires 25 tons of steam at cost of $10.28 per 24 hours. With evaporators 22 tons are required and 868 Kw.-Hrs. to operate compressors and pumps replacing steam units. Then $10.28 — $2.68 equals $7.60, or 875 mills per Kw.-Hr. as cost of furnishing the 868 Kw. Hrs. on the electric basis. For a 100 ton plant a similar figure was given as 1.11 cents per Kw.-Hr. Referring to the operation of such plants by the Knickerbocker Ice Co., of Chicago, and other plants in Canada, the author said that the operating cost for the three largest items in an electrically driven distilled water plant of 160 tons capacity were as follows: Coal 12 cents per ton; labor 37 cents per ton and power 46 cents per ton.

Final Session—General.

At the final or general session, held Saturday morning, a paper on "Daily Meter Readings," was presented by F. B. Culley, auditor of Augusta-Aiken Railway & Electric Company, Augusta, Ga. This paper was an excellent presentation of the commercial advantages of daily meter reading practice and gave much useful information on the system as used in Augusta. Here 3,043 meters are read over an area of 12 square miles by one man in twenty working days of eight hours.

DAILY METER READINGS.

The meter index record slips in the meter reader's route book are provided with columns for dates, readings and Kw. Hrs. consumed. The meterman is required to make subtractions before leaving the meter, and is thus assured that his work is correct. If comparison reveals a greater or less consumption, sufficient to be questioned by the accounting office, notation is made from such information as may be had on the premises, thus avoiding delay, and making acceptable the first record given the

CLASS A AND B MEMBERS OF SOUTHEASTERN SECTION N. E. L. A.—EXECUTIVE COMMITTEE STANDING IN BACK ROW.

book-keeper, at the same time placing the accounting department in possession of the necessary information, showing why the customer's bill is higher or lower than would be ordinarily expected. If for any reason a meter cannot be read on the regular reading day effort is made on successive days to take the reading, allowing only insurmountable obstacles to finally prevent the record within each calendar month.

Readings thus taken are daily returned to the book-keeping department on the afternoon of the day such reading is made. The first duty of the book-keeping department each day is to prepare customers bills from the readings taken the previous day. These bills are placed in the hands of the collector the same day, and are delivered to the customer the following day. Thus it is that this continual grind is in progress; reading on the one day, billing the next day, and delivering the bills the following day, placing in the hands of the consumer a statement of his account for the thirty days specified thereon, which statement if paid within ten days is allowed a discount of ten per cent. If not paid within the grace period, notice of discontinuance of service is immediately sent out fixing the expiration of the next ten days as final limit for payment in order to retain the service. Each of these processes is therefore accomplished daily, distributing the work over the entire month, in small parts.

Readings are transcribed from the meter-reader's books to a customer's meter record card. This card shows date of reading, state of meter, Kw.-Hrs. consumed, rates, amount of bill, consumption discount, net bill and remarks. Total Kw.-Hrs. consumed on this card is compared with the Kw.-Hrs. consumed on the meter reader's route sheets, thus affording the first check. These cards, with the meter-reader's route book, are given to the book-keeper. The cards are again verified with the meter-reader's book, extensions are checked and transferred to the customer's ledger, from which customer's bills are made. As it is now the practice with a great many companies to omit meter readings from customer's bills, stating only the total Kw.-Hrs. consumed, this seeming repetition in checking meter readings is found to be necessary to avoid that loss which would be sustained by errors made in subtracting the previous from the present reading.

The accounts being written up and the bills in the hands of the collector, the book-keeper prepares his summary of the day's work. Thus it is found that daily and accumulative earnings are available if desired by the management making it possible at all times to keep in close touch with the revenue collectable, and finally permitting a full and complete statement of the gross revenue for the month being in the hands of the management within a few hours after the last reading for the month is taken.

Operating under the method above outlined, a company with 3,043 meter customers and 1,022 flat rate customers conducts its business having on its bookkeeping staff the head bookkeeper who supervises the accounts, enters all cash, makes all summaries and records all orders taken on consumers, or disconnecting services; as assistant bookkeeper who writes up all consumers' accounts; and a clerk who transcribes meter readings to the cards, takes care of the addressograph, does the mailing and stamping of all notices to consumers, and such bills as are mailed.

A most pleasant result from the method of reading meters daily is found in the treasury department. Bills are presented each day and are due and payable in ten days. There is, therefore, a discount period expiring every day and each day there is that certain income, the sum total of which no doubt is the same as would be under the old method, but distributed over the month, avoiding rush, confusion and inconvenience to the public and to the cashier in the collection of accounts.

The paper on "Daily Meter Reading," was discussed by A. A. Wilbur, Columbus Power Co., Columbus, Ga.; Richard Onderslys, Macon Railway & Light Co., Macon, Ga.; J. E. Bigham, Tampa Electric Co., Tampa, Fla.; E. S. Roberts, Savannah Electric Co., Savannah, Ga.; J. H. Robertson, North Carolina Public Service Co., Greensboro, N. C.; R. S. Linsey, Durham Traction Co., Durham, N. C.; W. R. Collier, Georgia Railway & Power Co., Atlanta, Ga.; E. C. Deal, Augusta-Aiken Railway & Electric Corporation, Augusta, Ga.; J. S. Bleecker, Columbus Railroad Co., Columbus, Ga., and M. H. Hendee, Augusta-Aiken Railway & Electric Co., Augusta, Ga.

The discussion brought out the fact that the following stations are making use of the system of daily meter reading: Columbus, Tampa, Savannah and Augusta. The details of the system are now being, or soon will be, taken up by Atlanta, Durham, N. C., and Macon, Ga.

Mr. Wilbur, of Columbus, outlined the system placed in use January, 1913, stating that one meter reader now does the work of 3 or 4 men formerly. One man reads both gas and electric meters, over an area of 16 square miles, reading 4,150 meters. A bicycle is used. Where two bills are required for office and residence of any customer, bills are sent together.

Mr. Oudersluys mentioned the posting of meter readings on a card placed near the meter so as to encourage customers to check consumption. Mr. Bigham explained the sending of bills to a customer using service in two or more locations. The bill falling due first is advanced and all bills sent together, a card system being used for these accounts. Thirty days after discount date is allowed for payment of bill before cut-off notice is sent.

Mr. Roberts, of Savannah, stated that with their system bills are sent once a month and that 80 per cent of the 4,000 customers pay before the 10th.

Mr. Collier, of Atlanta, said the system was being investigated for Atlanta and outlined some of the conditions hindering the change. Important among these was the necessity of changing some 40 thousand contracts which specify that bills must be paid on the 10th to secure a discount. This question of change was discussed and the opinions expressed, backed by the experience of Columbus, Tampa and Augusta that little trouble need be feared on account of the change.

Mr. Deal, of Augusta, referred to changing the meter reading system to daily readings in Seattle 13 years ago caused by transient nature of customers at time of Klondike boom. The scheme was successful and enabled the collection of accounts promptly. The scheme has worked successfully since with several properties with which he has been connected.

Executive Session—Election of Officers.

At the executive session held at the end of the Saturday morning general session, the revisions to the old Georgia State Section constitution, to make it cover the Southeastern Section, were read and adopted. In the main these included vital changes only in the addition of one vice-president and the election of five members instead of three to the executive committee, one member being selected from each of the five states.

The committee on nominations named the following, who were unanimously elected, to serve as officers for the next year: President, T. W. Peters, commercial agent, Columbus Railroad Co., Columbus, Ga.; first vice-president, J. E. Bigham, Tampa Electric Co., Tampa, Fla.; second vice-president, C. D. Flanigan, Athens Railway & Electric Co., Athens, Ga.; secretary and treasurer, A. A. Wilbur, Columbus Railroad Co., Columbus, Ga.

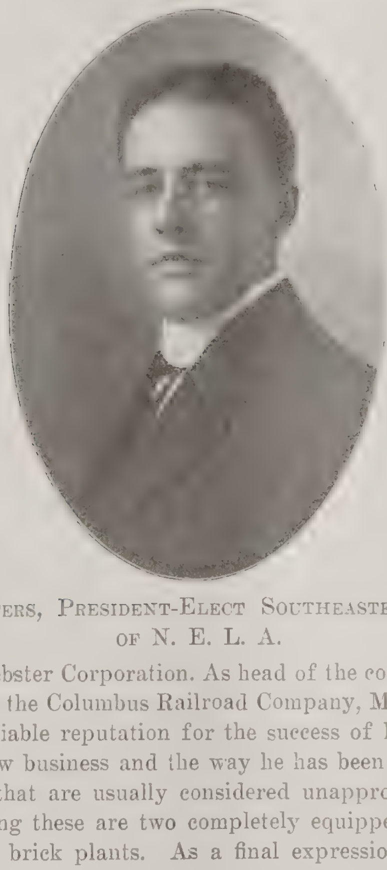
Executive committee, R. L. Linsey, Durham Traction Co., Durham, N. C.; G. K. Dustin, Columbia Railway, Gas & Electric Co., Columbia, S. C.; E. S. Roberts, Savannah Electric Co., Savannah, Ga.; H. C. Adams, Southern Utilities Co., Jacksonville, Fla.; M. Webb Offutt, Alabama Power Co., Birmingham, Ala.

Public policy committee, P. S. Arkwright, president, Georgia Railway & Power Co., Atlanta, Ga.; M. Webb Offutt, Alabama Power Co., Birmingham, Ala.; Z. V. Taylor, North Carolina Public Service Co., Greensboro, N. C. Membership and finance committee chairman, W. L. Southwell, Macon Railway & Light Co., Macon, Ga.

The meeting place for the next convention will be selected at the mid-year meeting of the executive committee.

T. W. Peters, President Southeastern Section.

President-elect T. W. Peters was born in Hartford county, Maryland, in 1881, the son of a Methodist minister. He attended the public schools of Baltimore county, Maryland, receiving his college training at St. John's college, Annapolis and at Lehigh University, South Bethleham, Pa. After graduation he connected with the Viaduct Mfg. Co., of Baltimore, Md., and later with the Potomac Electric Co., of Washington, D. C., and the Philadelphia Electric Co. With both these central station companies he was employed in the operating department. He left the Philadelphia Electric Co. to go with the Consolidated Gas Cos. Electric Light & Power Co., of Baltimore, leaving this company to come to Columbus, Ga., to the position of contract agent, which position he now holds under the management of the



T. W. PETERS, PRESIDENT-ELECT SOUTHEASTERN SECTION OF N. E. L. A.

Stone & Webster Corporation. As head of the commercial department of the Columbus Railroad Company, Mr. Peters has won an enviable reputation for the success of his ideas for securing new business and the way he has been able to connect loads that are usually considered unapproachable; included among these are two completely equipped laundries, and several brick plants. As a final expression along this line, we refer to the report of the Georgia Railway Commission which shows the gross earnings per capita (white) of the Columbus Railroad Company as $24.04.

Mr. Peters has been connected with association work in the South since the organization of the Georgia State section, serving as secretary and treasurer during the first year of its existence and on various committees since. In him the Southeastern Section has a capable leader well fitted for the work now well started for a most prosperous organization.

ENTERTAINMENT.

No session was held Friday afternoon, the entire convention being guests of the Central Georgia Power Company, at an old-fashioned Georgia barbecue at the Log Cabin Club, an exclusive country club just outside the city of Macon. Special cars were furnished to take the delegates to and from the club. Ball games on Thursday and Friday afternoons also furnished entertainment for many.

On Thursday evening a dinner was given by the executive committee in honor of T. C. Martin, executive secretary, who came from New York to address the convention.

Exhibits of heating devices, meters, fans and metal molding were displayed by the General Electric, Westinghouse Electric and Mfg. Co., and National Metal Molding Co. A large number of photographs were also on display showing progress in the construction of the plants of the Columbus Power Co., at Goat Rock, the Jackson plant of the Central Georgia Power Co., and its substations and the plants and substations of the Georgia Railway and Power Company at Tallulah Falls, Atlanta and other places.

Comments on Plans of Society for Electrical Development, Quoting Prominent Electrical Men.

BY J. M. WAKEMAN, GENERAL MANAGER.

The Society for Electrical Development, Inc., which embraces in its membership central stations, electrical manufacturers, electrical contractors and electrical supply dealers in the United States and Canada, has one object on which its every energy is concentrated, as follows: To increase the use of electric current by the general public and, consequently, to increase the use of electrical apparatus and devices. The actual work of the society will include the promotion and facilitating of plans and the execution of various methods and means to this end. It will further encourage the development of electrical science, art and industry, develop and promote the welfare of individuals in all branches of the industry, encourage harmonious relations that will assist in maintaining the industry in the highest confidence of the public and establish co-operative relations among the different electrical interests, so that each may have the opportunity of contributing in some degree toward the result desired by all.

Mr. J. Robert Crouse has enunciated some of the underlying principles of the Society for Electrical Development, as follows: "Progress in our electrical business during thirty years (notwithstanding that less than 30 per cent of the population is electrically served) has been one of the wonders of the world; its contribution to the comfort, happiness and efficiency of our modern life are so great that we wonder how a preceding generation did without electricity. We may justly feel proud of such a magnificent business which in every department of its development is so worthy of our best thought and effort.

"However, in the field of selling and distribution, we are challenged by the cold fact that no essential progress—meaning by this a decreasing ratio of sales expense to sales—has been generally accomplished. Not only this, but there is a prevailing opinion among the manufacturers, contractors, jobbers and dealers that the ratio of sales expense to sales tend to increase. The annual reports of some of the largest electrical manufacturers makes specific mention of this tendency as a fact in their operation.

"Our electrical business, technical in its very nature, has doubtless for that reason placed less emphasis in the past on aggressive selling and distributing effort—witness the fact that the first commercial papers in the National Electric Light Association appeared only so recently as 1905, and national advertising by individual companies began about 1907, 1908.

"It is estimated that the gross sales, ratio of sales expense and sales expense for 1912, in the electrical business, were approximately as indicated in the following table. The $80,000,000 of sales effort (which is equal to one-fifth of the gross sales of all the central stations) is incurred by approximately 5,000 central stations, 500 manufacturers, 200 jobbers, 5,000 dealers and contractors—a total of 10,700 organizations. It is of special importance to note that $60,000,000 of this $80,000,000 sales effort is incurred by the manufacturers, jobbers, dealers and contractors who operate under complete competitive conditions, at a sales expense ratio of at least 15 per cent, and tending to increase.

"While this table and the above comments are broad generalizations, the reader is asked to check the principle and its application in his own particular case.

Branch of Business	Gross Sales 1912	Per Cent Ratio Sales Expense to Sales	Sales Expense, 1912
Central Stations	$400,000,000	5	$20,000,000
Dealers and Contractors	100,000,000	15	15,000,000
Manufacturers and Jobbers	300,000,000	15	45,000,000
Total	$800,000,000		$80,000,000

"These facts in themselves are a challenge to commercial men, which cannot be avoided. They justify the most careful search for causes and investigation of plans for improvement.

"The Society for Electrical Development proposes a broad, common organization of our entire industry; central stations, manufacturers, jobbers, dealers and contractors (controlled by a balanced representation from each), through which a part of this $80,000,000 of unorganized and competitive sales effort can be more effectively exerted through organized and co-operative effort in promoting and popularizing electrical service. These plans to teach the public to 'Do It Electrically'—many more than can at once be undertaken—have been worked out and endorsed as entirely practical by many prominent men in our business.

"The Society proposes at the start that a minimum of $200,000 or only one-fourth of 1 per cent of this $80,000,000 of competitive sales expense, be co-operatively expended. The basis of subscription is for manufacturers and central stations, one-fifteenth of 1 per cent of gross sales, and for jobbers, dealers and contractors, one-twentieth of 1 per cent, amounting, for illustration, in the case of the former, to $66.66 per $100,000 of gross business, and in the latter case to $50 per $100,000 of gross business—the subscription being on an annual basis. This means in the case of a company having a 15 per cent sales expense account, only one three-hundredth of its sales appropriations. There are few organizations which cannot locate competitive expenses of doubtful value equal to the Society's subscription. While individual subscriptions are comparatively small and in no sense burdensome, yet general co-operation in the movement will make a fund of $500,000 per annum available for progressive and aggressive market cultivation along these new lines.

"This Society creates the organization and the fund through which some of our dollars can co-operate with the good will of us all in broad, effective activity for the expansion of the market, while we continue with the most of our dollars to compete for our fair share. This plan means real progress in the direction of more efficient distribution of electrical service through joint cultivation of our common market—the great pre-occupied, incredulous, money-spending public—a result which our present systems neither accomplish nor promise ever to achieve on the old lines."

Naturally, one of the first questions asked by prospective members is as to the cost of membership. Mr. W. E. Robertson has undertaken to answer this inquiry, so far as the electrical jobbers and electrical contractors are concerned, as follows:

"The cost of participation on the part of jobbers and contractors in the work of the Society for Electrical Development has been fixed at one-twentieth of 1 per cent on the gross sales. A correct analysis of the purpose of the contribution will take it out of the 'cost-of-doing-business' column and place it properly where it belongs, that is, in the 'creating-a-larger-market' column. An appropriation of from 1/300 to 1/400 of 1 per cent of the expense account of jobbers and contractors is equivalent to one-twentieth of 1 per cent on the sales. Viewed from this standpoint the cost of co-operation in creating an increased market is infinitesimal. The average cost of doing business over a period of years on the part of both contractors and jobbers is from 15 to 20 per cent of the sales, and heretofore this entire amount has been spent in securing business on a competitive basis, and nothing has been spent in increasing the total demand.

"It has never been possible in the history of civilization to secure co-operative effort on the part of an entire industry, the reason being the very old one that human nature is so distrustful of the future as to make it exceedingly difficult to get men as a class to part with a present tangible dollar for the purpose of securing, and in fact positively insuring many future dollars. The impossibility heretofore of overcoming this stupidity on the part of men should not prove detrimental, as an increasing confidence in one's fellowmen, added to an ever-increasing intelligence, has prepared our industry to do things never before done.

"Since our industry as a whole owes its existence to the demonstration that was formerly impossible is now possible, it is logical to believe that the imagination of the jobbers and contractors has been sufficiently aroused, and their faith in the integrity of the administrative details of the society has become sufficiently strong, to warrant the belief that from 1/300 to 1/400 of the cost of doing business will be set aside for the purpose of increasing the sum of the opportunity to do business, leaving the other 299/300 or 399/400 of the cost to be used in its present and former channels."

Annual Convention of National Electrical Contractors Association at Chattanooga, Tenn.

On July 16 to 19, the National Electrical Contractors Association held its thirteenth annual convention at Chattanooga, Tenn. While the attendance at this meeting was not large, it was representative of the industry and the convention will go down in the history of the association as perhaps one of the most successful. There are now 1,275 members of the Association, 214, including ladies and guests, attending the Chattanooga meeting. While the first session of the convention did not open until Wednesday morning, July 16, the annual meeting of the board of directors of the association was held on Tuesday the 15, at which the regular routine of annual business was transacted. This meeting showed the association in a healthy condition financially.

The first session was formerly opened by an address by Joseph A. Fowler of the Tennessee State Association. To this address President Earnest Freeman responded, making special reference to Chattanooga and the hospitality which had been extended to visiting contractors. Following this address H. Clay Evans welcomed the visitors on behalf of the State of Tennessee. On behalf of the city of Chattanooga the visitors were welcomed by T. C. Betterton, who commented on the hydro-electric development in Tennessee. Mr. A. M. Schoen, of Atlanta, was the last speaker of the session, touching upon the electrical development in recent times and the origin and growth of the National Electrical Code. The remaining sessions of the convention on Wednesday afternoon, on Thursday and on Friday were executive sessions and open to members only. At these times, reports of the officials were presented and other matters of a general business nature taken up.

On Wednesday afternoon President Ernest Freeman, of Chicago, delivered his annual address and reports of Treasurer J. R. Galloway, of Washington, D. C., and Secretary W. H. Morton, of Utica, N. Y., were read. President Freeman's address gave the features of the progress of the organization and outlined a bright future for it. He showed that the membership includes substantial companies from all parts of the country and that the past year has been one of successful growth and development. He believes that the association has done much to bring about co-operative work among companies and create harmonious relationship with the various interests in the electrical business.

At this session Mr. W. H. Morton, who has served the association as secretary since its organization, twelve years, tendered his resignation to take effect September 1st. A committee was appointed which introduced resolutions thanking Mr. Morton for his able work as secretary for the association.

The recent changes in the rules of the National Electrical Code at the biennial meeting held in New York last March were explained by Ernest McCleary of Detroit. Mr. McCleary went into the subject, thoroughly explaining all recent changes. The subject of guaranteeing the work of the members of the association was next brought up and thoroughly discussed, it being decided that the scheme would reflect credit to the association as a whole and give its members a better standing with central stations and customers. This subject was turned over to a committee for investigation and report.

At the Thursday session J. M. Wakeman, general manager of the Society for Electrical Development, gave an address outlining the purpose and scope of that body. Considerable interest was manifested in the organization and some 24 contractors made application for membership.

The subject of a general contract now made by architects covering all work was thoroughly discussed, it being decided that the National Electrical Contractors Association would suggest to the American Institute of Architects a segregation of contracts so that the general contractor in subletting electrical work could not use one contractor against the other.

The sessions on Friday were devoted to subjects of progress, policy and business matters. The bookkeeping system adopted by the National Electrical Contractors Association was explained by F. L. Decker. This system is sold to members at $15.00 and is a plan devised for handling accounts from beginning of construction to completion that will show how much money has been made or lost on every job and also the true status of the business at the end of every month. This system should be of considerable value to electrical contractors.

A report on the standardization of finishes by G. M. Sanborn, of Indianapolis, brought out the intention of the association to induce manufacturers to adopt standard finishes of fixtures, sockets, wall plates, etc., through distributing to members numbered samples and requested them to order from the manufacturer by a number. In this way a standard can be established. Standardization of sizes of conduit for the insulation of wires and cables adopted by the National Electrical Contractors Association was also explained at this session. The charts constructed by the association were explained and their use recommended to secure conduit of sufficient size to cover all work and at the same time be economical in installation.

The universal data and sales book issued by the association was explained by Mr. G. M. Sanborn, this book being a guide for the members and not a code of understanding or agreement, fixing or in any way affecting prices of material.

During the Friday session addresses were delivered by W. E. Robertson of Robertson-Cataract Company, of Rochester, N. Y., in which the fields of the jobber, dealer and contractor were thoroughly defined. The speaker emphasized the need of closer co-operation between jobbers, dealers and contractors. P. L. Miles, of the National Quality Lamp Division of the General Electric Co., also delivered an address on Advertising and Its Benefits in the Electrical Contracting Business.

OFFICERS FOR 1913.

The officers elected for the coming year are as follows: President, Ernest Freeman, of Chicago, (re-elected); first vice-president, Mr. J. C. Hatzel, of New York; second vice-president, Mr. W. L. Hutchison, of Kansas City; third vice-president, J. C. Hendley, of Los Angeles; treasurer, J. R. Galloway, of Washington; and sergeant-at-arms, J. C. Sterns, of Buffalo. Mr. W. H. Morton was re-elected as secretary of the association with the understanding that the executive committee will fill the position by September 1st, when his resignation takes effect. The next convention of the association will be held at Detroit, Mich., sometime during the spring of 1914.

Saturday morning was given over to entertainment and a visit to Signal Mountain. In the afternoon the members and guests visited the lock and dam of the Chattanooga & Tennessee River Power Company at Hales Bar. Entertainments of the usual convention nature were held throughout the convention and formed an enjoyable part of the meeting.

Convention of Illuminating Engineering Society.

At a meeting of the general convention committee of the Illuminating Engineering Society, held in the rooms of the Society, New York City, Thursday, August 14, arrangements were completed for the seventh annual convention, to be held at Hotel Schenley, Pittsburgh, September 22 to 26.

New Business Methods and Results

Representing Interests of Central Station, Electrical Jobbers, Dealers and Contractors.

Current Topics and Events in Central Station Fields.

We note with interest the communication from a Southern commercial manager in the August issue. While the reference might have been noted by several companies (we have since learned), his response in defense of his position shows clearly that he is alive and after business. It is quite true that the electric truck cannot compete with the gasoline machine for long distance work, yet the electric can be used several miles in the country when the roads are good. One company especially referred to by the editor in his comment has no electric truck, yet most of the work could be accomplished quite as well by an electric as by a gasoline driven machine.

PUBLIC SERVICE COMMISSIONS.

There are now some 30 public service commissions, and the number constantly increasing both in importance and dignity. Pennsylvania is the latest state to yield to the inevitable. The new law, while not what might have been desired, has some good features. It protects a company already serving the public from wasteful or needless competition and the consequent duplication of investment. However, it has the weak point in common with the laws of several other states, in that it exercises no control over municipal plants, nor does it protect central stations from unfair competition with municipal plants.

Most public utilities are accepting the new regime as gracefully as possible, but some are protesting that if rates are reduced to a point where the capital invested is only able to earn what the commissions consider a reasonable return, that it will not be possible to attract sufficient capital to properly exploit the industry. While all the dark clouds have not rolled by, we believe this matter will right itself. There are very few if any cases of any unfair advantage being taken by the commissions and few if any instances where they have abused their power. The popular distrust of corporations seems to have about reached its high point, if not now actually on the decline. The real objection in the minds of thoughtful persons is not in regard to the centralization of capital itself, but to the abuses which such centralization renders possible.

It seems to be now generally believed that the increasing regulation by commissions will check the installation of municipal plants. Two cases have recently come to our attention. One of these was at Camden, N. J., where a report of experts showed that the city could buy current for lighting the streets cheaper than they could make it. The other case was at Sandusky, Ohio. Here an ordinance was passed reducing the rates for current. Then Sandusky Gas & Electric Co. protested, and appealed to the state utilities commission, which ruled against the city. In retaliation, the authorities called for a special election to vote on a municipal plant, with the result that the project was decisively defeated. In an address before the Southeastern Section of the N. E. L. A., at Macon, Ga., August 14, Mr. T. C. Martin, secretary of the N. E. L. A., and expert for the census bureau, predicted that the data of the next census of the electrical industry will show a reduction of the capital invested in municipal plants, now about 10 per cent of the total invested in the industry, to not more than 5 per cent. Such seems to be the general tendency through the increasing importance and expansion of the large transmission companies.

THE SOCIETY FOR ELECTRICAL DEVELOPMENT.

The Society for Electrical Development is carrying on a strenuous membership campaign and making plans to secure a larger market for electrical goods. The readiness of manufacturers to support the movement has led some to believe that it was planned primarily for their benefit. However, Mr. Osborne, speaking for the Westinghouse Electric & Manufacturnig Company, states elsewhere in this issue that their attitude is cooperative in the broadest sense of the word, believing that that which is truly cooperative will be in the last analysis profitable to all. The membership is now past 300 with subscriptions pledged in excess of $134,-000.

NEW BUSINESS METHODS AND NOTES.

The Narragansett Electric Co., of Providence, R. I., has posted the following rules for the guidance of its employes:

Treat all customers politely and courteously.

Do not misrepresent anything.

Do not try to be smart.

Do not think you are doing the company a favor by beating a customer.

The motto of this company is "A square deal to the public."

See that you live up to it.

The New York, Brooklyn and Chicago Edison companies have adopted a free renewal policy for all tungsten lamps of 100 watts and over.

The use of electrically operated domestic appliances is helping out with the servant problem. A "help wanted" ad recently published in a Chicago paper calls particular attention to the fact that electric washers and cleaners are used in the home.

The Union Light & Power Company, of Franklin, Mass., is adopting an idea that has been used in England for some time, consisting in renting electric wiring, the same being put in by the company, and remaining its property, the monthly rental charge is very moderate, covering simply the interest on the investment.

The value of a record of wired houses for the convenience of central station customers has often been pointed out. The Baltimore Gas and Electric is becoming quite a serious competitor of the real estate agent through such a record, having listed over 1,200 properties.

A new use for current consists in operating a refrigerating system for keeping water cool for tempering steel. When the water is allowed to cool naturally, the temperature is found to often cause a partial annealing. It has been found that the output can be increased 1-3 with an artificial cooling system installed.

The isolated plant should be a valuable off-season load to the central station. During the summer, no steam is needed, and the labor cost will run high per Kw-hr. Why shouldn't the owner and the commercial manager get together to their mutual advantage?

In the last two years the Tri-State Railway & Electric Company has achieved a remarkable growth at Steubenville, Ohio, having quadrupled its connected load. The motor load showed the greatest increase from 40 to 1,500 horsepower.

TESTING THE METER.

With every unexplained increase in bills complaints are sure to come, and a goodly number of these will reflect seriously on the veracity of the meter. The initiated know that out of every 1,000 meters taken at random, about 500 to 600 will be very nearly correct. Of the balance 90 per cent will be running from 5 to 15 per cent slow, while perhaps from 20 to 40 out of the 1,000 will be a little fast. Consequently, when a meter complaint comes in, heads shake wisely, and certain conclusions are drawn. Perhaps, if it were explained that every meter is tested when installed, and that as time goes on and the jewels get worn and full of dust the meter runs slower and slower until it gets so slow that the company in self defense has to take it out and recalibrate it, the customer may be made to see that the high bill is due to other causes. There comes a time, however, when a test is demanded, and most companies have found it wise to make a test even if assured that the reading is correct, rather than antagonize the customer by refusing to do so.

THE N. E. C. A. CONVENTION.

The recent convention of the National Electrical Contractors' Association, held at Chattanooga, showed among other things, that the contractors are now giving more attention to maintaining a high standard of work and overcoming the abuses which have injured their own business, than to throwing up breastworks against imaginary foes. While the spirit of cooperation is not all that could be desired, yet the tendency is decidedly favorable to greatly improved conditions.

NOTES.

Eight states now require electric headlights on locomotives.

The St. Louis Board of Education has purchased four electric trucks for use in distributing supplies, etc.

A tungsten lamp consuming but .5 watt per c.p. has been developed. The filament is short and thick, taking about 6 amperes, making it suited to series street lighting.

Profitable and Unprofitable Loads.

The subject assigned for this issue, namely, "An Analysis of Various Loads, Showing Their Relative Profitableness," is closely related to the subject discussed last month, when an analysis was made of the factors affecting central station income. It also overlaps the topic for November in which special loads, such as pumping, laundries, steam heating, etc., will be taken up and analyzed. For this reason we will not atempt to treat this subject as an entirely isolated topic but continue the discussion of last month, especially in its relation to profitable business and lead up naturally to a consideration of the specific instances in the November issue.

While the subject of cost analysis and the corresponding rates for electric service have been made the subject of almost endless discussion, and while numerous rate schedules have been proposed, many of them differing only in their degree of complexity, the basic principles are essentially simple. The conduct of any business involves a number of expenditures, some of which can be equitably apportioned among individual transactions and some cannot. Some are related in a simple way to the volume of business while others have no such relationship, and hence must be considered as a general burden upon the business, or as now generally termed an "overhead" expence.

Naturally, lying between that class of charges which can be easily distributed, and those which cannot be even approximately apportioned, there are a number capable of more or less exact analysis, and it is over these that the most discussion has arisen.

It is now recognized by commercial experts that the volume of overhead or undivided expenses should be made as small as possible, since the effect of undivided charges always attracts unprofitable and repels profitable business. This is evident, for if a certain expense which is necessary in order to supply A, for instance, be equally divided between A and B, then since A is being served at less than he should equitably pay, he is a relatively unprofitable customer, and also for that very reason others of the same class will be attracted. The converse is true of B. The class of business which he represents will be rather repelled on account of having to bear part of a fixed expense which was incurred for the benefit of others. It may be seen, therefore, that every item that can be apportioned among customers with reasonable exactness and without undue complications of method, should be so distributed.

Considering now this analysis as it relates to the central station industry, we find that the expense of supplying service is divisible into variable and fixed charges, that is, those which vary with the output, and those which do not. In the first class is included fuel, water, oil, repairs to equipment, etc. We can therefore quite readily arrive at an equitable charge per Kw-hr covering the expense of production. The fixed charges, however, are not proportional to the output, and must be provided for in some other way. It is true that we can increase the rate per Kw-hr to a point where it will provide for all the expenses necessary to run the business, but the arrangement will not be equitable, and it will drive away profitable business, as we have stated, since the effect of lumping together the fixed charges will be to overcharge the long burners, and serve the short-hour customers at a loss. Naturally, therefore, those using light, for instance, for long periods will find it cheaper to produce it themselves, or will go to competitive illuminants.

Since in the production of electricity, we are dealing with a non-storable product, a very important factor in the cost of supplying service, is in the providing of the equipment needed to supply the demand for current at any time, and as the necessity for the proper apportionment of charges became more apparent, it was suggested that a large part of the overhead or fixed charges were proportional to the demand, and that as these charges were measured or estimated, a further distribution could and should be made. Of course, there are a number of things which the most rigid analysis can not apportion equitably among the customers. For instance, it would be manifestly absurd to charge a customer having business with the general manager, with the value of his time for the period of the interview, and likewise many other cases.

Other expenses which are not in any proportion to either the consumption or the demand are those of the commercial department, including advertising and general publicity, legal expenses and the like. There are, however, other charges, such as the running of services, rental of meters, replacing fuses, etc., which can be made the subject of individual charges, if desired. In fact, these things were formerly handled in just this way by a number of companies, but the labor involved in handling and accounting for so many petty items overbalanced any advantage gained in the accuracy of the distributions.

However, such items should not be totally neglected. For instance, considering service charges, if a company has a number of city customers, where but a small amount of labor and material are required to make connections, and at the same time have a good deal of outlying business where long extensions are necessary, some provision should be made for making those who benefit by the service bear their share of the expense. Unless this is done, it adds an unjust charge, even though a small one, to the amount paid by the profitable city customers, and at the same time encourages more demands for extensions further into the country.

The unprofitableness of such business is not always realized at first, but when the line gets in need of frequent repairs, it becomes apparent, and it is easier to inaugurate service than to discontinue it, or to adjust the rate, as many central stations who have pushed their lines out through sparsely settled country with insufficient guarantee of business have already discovered. We have in mind at this writing a line about 10 or 12 miles long in Pennsylvania, running through two or three small villages with a total of 38 customers. After a couple of years' operation, the company awoke to the fact that they were losing money, and the line was cut off amid a storm of protest. Had a sufficient charge been made at the time to cover the cost of the construction and the upkeep of the line, it would no doubt be in operation today.

What then may we consider as a profitable load? It may seem almost absurd to say that a profitable load is one which is carried at a profit, and yet there is no other distinction. However, as a further criterion, we might say that any load which involves a large fixed and undistributed expense, (or which has a large investment, in proportion to the revenue) may be suspected of being unprofitable. Bear in mind here that it is not alone the fact that a lighting load may be short hour, or that a small house may require a long extension, that makes it unprofitable, but the fact that there is no adequate apportionment of the cost of the service. If every expense incurred by the central station would be covered by a corresponding charge, one piece of business would be as profitable, in proportion, as any other. We might further say that any load which is capable of being accurately analyzed, if not profitable, may be made so. If, under a proper distribution of the costs, the business will not come to the central station, it is better not to have it, because if taken on otherwise it will only serve as a burden upon the other and more profitable business.

While, as we pointed out last month, the long hour user is not necessarily more profitable to the central station than other customers, yet he is of more value to the community, because his load makes for efficiency of production, and hence enables the central station to serve its customers at lower cost and thus indirectly stimulates electric service in general. Likewise it is of advantage to secure as many customers in a district as possible, because this makes for efficiency of distribution with the same results. Still further, we might say that it is to the advantage for every one using electric light to use the metallic filament lamp because it aids in efficiency of utilization.

A. G. Rakestraw.

Electric Washing Machine Campaign Conducted by the Chicago Electric Shop.

A unique electric washing machine advertising campaign was recently used by the Electric Shop of Chicago. While the advertising was in a sense an experiment, it has proven extremely successful and offers great possibilities for advertising other electrical appliances. The plan was to offer an $85 Federal electric washing machine as a prize to the person estimating the nearest saving possible in one year by the use of an electric washing machine. The campaign was started by a number of newspaper advertisements showing illustrations of the machine, giving full details of the contest and having blanks for the savings to be filled out by the contestants. Each contestant was then to write a twenty-five word article upon the advantage of using an electric washing machine in the home. Circulars giving these details were handed to customers at the Electric Shop, and were enclosed with bills.

Replies began to come in almost immediately and up to the time of the closing date, July 1, over five hundred persons had submitted articles and estimates for the prize. While some estimates were entirely beyond reason, the majority showed that the matter had been carefully considered and the saving figured out upon a logical basis. Twenty-three judges were selected from representative business men in Chicago to pass upon the contest. They awarded the prize to Orlander P. Tidd, whose estimate of savings is as follows:

Wages to servants and washwomen	$ 63.00
Food and car fare to servants and washwomen	8.40
Labor	22.00
Fuel	6.30
Soap	4.50
Wear and tear on clothing and materials washed	13.50
Tearing out buttons	.60
Laundry damage, such as marks of iron rust, etc.	1.30
Laundry losses	2.70
Cleaner's bills	6.00
Time	37.80
Space	10.50
Damage from quantities of steam in the room	2.75
Long boiling	1.00
Health	4.20
	$185.05

Mr. Tidd's article follows: "Cleanliness is next to Godliness," and the "Ideal State of Absolute Cleanliness" can be realized by the use of a Federal Electric Washing Machine. To enumerate the advantages of this, the most modern health, labor, time and money savers, would require far more space than this sheet allows; but it may be safely said that our women—who are necessarily responsible for that ideal state of cleanliness—who are so fortunate as to become possessors of this magnificent addition to the world's great inventions, can rest assured in the future of the elimination of the dangers of infections, of bad temper, of that worn-out feeling caused by many steps, to the hands and most important of all, to good health.

Mr. Tidd's estimate was nearest to the estimate prepared by the judges, which follows:

Wages to servants and washwomen	$ 78.00
Food and car fare to servants and washwomen	18.20
Labor	22.00
Fuel	6.30
Soap	4.50
Wear and tear on clothing and materials washed	13.50
Tearing out buttons	1.67
Laundry damage, such as marks of iron rust, etc.	2.50
Laundry losses	2.75
Cleaner's bills	6.00
Time	20.20
Space	4.50
Damage from quantities of steam in the room	2.75
Long boiling	1.00
Health—cannot be estimated in money	
	$183.87

Immediately after the close of the contest, letters were sent to all announcing the result, thanking each contestant for his interest, and stating that a representative of Electric Shop would call to thank them personally for the trouble they had taken. The salesman then followed these letters. As all of the contestants were already convinced of the saving to be effected by the use of an electric washing machine, it was not difficult to secure orders from those who were not already using washers. The estimates and savings and the articles submitted afford very good advertising matter for future advertisements. Altogether, the campaign proved far more successful than was expected.

Meter Records of New York and Queens Electric Light & Power Co., New York.

The system of receiving and keeping a record of meters by the N. Y. & Queens Electric Light and Power Co. is considered a complete one and one into which liability of error has been carefully guarded against. On receipt of the meters from the manufacturer they are unpacked and their serial number and rating entered in what is called the stock book, together with the company number, which is placed on the magnets in white figures one-quarter of an inch in height and which can plainly be seen through the glass cover at any angle or height within the limits specified by the company's rules of installation. The stock book is then turned over to the department clerk, who enters the above data on a card, which is filed for record.

The next step is to check the meter for accuracy and place it in stock. The result of the test is then entered on the card, which up to this point gives the complete history of the meter until an order is drawn and the meter installed in the consumer's premises. The man who does the setting is required to check both company and serial numbers, also the rating on the work order, which is returned to the meter clerk for entry, who then sends it to the accounting department for filing. The meter data by this time has been checked three times, and if any errors had been made they would have been discovered and corrected. While the system of checking does not vary from that employed by member N. E. L. A. companies, yet the system of record of test, etc., is one peculiar to this company and a very simple and complete one, as the following will show. With the exception of laboratory tests, all test cards are made in duplicate and upon an order drawn by the accounting department to the meter department. The meter department, on completion of the test, enter it in their card system and give it a test number. The test order bears the consumer's application number, which is always used by the main office for filing purposes. This test number is for meter department filing. Both application and test numbers used, eliminate any duplicate order which might be placed to have tests made of same meter for the same reasons.

The test cards are then separated, the duplicate of which is sent to the acounting department and placed on file for general information. The original copy is returned by the meter department and filed in numerical order. The system employed in filing test cards is a very unique one. Instead of the cards being filed in a regular filing cabinet they are placed in temporary binders until two hundred cards have accumulated, which are then permanently bound in book form, the index of which is obtained by referring to the card system.

R. B. Mateer, Sales Manager, Great Western Power Company, Writes on Competitive Situations.

Where rival light and power companies occupy the same field, it does not necessarily follow that duplication of equipment and distributing systems represent large waste expended to no purpose, nor does it result in a merger where the town and country is scoured for non-consumers by strong soliciting forces. Competition today is not the result of a stock jobbing scheme nor a desire on the part of the banker to risk the cash of his clients, but is the direct consequence of one of several evils. (a) Narrow business policy of existing utilities. (b) Failure to develop territory. (c) Tendency to charge all the traffic will bear—high rates. (d) Poor service. (e) Over capitalization—watered securities. (f) Failure to recognize the public as a partner. (g) Greed—on the part of the so-called power trust to provide funds necessary to pay interest on stock and bonds of holding companies that are without earning power, except by bleeding underlying subsidiary concerns. (h) Failure to grow with the development of the country. The latter is by far the potent factor in the organization of competitive utilities and is the result of a narrow business policy of denying extensions into suburban districts and agricultural sections.

Before the organization of what is possibly the largest hydroelectric development in the West, the suburban resident sought in vain for light, the farmer was dependent on internal combustion engines or air-motors. Service was denied, as an aggressive expansive policy involved the rebuilding of a system planned for the present and without thought of the future. With each authorized increase of capital, small water powers were devoloped while those of huge proportions and future possibilities passed unnoticed, awaiting the approach of the far-seeing capitalist who built for the future.

With the slogan, "If it's modern—it's electrical," competition is necessary, not only to keep pace with the demands occasioned by new applications of electricity, but for the natural readjustment of rates on that commodity that today is not a luxury but a convenience and necessity.

Questions and Answers from Readers

Readers are invited to make liberal use of this department for discussing questions, obtaining information, opinions or experiences from other readers. Discussions and criticisms on answers to questions are solicited. However, editors are not responsible for correctness of statements of opinion or fact in discussions. All published answers and discussions are paid for.

WHAT IS MEANT BY TERM "PHASING IN?"

Editor Electrical Engineering:

(397) Please publish an explanation of what is meant by the term "phasing-in" alternating current apparatus. For instance, what is the operation when "phasing-in" a synchronous motor at a substation? W. E. F.

WHAT'S WRONG WITH REFILLABLE FUSES?

Editor Electrical Engineering:

(398) The writer has never been able to learn what features of the refillable fuse, for instance the "Daum" type, are so radically wrong as to justify the underwriters in withholding their approval of them. If some reader can give this information through the question and answer columns, it will be appreciated. W. E. C.

SERIES VS. PARALLEL ARMATURE WINDINGS.

Editor Electrical Engineering:

(399) Please explain difference between a series and parallel armature winding on a four pole machine. Explain relation of coils under the field poles and armature connections. F. W. Topping.

TESTING OUT SIGN WIRING.

Editor Electrical Engineering:

(400) In the case of a sign, wired in series-multiple, when unbalancing causes the burn-out of one series multiple branch, how can the burned out branch be located without testing all the lamps? K. W. H.

POSITION OF BRUSHES ON D. C. GENERATORS.

Editor Electrical Engineering:

(401) In some designs of D.C. generators, the brushes are directly opposite the pole pieces, in other designs they are in the neutral region. What conditions determine the location? V. K. S.

METER CONNECTIONS AND COST ON 3-PHASE, 4-WIRE SYSTEMS.

Editor Electrical Engineering:

(402) How is it that the four-wire, 3-phase system is objectionable for central station work on account of an increased cost of meters over the 3-wire, 3-phase system? Please show by diagram he connections for meters on such a system. L. E. W.

Spacing of Wires on Transmission Lines. Ans. Ques. No. 358.

Editor Electrical Engineering:

In regard to the spacing of wires on transmission lines, as mentioned by W. E. C. in Question 358 of the March issue, I may say in general that the spacing is usually a compromise of the several factors going to make up the electric properties and the reliability of the line. If it were not for the mechanical construction, the spacing of the wires could be made such that a proper balance between line reactance and capacity could be produced for practically any voltage and length of line. It is apparent, however, that if the spacing is not sufficient that trouble will be caused, owing to shorts from the swingings of the conductors together or by birds bridging the conductor. Power arcs are also likely to do much damage to conductors where the clearance is small.

Where the vertical arrangement of conductor is used, there is likely to be considerable trouble owing to wires swinging together during sleet storms. The sleet drops off of the conductor in one span allowing this conductor to jump up and if it does not strike, the greater deflection in the adjacent span may cause trouble. Some companies have gone to considerable trouble to get away from the vertical arrangement, reconstructing their lines so as to give horizontal clearance for sleet conditions.

The prevention of shorts is of much more importance than any changes in the reactance of the line. So in laying out the clearances of a line, the factor governing the swinging of the conductors together under probable operating conditions should be given the most attention.

In general the shorter the span the smaller the clearance, without danger of the wires swinging together. Also the higher the tension in the line the greater the effective clearance for a given spacing. In mountainous local tie spans which give trouble from swinging together are often put in with steel cable so that the tension may be high, making the effective clearance as large as possible.

While high tensions in the transmission line tend to increase the effective clearances, care must be taken that too great load is not placed on insulators, as the factor of safety will be so lowered that considerable trouble may result in time. In places where the line is dead ended or at angles where the stress is heavy, if too high tension is used a slight arc on the conductor may anneal it, and so lower its strength that it will soon break.

The cost of constructure and amount of power distributed and the value of reactance of the circuit must all be given careful consideration in deciding upon the clearance for the line as well as the mechanical properties of the conductor.

The question of line construction is more or less of an engineering problem, factors varying greatly with each installation. The tendency at the present time is to use shorter spans, as there has been too much trouble in the long spans where only moderate clearances have been used. If the system is to have any long spans believe it highly advisable to construct the tower so that greater clearance can be obtained for this part of the line.

A. O. Austin, Electrical Engineer, Ohio Insulator Company.

Spacing of Transmission Lines. Ans. Ques. No. 358.

Editor Electrical Engineering:

In regard to spacing of transmission line conductors mentioned by W. E. C. in the March issue, it is essential that the spacing be such as to prevent wires from swinging together or against towers in wind storms. The following distances have been determined and represent good practice:

Voltage	Distance apart—inches	Voltage	Distance apart—inches
6,600	18 to 24	44,000	48 to 60
11,000	18 to 24	66,000	72
15,000	24 to 30	88,000	96
22,000	30 to 36	110,000	120
33,000	36 to 48		

The spacing for one locality may not always be suited to other localities as the effect of corona must be considered. The critical voltages and spacings at which corona losses begins are as follows:

Spacing in Inches	Critical Voltage	Spacing Inches	Critical Voltage
15	42,000	35	49,000
22	45,000	52	52,000

H. H. Williams (Ala).

Grounding Secondaries. Ans. Ques. No. 364.

Editor Electrical Engineering:

The writer is not sure that he understands what the author of question No. 364 has in mind, but if he does understand rightly, the following suggestions may be of some use:

There are no factors that determine exactly the size of wire to be used in grounding secondary. Each case has to be worked out by itself. If, however, a particular lighting company makes 50 amperes, the minimum fuse on any of its primaries, at least 50 amperes must be able to flow constantly through ground connection including the ground wire without allowing any portion of the secondary to be raised more than a reasonable amount (say 25 per cent) above its normal voltage (say 110 volts). So, if above other conditions, wire of such size must be chosen that the resistance of its entire length from secondary to ground connection plus the resistance of ground connection plus the resistance between ground connection and grounded surfaces in building plus the resistance from the point of connection of ground wire and secondary to nearest point to building on which primary might possibly make contact, shall not total more than one-half ohm.

With the present use of miscellaneous sizes of primary fuses it seems much better to require by ordinance as will shortly be the case in Colorado Springs, that combined resistance of secondary grounds must in no case exceed one-quarter ohm, that in no case shall any secondary have less than two grounds initially, and that all buildings hereafter connected to lighting service shall have proper secondary wire connected to ground.

No matter what the size of primary, up to, say, 200 or 300 ampere fuse protection, a secondary would have good protection against serious voltage rise if not less than No. 6 gauge copper wire (which should be the minimum size) be used for any secondary ground connection. Secondaries are rarely, if ever, less size than No. 6. Of course, ground connections should be properly placed to protect building installations more than one ground being absolutely essential for thorough protection of any extended secondary.

A fair length of No. 6 wire can dispose of 200 ampere without serious voltage rise i fthe ground connection itself is "thorough." In the writer's opinion the only really "thorough" ground connection is that to a good water main or water service. And the best point to make such a ground is from the secondary service of any building to be protected to the water service of that building.

W. J. Canada (Col.)

Checking Meters and Transformers. Ans. Ques. No. 368.

Editor Electrical Engineering:

Following are answers to questions marked No. 368: A detailed description of testing A.C meters, with and without instrument transformers, and D. C. meters was given in the April and May (1912) issues of *Southern Electrician.* The derivation of the formula W = (3600 K R)/S is also given. These articles answer all sections of this question. Further, the diagrams asked for are on Page 191, of the May, 1912, issue.

Briefly, in answer, if the meter is to be checked against a standard in the primary line, the standard meter would be connected to standard instrument transformers. The reading of the standard meter should be multiplied by the product of the ratios of the transformers to get primary watts. The watthour meter would be considered as any other meter, and the disc constant would be used in the formula W = (3600 K R)/S. The meter in question has no constant marked on the disc, but has 80 K W H = 1500 R of disc. Then, 80,000 watthours = 1,500 revolutions, and since one watthour = 3600 watt seconds, then 3600 × 80000 watt seconds = 1500 revolutions. From the formula W S = 3600 K R, therefore 3600 × 80000 = 3600 × K × 1500, and K = 53.33 +.

If the meter is provided with current and potential transformers, but checked without them, the constant (K) should be divided by the product of the two ratios to get the secondary calibrating constant:

[53.33 /(cur. trans. ratio) × (pot. trans. ratio)].

The formula as given in the first part of this answer applies also to some makes of D.C. meters. The figure (1) on the disc of the D.C. meter is undoubtedly the calibrating constant and would apply in the formula if the meter is made by the General Electric Company. Some other companies use other formulas, hence the make of the meter must be known to give a definite reply. E. P. Peck (Ga.)

What Lengths Mark Division Between Long and Short Transmission Line for Calculation Purposes. Ans. Ques. No. 370

Editor Electrical Engineering:

The following formula may be used for determining the size wire when the per cent power loss is known: $A = (57 \times 10^{12} \times l \times K.W.) \div (P \times E^2 \times (P.F.)^2)$.

Where A = area of copper wire in circular mills; L = length of transmission line in miles; K.W. = kilowatt load; P = power loss in per cent; E = voltage between transmission wires; (P.F.) = power factor in per cent. This formula applies to the size wire in polyphase transmission lines, both two and three-phase. For single-phase multiply the area in circular mills by two.

So far as applying a formula to any given set of conditions, and expecting it to give correct results, it is impossible to state what length of line would be considered long or short, as the amount of load that a line carries and the voltage determines the effect of the charging current. The above formula solved for the line in question gives about 450,000 circular mills. This gives an error of 3 per cent in the power loss, as it neglects the charging current. If only 1,000 kilowatts were transmitted and conditions were the same, the error in the loss would be 9 per cent. If the voltage were double on this same line, the error would be about 15 per cent. It is, therefore, very apparent that this formula can only be used as the first approximation for determining the size wire, and it will then be necessary to calculate by some accurate means, the actual loss for the size wire determined by this formula. The inductance can never be neglected, and it is always necessary to use an accurate formula for determining voltage loss for, if the line is solved as a D.C. line, in this particular instance, the error is something like 300 per cent.

The above statement not only applies to high voltage long distance transmission lines, but also to 2,400 or 1,200-volt lines, insofar as inductance is concerned. The formula for power loss will be fairly accurate on any line less than 20,000 volts and having a length not greater than about forty miles, although it is possible that there might be some exception even to this rule, depending upon local conditions; such as the number of branches on the straight way transmission line and the value of the load carried. Small loads would give errors between 6 and 10 per cent.

N. E. Funk (N. J.)

Corrosion of Mine Cables. Ans. Ques. No. 372

Editor Electrical Engineering:

There is no doubt in my mind but that the corrosion in question is electrolytic. Current is leaking from the positive conductor to the ground, (which is here connected to the negative side of the network). The air in the return airway of a mine is particularly foul, and this, together with the usually high percentage of salts in water filtering into colliery workings, makes condensed or dripping moisture quite a good electrolyte so that, apart from direct chemical attack by the moisture, (which attack is generally quite considerable), a low resistance leakage path is provided wherever moisture can gain access to a live conductor above or below earth potential. Corrosion occurs at that electrode, (here the positive cable and its armoring), from which current flows.

The remedy for the trouble is to clean the joint thoroughly, (remaking it, if it has been weakened or pitted by corrosion), cover it with thoroughly waterproof insulating tape and paint the whole with a tough, waterproof insulating paint (asphaltum, etc.), or, preferably, form a wiped lead joint. The latter is, of course, only applicable when the cable itself is lead sheathed. Lead sheathing is inflexible, heavy and not altogether immune from corrosive attack. A most valuable sheathing material for cables which have to be exposed to corrosive moisture and rough handling and in which it is desirable, (as in most colliery service), to retain a considerable degree of flexibility, is siliceous rubber. This sheathing material—which must only be depended upon for mechanical protection and not for electrical insulation—is made by kneading together rubber and siliceous powder in about equal proportions. The mixture is forced while cold and under great mechanical pressure around the cable to be protected and is then vulcanized. The efficiency of the protection afforded seems to be due to a shielding or armoring effect of the siliceous material on the rubber particles. Cables thus protected will withstand any reasonable and a good deal of unreasonable treatment. Joints in cables sheathed with this material must be covered by truly waterproof tape, painted between layers and overall with tough waterproof composition. Tape or braiding which is not waterproof is worse than none at all.

R. E. Neale (England).

Calculating Economical Size of Conductor. Ans. Ques. No. 373.

Editor Electrical Engineering:

Answering W. L. E.'s question (373), in the May issue, the formulæ for calculating the size, in circular mills, of a conductor is: $(D \times W \times C) \div (p \times E^2)$.

In this formula, D is the distance of transmission one way in feet. W, the total number of watts delivered, C a constant depending upon the power factor, p the loss in line in per cent of power delivered and E the voltage between the main conductors at receiving end.

The value of C for any particular power factor is obtained by dividing 2,160—the value for constant current—by twice the square of the power factor, which is nearly 1690 in this case.

Then, $(400 \times 22380 \times 1690) \div (5.45 \times 110 \times 110) = 229{,}225$ cir. mills. Thus, a 300,000 cable is required at 110 volts. Now raise the voltage to 440 volts with the same voltage drop.—Then, $(400 \times 22380 \times 1690) \div (1.36 \times 440 \times 440) = 57{,}445$ cir. mills, or a No. 2 wire.

It is thus observed that by raising the voltage 4 times the area of the conductor will be decreased to one-fourth with the same drop of voltage. But by taking the same per cent of power loss you will decrease the area one-sixteenth, that is: $(400 \times 22380 \times 1690) \div (5.45 \times 440 \times 440) = 14{,}370$ cir. mills, or a No. 8 wire. From this W. L. E. will see it is to his advtanage to raise the voltage as high as practical.

F. N. Irvin (Texas).

Natural and Critical Frequency of Transmission Line. Ans. Ques. No. 387.

Editor Electrical Engineering:

If the self-induction were neutralized by the capacity, the current flowing under a given impressed E. M. F. would be a maximum and determined by Ohm's law. The frequency at which this neutralization occurs is called the critical frequency, since there is only one value of frequency at which this happens.

For inductance, we have, $E = 2\pi f L I$, where f is the frequency in cycles per sec., L inductance in henrys, and I the current. For capacity only we have $E = I/2\pi f k$, where k is capacity in farads.

For resonance $2\pi f L I = I/2\pi f k$; $2\pi f L = 1/2\pi f k$; $f = 1/2\pi \sqrt{1/KL}$.

This value of f is the frequency corresponding to the values of K and L. If the resistance of the circuit is very low the current will be excessive ($E = RI$). In ordinary practice, the frequencies employed are not high enough to make effects of resonance very common.

A. G. Riddick (Ala.).

Economical Size of Conductor. Ans. Ques. No. 373.

Editor Electrical Engineering:

In calculating the size of wire for the transmission of a given power, under definite conditions, the first step is to find the current required per phase, which can be calculated from the formula, $I = (P \times 746) \div (E \times \cos \Theta \times \sqrt{3})$

In this formula I is the current per phase, P the horsepower to be transmitted, E the phase voltage and $\cos \Theta$ the power factor. The question concerns the transmission of 30 horsepower a distance of 400 feet by 3-phase, 60 cycle, 110 volt current, power factor 80 per cent, drop 6 volts. Substituting in the above formula we find $I = 146.8$ amperes per phase.

The voltage drop depends upon the current flowing and the inductance and resistance of the line. The effect of capacity may be neglected for all cases except very long lines, operating at very high voltages. The inductance of the line may be figured from the formula $L = (80.5 + 740 \log D/r) \div 10^6$. L being inductance in henries per line, D the distance between centers of wires, and r the radius of the wires. The reactance per line may then be found from the formula $X = 2 \pi f L$. Where X is resistance in ohms and f the frequency of the circuit in cycles per second. These calculations will be much simplified by using values for inductance of circuits of various sizes of wire and spacing, tables of which are published in all electrical handbooks.

As a starting point let us assume a current density of 500 amperes per square inch in the line, which will require a conductor whose cross section is $146.8 \div 500 = .293$ square inches, or about 375,000 circular mils. Thus each conductor must be either a single cable of 375,000 circular mils, or say two No. 000 wires. If the single conductor be used, the resistance of the 400-foot circuit will be .0113 ohms per wire, and the inductance .0359 ohm per wire, at a frequency of 60 cycles, assuming that the wires are spaced 12 inches apart. Then the impedance per wire will be $\sqrt{(.0113^2 + .0359^2)} = .0376$ ohm, and since the impedance of a three-phase line is $\sqrt{3}$ times that of a single wire, the impedance of the above line will be $1.73 \times .0376 = .0651$ ohm, and the voltage drop would be $146.8 \times .0651 = 9.54$ volts, more than 50 per cent above the prescribed limit.

The marked effect upon the voltage drop, resulting from subdividing the conductors of an alternating current transmission line, may be seen in this case. By using two No. 000 wires instead of the 375,000 circular mil cable, the cross section, and weight of copper will be increased about 13 per cent. and the resistance decreased in the same ratio, that is, to .0098 ohm per leg. The inductance of the two No. 000 wires will be .0193 ohm per leg, so that the impedance will be $\sqrt{(.0098^2 + .0193^2)} = .0235$ ohm per leg, or $1.73 \times .0235 = .0374$ ohm for the three-phase line. Thus the voltage drop will be $146.8 \times .0374 = 5.96$ volts, which is within the limit given in the original question. Here the voltage drop has been reduced 37½ per cent, while the amount of copper has been increased only 13 per cent.

On account of the number of factors to be taken into consideration in designing a transmission line, it would be difficult, if not impossible, to lay down any fixed rule for determining the most economical voltage, or size of wire, to be used. Both depend upon circumstances which vary for different installations and each transmission line must be considered as a new problem. It is obvious that to transmit a given power, the higher the voltage the less the cost of copper for a given power loss or voltage drop, by reason of the lower value of current required. However, a minimum size of wire is soon reached on account of mechanical limitations and there is an increase of cost, instead of a saving, on account of the more expensive insulation required if the voltage is increased beyond the value corresponding to the current which such minimum wire will economically carry.

For large transmission systems, the voltage on the lines has gradually increased, keeping pace with, or perhaps, furnishing the incentive for developments in insulation of transforming and switching equipment and the line itself. The limit is undoubtedly fixed by the dielectric strength of the air at least until a reliable weatherproof insulation is developed, which will not unduly increase the weight and cost of the line.

Mr. John Greenhalgh (Engineering Magazine, October, 1912), gives a rough rule for determining the voltage of a transmission line, depending only upon the distance to which power is to be transmitted, namely, the voltage should be one thousand volts per mile for the first three miles and four hundred volts additional for each additional mile. A more complete formula (for three-phase transmission) is also given.

$$V = W \div [3 \sqrt[3]{(D\, e\, w \div 300\, r\, L)}]$$

Where V = voltage per phase; W = watts supplied to line; L = length of line in miles; D = current density in line in amperes per square inch; e = permissible power loss in per cent; r = resistance of a wire 1 mile long and 1 square inch in cross section.

For direct current work the formula is

$$V = W \div [\sqrt[3]{(D\, e\, w \div 100\, r\, L)}]$$

Where the symbols have the same significance as in the preceding formula, except that L is the length of wire, or twice the length of the line.

It must be borne in mind in designing a transmission line that such formulas as given above, as well as Kelvin's law for the most economical area of cross section of conductor, should be used with extreme care. The following statement is from "Electric Power Transmission" by Bell: "For one without the gift of prophecy the attempt to figure the line for such a transmission (general distribution from water power) by following any canonical rules for maximum economy is merely the wildest sort of guesswork."

C. S. Stouffer, (Ill.)

Operation of Water Wheel and Motor on Same Shaft. Ans. Ques. No. 384.

Editor Electrical Engineering:

If a shaft connected to a water wheel, and carrying load, be coupled to an induction motor driven shaft, the two will work together. The power developed by an induction motor is proportional to the slip, or per cent decrease of speed at load from synchronous speed. If the total load on the shafting is greater than the capacity of the water wheel at full gate, the speed will drop until the slip of the induction motor gives it enough power to carry the balance of the load. The speed regulation would be better than before on the water wheel side, and possibly on the motor side as well, for the wheel has excess power.

In case the load should be dropped suddenly, the wheel would tend to speed up the motor. When the speed rises above the synchronism the motor will act as an induction generator, delivering power to the line, the amount of power so delivered depending on the negative slip, or per cent excess of speed above synchronous speed. The speed of the motor will not be likely to increase over 6 or 8 per cent, depending on the capacity of water wheel and motor.

Why Does Lead Suddenly Increase? Ans. Ques. No. 380.

On a steady load of 20 amperes a sudden increase of load to 60 or 80 amperes may indicate malicious interference with lines, at a point sufficiently distant from the plant to give enough resistance in the primary feeder to prevent the current from reaching a value sufficient to blow fuses or trip breakers. L. P. Brode (Cal.).

Size of 3-Phase Motor Starters. Answers Question No. 383.

Editor Electrical Engineering:

For a star-delta starter it is only necessary to know the voltage and horsepower of the motor. For an auto-transformer starter the voltage, horsepower, frequency and number of phases of the motor must be given. It is sometimes necessary to know the starting torque required and the starting torque of the motor at different voltages. This enables one to descriminate between the necessity of using an auto-transformer or a star-delta starter. Also, if an auto-transformer is used it enables one to determine the per cent of normal full line voltage to be used on the starting taps. As a matter of fact there are only one or two makes of motors on the market which do not require an auto-starter. Furthermore a star-delta starter can be used only on a three-phase circuit.

Operation of Water Wheel and Motor on Same Shaft. Ans. Ques. No. 384.

Under the conditions given, J. P. L. can couple the two shafts together and rest assured that the motor will hold the speed of the water wheel constant, within certain limits according to the size of the motor as compared to that of the water wheel. To accomplish the desired results successfully he should adjust the governor of his water wheel so that the speed of the shafting and necessarily that of the motor would not cause the motor to deliver power until the gate of the wheel is wide open. This can be done by not allowing the speed to fall below the synchronous speed at no load. That is, the belt or chain between motor and shaft must be slack on both sides.

Care should be taken not to overdo this as such a procedure might over speed the motor, which would at once deliver back power into the line. This would be the case in any event should the load be suddenly removed. As a further precaution in case the motor is small compared to the size of the water wheel, it must be noted that the speed might rise so as to overload the motor excessively. This can be avoided by properly fusing the motor. This is altogether a very pretty problem and will give excellent results if carefully worked out.

Use of Time Limit Relays. Ans. Ques. No. 388.

The use of the time-limit relay has its only advantage in that a surge which is merely temporary in its effect cannot open the circuit. The disadvantage is that a real serious "short" may open the main line or even open the main breakers which, of course, gives unnecessary trouble. The trouble with time limits, however, has been found to be less than without them. This is taking everything into consideration.

Synchronous Motor Generator Set vs. Induction Set. Ans. Ques. No. 386.

In addition to the advantage of the power factor correction with a motor generator set we have the very important fact that the direct current voltage is absolutely independent of the alternating current voltage and cannot be affected by surges which always accompany sudden charges in load, and the direct current voltage is constant, depending only on the frequency of the alternating current side. When considering the difference in price, it should be remembered that the value of the investment in the motor generator set is very much higher than the rotary. The rotary is a special machine and can be satisfactorily operated only under special conditions.

Natural and Critical Frequency. Ans. Ques. No. 387.

The natural frequency of anything physical, electrical or otherwise is its resonant frequency. The critical frequency of any electrical circuit is that frequency at which the circuit begins to send out ether waves.

Why Load Suddenly Increases. Ans. Ques. No. 389.

The conditions stated here point to a floating cross. That is, some wire is supported loosely and occasionally allows a flash over from phase to phase.

William Mangum (N. Y.).

Corrosion of Switch Blades. Ans. Ques. No. 390.

Editor Electrical Engineering:

The action of the SO_2 (sulphur dioxide) gas from the producers would be less marked if it were possible to keep the switches perfectly dry. Since SO_2 is the anhydride of an acid, it will combine with the moisture on the switches and form sulphurous acid, according to the equation, $SO_2 + H_2O = H_2SO_3$. The addition of oxygen from the atmosphere may change it further into sulphuric acid (H_2SO_4).

I would suggest that the switchboard be protected from steam as much as possible. Any hydroxide, such as lime or crude caustic soda, will absorb the SO_2 and render it harmless by converting it into a sulphite. Therefore, the air for the switchboard room may be purified by passing it through a screen containing the hydroxide, or the air might be kept pure by passing the producer gas through such a screen or a tank of lime water, if such an arrangement were mechanically possible. This arrangement would also remove the carbon dioxide gas. T. G. Seidell (Ga.).

Transformer Ground Detector Arrangement. Ans. Ques. No. 391.

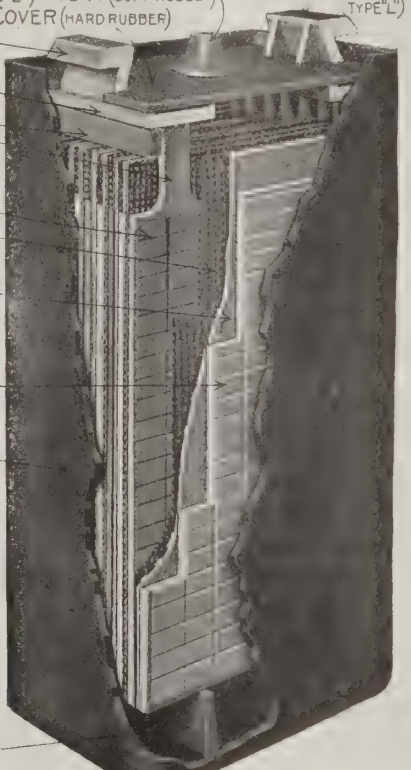
Editor Electrical Engineering:

Replying to question 391 by T. C. M., I do not see how the star connection of potential transformers with star point grounded could add any strain to insulation of delta connected transformers and motors on the system. Any system of a large size has practically this same condition, due to the electrostatic capacity of the lines, transformers, etc. That is, a voltmeter connected from line to ground would read practically star voltage due to the capacity leakage, if I may use the term. Star connection of power transformers is standard and no trouble is experienced on apparatus connected to these systems due to grounding the star point of the transformers. The potential transformers themselves are very liable to give trouble, as they provide a very small capacity path to ground for any lightning disturbance. E. P. Peck (Ga.).

New Apparatus and Appliances

The Gould Storage Battery for Vehicle Propulsion.

The illustration shown here is the type of cell now sold by the Gould Storage Battery Co., New York, for electric vehicle propulsion. In the positive plates in this cell the paste composition is made hard and dense by a new process and has the same high electrical capacity as the softer but less durable paste ordinarily used. The Gould plate is said to develop its full capacity by the softening of a mere surface layer while the oxide in the body of the plate remains firm and impervious to the jarring and vibration of the vehicle. Thus extremely long life is combined with continued high capacity, and renewal of the plate does not become necessary until the last particles of oxide have done useful work.



IMPROVED GOULD ELECTRIC VEHICLE BATTERY.

Gould batteries for electric vehicle propulsion are said by the makers to be in every way equal to those types made by the company for standby service in prominent electric plants, in driving submarine vessels of the U. S. and foreign navies, in driving New York street cars, in driving rush hour trains in the Grand Central Station, New York, and in lighting the trains of America's leading railroads.

Records for Bailey Electrics.

Ruggedness and reliability of service are important features of electrics used for commercial work. The Bailey roadster is a car especially serviceable to lighting companies, some twenty-four companies using it in light service, for general superintendent, line construction superintendent, trouble calls, etc. One car in the service of the Malden Electric Company, Malden, Mass., has covered 16,092 miles in a period of ten months up to July 1, 1913. This is an average of 53 miles per day including Sundays and holidays, the car being on duty 18 hours out of 24. It is regularly charged and cared for between 3 and 7 a. m., and can be boosted if necessary between 12 and 1 p. m., and between 5 and 6 p. m.

One of these cars driven by its owner, regularly, takes a hill of 6/10 of a mile long with a 11 per cent grade at a speed of 9 miles per hour, and a consumption of from 9 to 12 ampere-hours, depending upon conditions of charging. About 14.7 miles of poor roads and hills are covered in less than one hour, three-quarters of an hour being considered good time with a 70-horsepower Renault gasoline car over the same route. It often taxes a 40-horsepower gasoline car to climb the hill mentioned.

Another car in the service of the Edison Illuminating Company, of Brockton, Mass., has covered 8,712 miles in the six months preceding July 1, 1913. Another car serving the Salem Lighting Company covered 11,000 miles in the first year of its use. These cars are equipped with Edison batteries and manufactured by S. R. Bailey & Company, Inc., 895 Boylston St., Boston, Mass.

New All-Porcelain Push Button Socket.

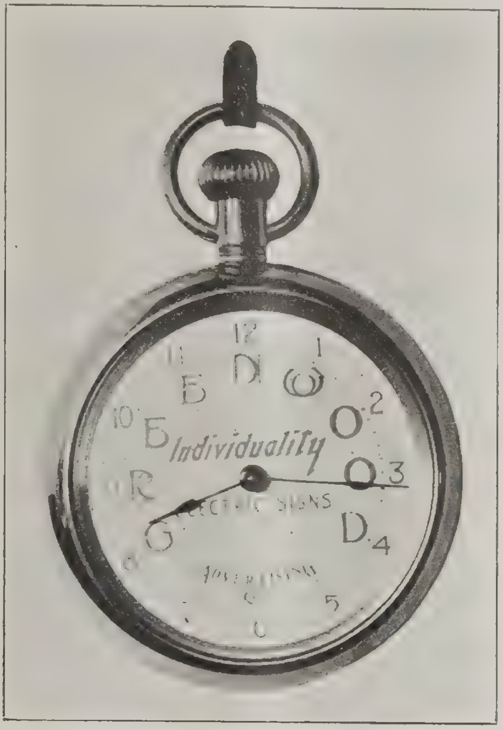
A new design of all-porcelain push button socket, shown in the accompanying illustration, has been placed on the market by the Cutler-Hammer Manufacturing Company, of Milwaukee, replacing a former socket. This new socket is smaller than the earner type, and is much easier to install. The casing consists of two halves, to one of which the mechanism is permanently attached. To wire the socket only one screw need be removed which then allows the halves to be separated and makes the two binding screws to which the cord is attached, easily accessible. A reducing bushing for the cord is supplied and provision made for standard socket shade holders.

NEW CUTLER-HAMMER SOCKET.

The high rating of 660 watts, 250 volts, makes this push button socket particularly well suited for use with heating and cooking appliances and small motor-driven devices. Also for basements, laundries and other locations where dampness is liable to be present, the shock-proof porcelain casing makes this socket desirable. The standard finish of the casing is gray, although brown, ivory and white can be furnished. These sockets bear the label of the Underwriters' Laboratories. As there is a demand for a socket of this kind for fixture work it is understood that such a model with 1/8, 1/4 and 3/8 inch brass nozzle is in preparation.

The Greenwood Watch.

The accompanying illustration shows a unique and effective advertisement now being used by the Greenwood Advertising Company, of Knoxville, Tenn. The watch is the regular Ingersoll $1.50 movement with the exception of the dial which as shown bears the words, "Greenwood."



THE GREENWOOD ADVERTISING WATCH.

"Individuality," and "Electric Signs," in such display as to attract attention and leave an impression. The idea must be credited to Norman B. Hickox, treasurer and manager of the company, who says that he is not at all superstitious but thoroughly believes in signs.

An Induction Motor of New Design.

A new line of squirrel cage induction motors has been designed by the Westinghouse Electric and Mfg. Co. possessing several noteworthy features. Among these are, the extensive use of pressed steel in their construction; rotors with cast-on short circuiting rings and moisture and heat resisting insulation. The use of pressed steel in motor construction represents a marked advance in motor design. It imparts great mechanical strength and is very uniform in structure. Hence a motor of a given weight can be made with more active material than motors of corresponding capacity in cast iron frames.

In these motors, rolled steel forms the frames of the sizes above 20 H. P., the end plates of the smaller sizes, (which are of the so-called frameless type,) and the feet and the slide rails of all sizes. As a result these motors are very compact, a feature that is of great importance in many applications. Above 5 H. P., the form-wound stator coils are laid in open slots.

In all sizes, the rotor bars are insulated with a special cement which is moisture resisting and will withstand a high degree of heat and mechanical stress. In motors above 15 H. P., the bars are connected electrically and mechanically by casting the shortcircuiting rings around their ends. Hence these rotors, having nothing that can burn out, deteriorate under heat, or work loose under vibration, are practically indestructible. The bearings, being the only wearing part, have been designed very liberally. They are protected from dust by a cap on the front end and by felt washers between metal rings on the pulley end.

The efficiency and power factors are high, not only at full loads, but at fractional loads also. This last feature is of special importance because industrial motors generally run at less than full load. These motors are being put on the market in all commercial sizes from 1 to 200 horsepower.

The Arrow Electric Company's New Factory.

The Arrow Electric Company recently completed a new factory and has equipped it with the latest machinery for the manufacture of electrical wiring devices. Electric power and drive is used throughout and the plant is constructed of special design along modern sanitary lines. The window space is about 66⅔ per cent of the wall space, which insures plenty of light and ventilation of air, and where there are confined spaces, or rooms which are apt to be congested, the air is charged every twenty minutes by motor driven exhausters. So far as possible all the machines are equipped with safety devices, but to take care of an occasional accident, bound to occur, there is provided a fully equipped hospital room with "First Aid" supplies, stretcher and cot.

The offices are illuminated by indirect lighting, and throughout the plant general overhead lighting is maintained, wherever possible, even when individual lighting is necessary. The whole building is wired with an automatic call system and telephones, making it possible to locate any person in any department without delay.

A new catalog will be ready for distribution the early part of September, announcing many additions to the Arrow line, besides presenting a complete ilne of wiring devices, and much information valuable to anyone interested in wiring specialties.

New P. & S. Products.

Pass and Seymour, Inc., of Solvay, N. Y., has made nine additions to its line of "Handy Wiring Devices." The devices are known by the numbers as indicated in what follows. Nos. 461, 462 and 463 are key, keyless and pull type receptacles respectively for use with condulet base. Nos. 458, 459 and 460 are key, keyless and pull type receptacles respectively for use with wood molding or Paiste pipe taplets. And Nos. 452, 453 and 454 are key, keyless and pull receptacles respectively for use in open wiring. All of these nine receptacles embody the "Fluto" style interchangeable shell. this style of shell being interchangeable with the entire P. & S. line of "Fluto" sockets and receptacles.

No. 428 is a pull receptacle for use on 4-inch boxes. In the past it has been the practice to use on outlet boxes, a pull receptacle which was primarily designed for use as a wall receptacle. This device is designed exclusively for use on outlet boxes. The porcelain projecting ring insulates the metallic shell from the box and from the ceiling; thereby permitting its use on metal ceilings. It is regularly supplied with pull chain 18 inches long, but may be supplied to special order with pull chain of any length.

Electrical Construction News

This department is maintained for the contractor, dealer, manufacturer and consulting engineer.

ALABAMA.

TUSCALOOSA. Additional equipment consisting of one 1500 Kw. Curtis turbo generator and 50 Kw. motor generator exciter set, and a 500 Kw. rotary converter with transformer, switchboard panels, etc., will be installed in the plant of the Birmingham-Bessemer Railroad Co.

FLORIDA.

JACKSONVILLE. A considerable number of ornamental posts have been ordered from the Union Foundry Co., of Anniston, Ala., for white way lighting in the business district.

TAMPA. The American Utilities Co. has been organized with a capital stock of $100,000 to construct water works, electric light system, etc. J. F. Taylor is president, J. J. Logan, vice-president, C. H Davis, secretary and treasurer.

TARPON SPRINGS. The Southern Utilities Co., of Jacksonville, Fla., will expend something like $25,000 in improving the electric plant of the Tarpon Springs Ice & Electric Co.

GEORGIA.

AUGUSTA. The Georgia-Carolina Power Co., Augusta, Ga., will install additional electrical equipment in its stations at Augusta and Clearwater, Ga., including three 2000 Kva., two 1000 Kva. and one 500 Kva. water-cooled transformers; six 750 Kva. transformers; a small 5 Kw. motor-generator set, and switchboard apparatus. All the apparatus will be built and the installation made by the General Electric Company.

COLUMBUS. The Columbus Power Co., Columbus, Ga., will add to the equipment of its station three 1333 Kva. transformers and switchboard apparatus recently ordered from the General Electric Company.

REYNOLDS. The city is planning to construct an electric light plant and has made inquiries to electrical manufacturers and contractors for carrying on the work. G. L. Cooper is president of the council.

ROME. The transmission system of the Georgia Railway & Power Co., is being tied in with the transmission system of the Tennessee Power Co., the latter system supplying power heretofore to Rome. After the connections are made the power will probably be received from the Georgia Railway & Power Co., which company has erected a substation at Lindale, five miles from Rome, and equipped it with modern apparatus. The cost of the substation is approximately $65,000.

LOUISIANA.

ARCADIA. It is reported that the North Louisiana Light & Power Co., of Arcadia, will erect within the next six months, a 6600 volt transmission line to Gibsland, a distance of eight miles and purchase one 90 Kw., three-phase, 60-cycle, 2300 volt generator and one 125 Hp. engine, also boilers, switchboards and protective devices, transformers and poles. The company has purchased the electric plant in Arcadia. J. B. Herring is president; B. Davis, vice-president; J. T. Reeves, secretary and treasurer.

HAMMOND. The Hammond Ice, Light & Bottling Co. is in the market for a 150 Kw. or 200 Kw., 2300 volt generator, directly connected to a turbine or oil engine. James Jamonville is manager.

RAYNE. It is understood that the management of the Municipal Electric Light Plant is to purchase a gas engine of about 150 Hp. and a three-phase, 2300-volt, alternating current generator. E. J. Bertrand is superintendent.

NORTH CAROLINA.

ALBERMARLE. The Piedmont Power Co. is reported to have plans for the construction of a hydro-electric plant on Yadkin River, near Albemarle. This plant will develop about 18,000 Hp. William B. Lawrence, of 18 Freemont St., Boston, Mass., is engineer in charge.

RAEFORD. The Raeford Power & Mfg. Co. is to install a 500 Kva. Curtis turbo generator with a 15 Kw. starter. Six 200 Kva. transformers, 25 Hp., 150 Hp. and 125 Hp. motors, switchboards and accessories are also to be installed.

MORAVIAN FALLS. A 50-foot dam will be constructed by J. T. Humphrey and the present power plant of the Moravian Falls Mining Co. will be constructed, installing turbine water wheels, and facilities to transmit and distribute electricity at Wilkesboro, N. C. Work on the transmission system has already begun.

WILSON. It is understood that the city of Wilson has engaged Gilbert White, of Charlotte, to prepare plans and superintend the construction of a lighting system which will cost approximately $100,000.

SOUTH CAROLINA.

LAKE CITY. A bond issue of $7,500 has been voted for the installation of an electric lighting system.

PEAKE. The South Carolina Development Co., Peake, S. C., has purchased for its stations at Columbia, S. C., six 2500 Kva., three-bearing motor-generator sets and switchboard apparatus. The machines will be built and installed by the General Electirc Company.

Seneca. The Seneca Oil Mills is planning to install a 100 Hp. and a three 55 Hp. induction motor for use on three-phase, 40-cycle, 2300 volt circuit.

OKLAHOMA.

CHICKASHA. Improvements will be made to the system of the Chickasha Gas & Electric Co., involving an expenditure of be tween $35,000 and $40,000. This company has recently purchased the property of the Chickasha Light, Heat & Power Co., and the consolidation will take place within the next few months. R. A. Overton is manager of the Chickasha Gas & Electric Co. This company also owns the Public Service Company, of Oklahoma, recently organized to purchase and operate the public utilities at Guthrie, Tulsa, Vinta, Atoka, Coalgate, and Lehigh.

KENTUCKY.

CLAY. The Clay Light & Ice Co. is planning to purchase and install a 30 Kw., single-phase, 60 cycle, 2300 volt, belt driven generator direct connected to a steam engine.

PIKEVILLE. The Sandy Valley Light & Power Co. has been incorporated by J. M. Hopkins, J. G. Strey and L. S. Wilson. The capital is $20,000.

WEST VIRGINIA.

CHEAT RIVER. The hydro-electric company of West Virginia, has filed plans and specifications for the construction of three dams on the Cheat River. The storage water will be used three times, 48,000 Hp. being developed at one point and 12,500 Hp. at another.

CHARLESTON. Application has been made to the Public Service Commission by the Gauley Power Co., for the right to build five dams estimated to develop 100,000 Hp. Two of these dams will be located on the Gauley River and three on the Meadow River. The Gauley Power Co. was recently organized with a capital of $250,000. J. A. Scaines is interested.

HUNTINGTON. The Tri-State Power & Mining Co., has made application for the construction of two dams on the New River in Summers County. These dams will back water sufficiently for the development of 35,000 Hp. A company has recently been incorporated with $600,000 capital stock for the development of 65,000 electrical horsepower and electrical transmission.

Personals.

COL. GEO. W. GOETHALS, chairman of the Isthmian Canal Commission and chief engineer of the Panama Canal, has consented to accept the honorary presidency of the International Engineering Congress, and will preside in person over the general sessions to be held in San Francisco September 20-25, 1915.

PHILIP S. DODD has resigned his position as secretary-treasurer of the Society for Electrical Development in accordance with an understanding made at the time he took the office. No announcement of Mr. Dodd's future is made at this time, although it it is understood that he will leave the electrical industry.

Philip Dodd is among the best known men in the electrical field. He first attracted attention through his work on the ELECTRICAL REVIEW, of which paper he subsequently became business manager. From the publishing business he went to the National Electric Lamp Association as director of its department of publicity. The electrical industry loses a good man with his retirement. Mr. Dodd's enthusiasm and stick-to-itiveness won him a prominent place and his abilities in advertising and in organization work are recognized as exceptional. A host of personal friends in the industry and hundreds to whom he was known only by reputation or correspondence will regret his leaving and wish him every success in his new work.

MR. STEPHEN L. COLES has been appointed acting secretary-treasurer of the Society for Electrical Development, to succeed Philip S. Dodd, who has resigned. As announced in these columns several months ago, Mr. Coles' services were retained by the Society as director of publicity. For the past four months the Society has loaned Mr. Coles to the Toronto, Electric Light Company, Ltd., of Toronto, Ontario, where he has been engaged with constructive service and advertising problems. Mr. Coles has had twenty-five years experience in daily newspaper, magazine, weekly and advertising agency work, and was for several years managing editor of the Electrical Review. His electrical education was obtained at the Massachusetts Institute of Technology and in the field during the formative period of the electrical industry.

VLADIMIR KARAPETOFF, Professor of Electrical Engineering at Cornell University, started August 6th on an extended western trip for the purpose of visiting hydro-electric developments and high-tension power transmission plants. He expects to visit the recent development on the Mississippi River at

ELECTRICAL ENGINEERING

PUBLISHED MONTHLY

Vol. 45. OCTOBER, 1913 No. 10

PUBLICATION OFFICE
DALTON, GA.

EDITORIAL and ADVERTISING DEPARTMENTS
GRANT BUILDING ATLANTA, GA.

D. H. BRAYMER, Editor.

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H. H. KELLEY
F. C. MYERS
L. L. ARNOLD
Associate Editors.

SUBSCRIPTION RATES

Domestic..................$1.00 For Two Years

Canada..................$1.00 Per Year

Foreign..................$1.50 Per Year

Complaints of failure to receive ELECTRICAL ENGINEERING regularly or of any errors of any nature, should be promptly made to the Atlanta office.

Advertising copy or change orders for standing advertisements must reach the Atlanta office by the 5th of the month preceding the month of publication.

Entered at Dalton, Ga., Postoffice as Second-class Matter.

CONTENTS.

The Status of the Tungsten Lamp.

When we stop to realize that at least 50 per cent of the one hundred millions of incandescent lamps that will probably be sold during the present year will be tungsten, the highest efficiency unit yet known, and remember that records show the demand for this lamp in 1909 as only 14 per cent of the 75 million lamps sold, against a demand of 70 per cent of this number for carbon units. the basis for the interesting development of the lamp business during the past few years is discovered. Tungsten lamp sales now stand at the same percentage of total sales that the carbon sales represented in 1911, while estimates of carbon sales for 1913 are placed at not more than 10 per cent. The decrease in the demand for carbon lamps has been accompanied by a shifting practically equally to the gem or metalized carbon-filament and the tungsten units. The sales of the tantalum lamp, while never popular, are now a negligible quantity.

This development is indeed phenomenal in view of the adverse conditions under which the tungsten lamp was introduced due to its fragile nature. The performance today however, is such that a comparison of this highly efficient unit against the low efficiency carbon lamp, when expressed in dollars and cents for operation over a considerable period, shows clearly that there is no logical reason that the demand for the carbon lamp should even approach 10 per cent. In fact, so rapid has been the reduction in carbon sales during the past two years, a drop in output of nearly 90 per cent, that indications point to a demand in the near future, probably the next year, for only two types of lamps now sold, the gem or metalized carbon-filament, and the tungsten, the former being already adopted by many central stations as the standard free renewal lamp, taking the place of the old carbon.

The last few years have been a period of refinement in lighting units causing changes in the commercial side of central station lighting business that have been so radical as to at one time create a fear that the profit in such business was to be reduced beyond a desirable point if the efficiency of lighting units was to keep on its upward climb. The prediction of the most optimistic, that larger numbers of customers could be connected and the old customers induced to use more lamps on the basis of securing more light at no increase in their monthly bills, has proven well founded as the results of central station commercial activity has clearly shown. The industry is now on a firmer foundation as far as the lighting business is concerned than in the days of the carbon lamp with high current consumption and low efficiency for it has indeed proven true that a large number of small customers previously unapproachable are now possible and a keener competition can be created with gas, gasoline, kerosene, and acetylene lighting than was possible before the introduction of the highly efficient tungsten unit.

While, as already stated, the gem or metalized carbon-filament lamp is now considered the standard free renewal lamp, having assumed this position almost within the past year, there is little excuse for even this type of lamp, with an efficiency of 2.5 watts per candle, against 1.15 watts per candle for the medium sized tungsten, to have a much more extensive use than at present. Undoubtedly this lamp is being used as the stepping stone to the tungsten in those cases where free renewal policies now exist, while such companies are carrying on campaigns to popularize the tungsten unit. The limits in the practical and successful sizes of the gem lamp are sure to be felt by those now adopting it, for customers are demanding units lower than 30 watts in residence service, and higher than 60 watts in industrial service, the present practical limits of the gem type.

Probably the greatest drawback to the general introduction of the tungsten lamp even today and especially where free renewal policies are maintained, is a greater price over the carbon and gem units and the reputation the tungsten lamp unfortunately gained in its early days for being fragile. The wire drawn tungsten unit, now exclusively marketed by lamp manufacturers has, however, shown such excellent performance that the fragile feature cannot rightfully be held against it. The price feature still remains, however, when considering first cost, but disappears when ultimate cost, the only just consideration from a cost point of view, is examined. In this case it is plainly shown that the lowest priced lamp is not the cheapest in view of the fact that the first cost in any case is only a small part of the true or ultimate cost. With the 40 watt gem lamp at a cost of 20 cents, a life of 700 hours, efficiency of 2.5 watts per candle, and power at 5 cents per kilowatt-hour, the ultimate cost of the lamp is $1.60, or the first cost of lamp is about 12.5 per cent of the ultimate cost. In this case, 16 candle power of light for 700 hours costs $1.60 For the 40 watt tungsten lamp at a cost of 35 cents a life of 1,000 hours and efficiency of 1.15 watts per candle and power at 5 cents per kilowatt-hour, the ultimate cost of lamp is $2.35, and the first cost of lamp about 15 per cent of the ultimate cost. Thus, 34.7 candle power of light is secured for 1,000 hours at $2.35, a price per candle per hour of about 0.0067 cents against 0.014 cents per candle per hour for the gem unit operating as above specified, and assuming a constant candle power during life in both cases. These figures show up relative life and difference in efficiency to the disadvantage of a less efficiency unit in such a way that there seems little argument from the standpoint of present first cost against an extensive use of the tungsten unit.

The life of the incandescent unit and the conditions under which it best operates is now getting due consideration. The unit termed best is not necessarily the one that has the longest life, but the lamp that shows the longest useful life. The best lamp today, therefore, is recognized as the unit whose initial cost plus cost of power is lowest or with units of equal first cost and economy, the lamp that has the longest useful life. This lamp for most commercial electric circuits is unquestionably the tungsten.

Many central station companies are now realizing that they can afford only to offer the best lamp available to their customers and in all cases where this opinion is held, good results have been secured, for the new business heretofore unavailable has more than offset the reduction due to the use of high efficiency units by old customers. Notably among companies to take this stand is the Hartford, (Conn.) Company, with its policy to be always the first to establish anything new that will benefit the business, which company has placed all tungsten lamps of 60 watts and over on a free renewal basis. The New York, Brooklyn and Chicago Edison companies have followed by placing on a free renewal basis all units above 100 watts. This liberal policy is without a question a good stimulus for the industry in general and those responsible for this step should get a goodly share of the glory for their stamina and broadmindedness of such a policy. Next year in the lighting issue of *Electrical Engineering*, we expect to report a decided development in this direction among a large number of companies, together with some interesting results. At this time, who can deny that the gem lamp, then, will be no more as the carbon lamp is now considered, and that the tungsten unit will hold full sway?

The Origin of the Term Mazda.

The origin and meaning of the term Mazda, the trade name under which the present tungsten lamp is marketed, is often the cause of much speculation. We have a statement over the name of the General Electric Company, which explains that Mazda was the God of Light, and one of two spirits recognized long before the Christian era in connection with an early Aryan folk-religion known as Mazdaism. The fundamental doctrine of Mazdaism assumed that in the beginning two spirits, one good and one evil, governed the actions of mankind. Mazda was the spirit of all good, glorified as the Creator and God of Light. The opposing evil spirit, Ahriman, was represented as darkness.

From what has been learned from the sacred works of the ancient Persians, it is believed, so the statement runs, that Mazdaism was constructed on a clearly conceived plan and stood on a high moral level for its time, a great advance in civilization. It appears from the oldest sources that it accompanied the introduction of agriculture and of settled life among the Iranians who occupied the Eastern part of Ancient Persia, then extending as far East as the River India. Probably at some time previous to the tenth century before the Christian Era, Mazdaism made its way over Media and Persia proper where it came under the influence of the priestly tribe of the Magi. This religion then fell into decay to be restored about 226 A.D. as a state religion of the Neo-Persian Empire. It retained its influence until overthrown by the Mohammedans in about 641 A.D.

Displaced forever by the more modern religious thought, its former greatness and influence were not without lasting results, for during the five centuries which preceded and the seven that followed the birth of Christ, a period which gave to the world the Gospels, the Talmud and the Koran, Mazdaism exerted much influence on each of the movements which produced or preceded from those three books, for it lent much to the first Heresiarchs, much to the Rabbis and much to the Mohammed.

While Mazdaism as a great religion has passed and is now almost forgotten, it is not especially unfitting that early historical aspirations and endeavor should be joined with present achievement; it is not unfitting that a trade name should be established in our lamp sales language for the best light which scientists and manufacturers can produce—that nature can offer and man can control—but what place shall this commercial term have in our technical literature? Should it find its way there at all except perhaps as follows: tungsten filament (Mazda) lamp? We are not yet convinced that the term should be given any technical standing.

A Review of Recent Progress in Outdoor Decorative Lighting

(Contributed Exclusively to Electrical Engineering)

BY ALAN BRIGHT, ILLUMINATING ENGINEER.

FIVE years ago the subject of street lighting was one that concerned only those who were engaged in the manufacture of the equipment used for such lighting service and those who were directly interested in the production, sale or purchase of electric current. There has, however, been a sudden realization that street lighting is something that concerns city officials, merchants and property owners, as well as private citizens. Now, that a poorly lighted street may mean business failure is fully understood by all business men. Men having to do with the sale of real estate are also concerned with outdoor lighting, for when tracts of land are opened up for sale it has been found that prospective buyers are attracted more readily if the streets are comfortably lighted.

FIG. 1. AN INSTALLATION OF TUNGSTEN CLUSTERS IN MEXICO CITY, MEXICO.

The first attempts to install ornamental lighting were usually made with the idea of creating a display rather than to establish a permanent method of street lighting. The installations served to convince people in general of the gross inadequacy of the illumination they had endured for years. The latest tendency therefore seems to indicate that municipal authorities are attempting to properly light all of the principal streets, rather than to depend upon the merchants to light up one or two of the principal thoroughfares, allowing the majority of the streets to remain in semi-darkness. It seems no more than just that this should be the case and that all streets should receive their due share of good lighting.

CLUSTER LIGHTING.

Many new designs of five and three light posts have made their appearance during the past year or so until it now seems as though each city has its own and characteristic design. Pressed or rolled metal and cast iron posts predominate, although reinforced concrete posts have been adopted with satisfaction in many places. Attempts have been made to fashion cluster posts in wood and in stone but not with success. In Bloomington, Indiana, for instance, the posts were cut from native limestone.

Cluster posts to meet all requirements of durability should have a substantial column and should be constructed of material that will not break when suddenly jarred, since it has been the experience in a number of cities that slender cast iron posts have been broken off when struck by wagons. Fig. 1 shows the lighting equipment installed in Mexico City, Mexico, just previous to the recent disturbances. This installation shows that the introduction of well designed cluster lighting has not been confined to our own cities. Avenida San Francisco and Avenida Del Cinco de Mayo are lighted with about 125 five light clusters of an unusual design which is rather typical of Mexican style. Instead of the ordinary arm that supports the lower lamps these posts have elaborate winged heads holding the four pendant lamps. The streets are forty feet wide and the staggered arrangement of locating the posts is used. There are five 100-watt lamps per post enclosed in diffusing ball globes. A very similar installation may be seen in Puebla, Mexico.

The question of post spacing is one that varies through wide limits for the location of posts is controlled by the width of the street, the number and size of the lamps, the length of the block and the light intensity desired. The average of a dozen business street installations in large cities shows that the power consumption per linear foot of street is 12.6 watts.

A curious arrangement for placing three light clusters is shown in Figure 2. This system was recently installed in Oakland, California. It will be noted that the three globes are placed on a line with the curb instead of at right angles to the curb line as is the usual practice in three light installations. This is undoubtedly due to the fact that the

FIG. 2. AN INSTALLATION AT LOS ANGELES, CALIF., SHOWING POSITION OF THREE LIGHT POSTS.

distance between the posts is less than the width of the street. Since the direction of maximum candle power is at right angles to the line of the three globes, this should be directed toward the portion of the street likely to be most distant from a lighting unit.

ORNAMENTAL ARC LIGHTING.

Although the tungsten cluster has lead the way in ornamental outdoor lighting, a successful ornamental arc lamp has been developed and is producing satisfaction in a num-

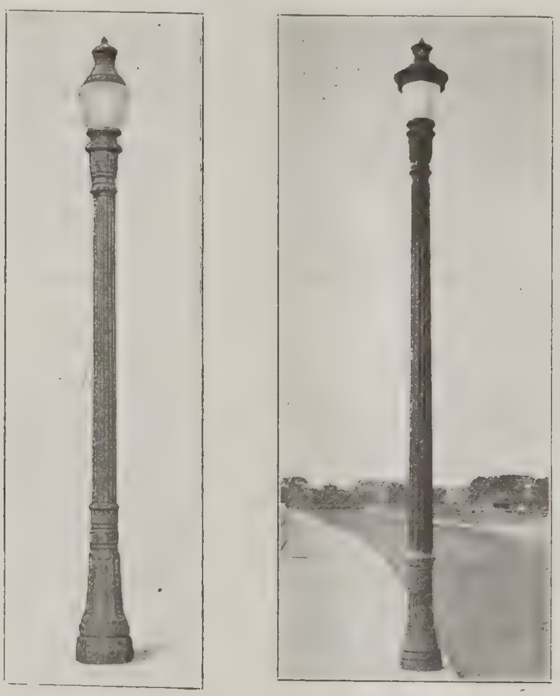


Fig. 3. The Ornamental Luminous Arc Lamp—the 6.6 Ampere and Parkway Types.

ber of cities. The lamp that has been designed for the lighting of business districts is shown at the left in Fig. 3. It is of the luminous type and may be mounted on an ornamental pole as shown. The mechanism is enclosed in the upper portion of the pole itself and a small door gives access to the moving parts. The removal of the globe is not required to trim the lamp, since the metallic top ornament may be raised and swung aside and held by a bayonet lock, the electrodes being inserted or withdrawn through the top opening in the globe. The lamp is said to consume 510 watts, the life of the lower or magnetic electrode being rated at from 100 to 125 hours.

In Fig. 4, Eutau street, Baltimore, Md., is shown lighted with this lamp. There are several hundred lamps in the down-town section of the city. The typical width of street is 60 feet. This is the largest installation of this type at present and shows a growing tendency to use high candlepower units with ornamental equipment to light business streets in large cities. The globes are of a peculiar shape and are designed to eliminate shadows, the Alba glass eliminating all glare from the arc.

The details concerning eight prominent lighting installations in business districts are given in the accompanying table. This data shows the prominent part municipalities are taking in ornamental lighting. The statistics presented may be of assistance to those who are contemplating installations.

RESIDENCE STREET AND PARKWAY LIGHTING.

The expense connected with installations of decorative lighting has heretofore confined their application to business sections. However, improved methods in manufacture and simpler designs have made it possible to adopt decorative lighting in outlying districts.

Residence streets are usually lighted with enclosed carbon arcs suspended above the center of the roadway. As streets in outlying districts are usually lined with trees, the enclosed arc lamp system with clear globes is very ineffective, yet if the lamps are placed high, the sidewalks and a portion of the street itself are in deep shadows from the foliage. Placing the lamps below the foliage increases the difficulty for automobile drivers to distinguish objects beyond the region of brightness immediately beneath the arc and accidents under such conditions are not uncommon.

It would be useless extravagance to specify the same construction and the same intensities for lighting in residence districts that are common in business sections. Lighting of driveways and streets used principally by passing pedestrians and pleasure vehicles has no trade drawing function and serves only to insure the safety of the roadway. There is no reason, however, why underground construction and ornamental posts supporting modern lamps should not be seen in such places. It is quite common to see streets, well paved with up-to-date sidewalks and curbing yet marred by heavily scarred wooden poles supporting a net work of wires. To remedy this a few cities have attempted ornamental lighting in residence streets and are fully convinced that the benefits resulting justify the expenditure. The Parkway type of the luminous arc lamp

Fig. 4. Eutau Street, Baltimore, Md., Lighted With Luminous Arc Lamps.

TABLE 1. DATA ON ORNAMENTAL LIGHTING SYSTEMS IN BUSINESS DISTRICTS OF EIGHT CITIES.

City	Richmond Va.	Baltimore Md.	Topeka Kans.	Columbus Ohio	Dayton Ohio	Mexico City Mexico	Pueblo Mexico	Toronto Ont.
Street	Broad Street	Entire Business Section	Business Section	Business Section	Business Section	Avenida San Francisco	Mercaderes Street	Bay Street
Number of Posts	113	358	157	938	400	62	164	47
Typical Width of Street	82 ft.	60 ft.	90 to 52 ft.	100 to 50 ft.	50 to 3 ft.	30 ft.	42 ft.	42 ft.
Post Spacing (Distance between posts on one side of street)	100 ft.	160-ft. staggered arrangement	92 and 106 ft.	90 ft. staggered arrangement	75 to 82 ft.	65 to 80 ft.	87 to 115 ft. staggered arrangement	85 ft.
Height of Post (From ground to center of top globe)	14'-0"	14'-6"	14'-8"	14'-0"	11'-10"	14'-6"	14'-6"	13'
Lamps per Post	5	1	5	5	5	5	5	5
Lamp Arrangement	1 upright 4 pendant	Upright	5 upright	5 upright	5 upright	1-upright 4-pendant	1-upright 4-pendant	1-upright 4-pendant
Size of Lamps	5-100 Watt	528 Watts	4-60 Watt 1-100 Watt	5-100 Watt	4-60 Watt 1-100 Watt	5-100 Watt	5-100 Watt	5-100 Watt
Size of Globes (Diam. in Inches)	1-16" Alba 4-12" Alba	1-16" Alba	1-16" x 8" 4-12" x 6"	1-16" Alba 4-12" Alba	1-16" Alba 4-12" Alba	5-13" x 8⅛"	5-13" Alba	1-14" 4-12"
Method of wiring	Multiple	Series	Multiple	Multiple	Multiple	Series	Series	Multiple
Kind of Current	A.C.	D.C.	A.C.	D.C.	D.C.	A.C.	A.C.	A.C.
Time of burning	Until 1 A.M.	202 All Night 156 Half Night	Top Lts—All Night Side Lts—Midnight	Top—All Night Side—Midnight	Top—All Night Side—Till Mid'nt.	All Night	All Night	All Night
Installation made by	Municipality	Municipality & Merchants	Merchants	Property Owners	Municipality Central Station	½ by Municipality ½ by Light Co.	Light Co.	Municipality
Installation maintained by	Municipality	Municipality	Municipality	Municipality	Municipality	Current—Municipality Other Expenses—Light Co.	Current—Municipality Other Expenses—Light Co.	Municipality

FIG. 5. A TYPICAL STREET VIEW AT ALAMEDA, CALIFORNIA.

shown at the right of Fig. 3 is an excellent unit for such lighting in boulevard driveways, automobile courses, etc. It gives an extended light distribution having a reflector above the arc, and is mounted at a height of 18 feet, well above the line of vision. This lamp is especially applicable to wide parkways where the lighting is not influenced by the presence of trees. There is another luminous lamp very similar in appearance and design to the ornamental type used in Baltimore known as the residential type. This lamp is mounted at a height of fourteen feet and may be placed below the foliage lining residence streets. Diffusing globes are used so that there is no apparent glare.

THE ALAMEDA SYSTEM.

The system in Alameda, California, is an excellent example of what may be accomplished by an enterprising city administration. The abundant foliage on the Alameda streets made the light from the old arc lighting units placed high, very ineffective on the streets below. To offset this disadvantage a post of the city's own design as shown in Fig. 5 was selected. The post consists of 3½ and 3 inch iron pipe with a concrete base and cast iron top. The total height to the top of the globe is 9 feet 7⅝ inches. The staggered arrangement of posts is used, there being 150 feet between posts on one side of the street.

Each post supports a 60-watt tungsten filament lamp enclosed in a 12-inch ball globe. All exposed metal and cement surfaces are painted green. About 4,000 of these single light standards have been installed in the city, covering every street, including all of the residence sections. The cost of the installation is about 21 cents per front foot and is assessed against the property owners. The post itself costs $11.50 installed and while not particularly ornamental, it has stability resulting in long life for the tungsten lamp and is something that most communities can afford. All of the arc lamps in the city have been removed and the street lighting consists entirely of tungsten lamps.

The system uses 110 volt tungsten lamps operated in parallel and fed from a transformer connected to a 2300 volt constant potential street lighting circuit. The city owns and operates the electric light plant. The maintenance of the street lighting system is taken care of by the light plant and the electric current required is paid for by the city of Alameda at the rate of 2¼ cents per kw. hr. Some of the lights have been in operation for more than a year and the system is highly satisfactory due to its superior distribution of light over the arc lighting system and on account of the low cost of installing.

ORANGE GROVE AVENUE, PASADENA, CALIFORNIA.

In contrast with the Alameda installation, it is interesting to note the installation on Orange Grove Avenue, Pasa-

Fig. 6. A View of Orange Grove Avenue, Pasadena, California.

Fig. 7. An Installation of Ornamental Posts at Windsor Square, Los Angeles, California, Using Alba Glass Cylinders.

dena, California, shown in Fig. 6. A distance of 8,000 feet is lighted with single light posts made of solid bronze costing $90 each. The height to the top of the globe is 10 feet, 2 inches. The standards are set one foot inside the curb and rest on a base of concrete 2 feet square and 20 inches high. There are 170 posts, each supporting 100 watt lamps enclosed in 18-inch Alba diffusing ball globes. The total installation cost was $30,000. This cost averages about $176 per post which is far above the expense most places can afford. This cost does not include, however, the cost of conduit, which amounted to about 32 cents per foot. This installation is mentioned to show the expense that is sometimes put into installations privately by groups of residents.

A novel design of outdoor lighting unit is shown in Fig. 7. It is a three light post employing the use of tungsten lamps enclosed in 8 by 10 inch diffusing glass cylinders. About 384 of these cylinders have been installed at Los-Angeles, California. The lamp and cylinder are very similar to the arrangement that has been used in Toronto, Ontario, for some time. However, this is the first instance where an attempt has been made to employ these cylinders on cast iron decorative posts. The effect is very pleasing.

DIFFUSING GLASSWARE FOR CLUSTER LIGHTS.

The effectiveness of a decorative system of lighting is largely dependent upon the proper selection of the glassware. There are a number of distinct types and each have their characteristics. Fig. 8 shows the relative values of illumination in horizontal foot candles resulting from a five-light cluster when equipped with a number of kinds of globes. The cluster tested was an isolated one and consisted of five 100-watt lamps—one in the upright position and four hanging pendant. With lighting conditions maintained at constant values, illumination readings were taken on a 36-inch working plane at intervals of three feet from the post. The results show that Opal glass is far too dense for the purpose of cluster lighting. To begin with the tungsten lamp lacks in efficiency for street lighting work and to lose such a large portion of the light by absorption in the surrounding glassware is wasteful.

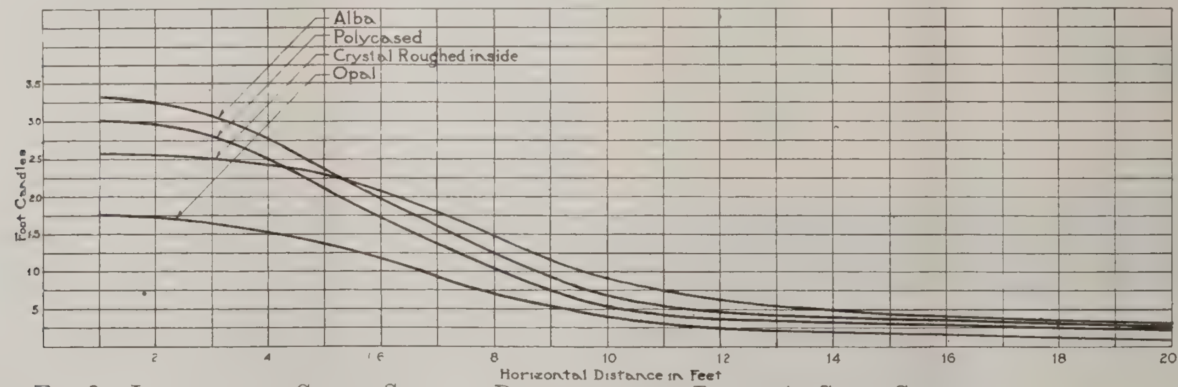


Fig. 8. Illuminating Curves Showing Performance of Diffusing Glass Globes.

It was formerly regarded as good practice to use clear globes sand blasted inside for white way lighting but the use of glassware of this kind has been discontinued for the reason that "C R I" globes are fragile, require frequent cleaning and are very inefficient when not clean. The illuminimum curve for "C R I" shown in Fig. 8 shows the performance of the glass when perfectly clean. It requires only a short time for the rough interior surface to collect dust particles on busy down town streets and not only does the globe assume an untidy appearance but the transmission of the light falls off rapidly.

Although Polycased glass, also known as Opalescent and Alabaster, is used somewhat, Alba glass seems to be very popular, not only from the standpoint of light absorption but on account of breakage. Polycased glass is made up of a number of layers of glass, all having different coefficients of expansion so that when changes in temperature occur, frequent breakage results. Alba glass is of the same structure and has been found to withstand weather conditions.

SPECIAL FEATURES.

One of the advantages of the cluster system of lighting is its adaptability to improved fire and police alarm systems. The old method of indicating the location of a fire alarm box was to apply a coating of red paint to the wooden pole supporting the box. This scheme is effective in the daytime only. After nightfall the location of the fire boxes is no longer visible. The ideal arrangement is to provide a system by which the location of the alarm boxes is visible at night as well as during the day. At Fort Worth, Texas, the fire alarm boxes are located on the cluster posts as shown in Fig. 9, and the top globe is equipped with a red band upon which appears the words, "Fire Alarm." The red band is easily visible in day light as well as by transmitted electric light. At the same time the four inch red band on the globe is not sufficiently prominent to be over conspicious. In the same manner police boxes are indicated by a green banded globe with the words, "Police Alarm." Other cities have adopted this same method to indicate railroad crossings, automobile courses, etc. It is sometimes the case that the names of streets are indicated on the cluster post located at a street intersection. Such an arrangement has been attempted in Los Angeles, California, as shown in Fig. 10.

Fig. 9. An Application of Fire Alarm Globes at Fort Worth, Texas.

Fig. 10. The Use of a Street Sign on a Cluster Post.

From a review of what has been accomplished in outdoor lighting during the last year or so one is lead to believe that ornamental lighting is receiving attention everywhere. Our cities are becoming more beautiful not merely on account of the improved lighting equipment but because better lighting has provoked a desire to make other improvements. The lighting of areas that have heretofore been in darkness has emphasized the necessity of replacing badly paved streets and defective sidewalks. It has resulted in the removal of street obstructions such as sidewalk awnings and overburdened wooden poles, thus placing good lighting among the factors that tend toward civic betterment.

The illustrations used with this article are presented through the courtesy of the Macbeth-Evans Glass Co., Pittsburgh, Pa., which company furnished the Alba glass globes for a large number of the installations.

Georgia Association of Electricians and Waterworks Superintendents.

An organization of the superintendents connected with municipal electric light and water works in the State of Georgia is being formed. Already a temporary organization has been effected to get the movement under way, when permanent officers will be elected. The acting officials are E. P. Harrison, president, Covington, Ga.; W. T. Butts, secretary, Monroe, Ga.; and Roy C. Warner, treasurer, State Board of Health Atlanta, Ga

The purpose of this association will enable the members to meet for the discussion of the phases of their business and to keep a record of openings and changes in the different Southern plants, assisting members in securing positions when out of employment. At a meeting to be held in the near future, rules and regulations governing the body will be decided upon, and the permanent organization formed. Already over 50 indorsers have been secured to the movement.

An intense light should be used only for advertising purposes.

A Summary of Recent Developments in the Field of the Illuminating Engineer

(Written Exclusively for Electrical Engineering)

BY A. G. RAKESTRAW.

A Discussion of Lighting Nomenclature, Photometric Developments, Present-Day Lighting Units, Lighting Systems, Fixtures and Reflectors, and Progress in Lighting Fields.

IT is particularly interesting to note a decided tendency on the part of electrical engineers, manufacturers and others responsible for illumination work, to use greater accuracy of expression and scientific terms in discussing illuminating problems and lighting equipment. The indefinite rating of light sources in candle power, without designation as to whether maximum, mean horizontal, mean spherical, or mean hemi-spherical is meant, has about passed away for now we find a tendency to rate lamps in watts and terms of the total light flux in lumens, and to express the efficiency in lumens per watt. So completely has the candle power rating vanished from the public mind that users of the tungsten lamps now buy and speak of them altogether by the watts rating, most users of a 100 watt lamp not knowing whether the candle power is 50 or 100. However, we still need a practical unit for brilliancy and surface illumination and on this account it is probable that the candle power, and the candle-foot will continue to be used for these purposes.

The net efficiency of lighting installations is now generally expressed in lumens per watt. To get this, the mean illumination on the working plane in candle-feet is multiplied by the area in square feet. This gives the total light flux on the working plane, or as it is called the effective lumens. This value divided by the total watts expended, gives the effective lumens per watt, which is a logical expression of ultimate lighting efficiency. Since a great many observations have now been made on all sorts of installations, it is possible to estimate very closely from empirical formulae, the watts which must be expended to give a required illumination, when the size of room, color of walls and ceiling, with standard light sources and reflectors are known. For instance we find that in rooms of ordinary size, with light walls and ceiling, using tungsten lamps with clear prismatic reflectors, it may be expected to get as high as 5.4 lumens per watt, and with satin finish reflectors, 5.0 lumens per watt. In large assembly rooms with light finish and the indirect system of lighting, we can obtain 2 to 2½ lumens per watt, and with mercury vapor lamps in drafting rooms, 8 to 10 lumens per watt. We also find quite close agreement when figuring on the basis of watts expended per square foot. Under ordinary conditions and with the most efficient light sources properly installed, offices require 0.5 to 1.0 watts per sq. ft.; stores, about 1.0; drafting rooms, 1 to 1.5; general manufacturing 0.3 to 0.5; and piers and warehouses 0.1 to 0.2. When carefully checked and used with judgment, these figures may be expected to give fair results.

DISTRIBUTING DIAGRAMS.

It is well known that the usual polar diagram of candle power is misleading to the casual observer, as the area is not at all in proportion to the light flux. For the same reason it is a tedious matter to compute the total or zonal flux from it. It is now proposed to use instead a polar diagram showing zonal flux, and which would then give the total light flux by simple integration. However, such a diagram would involve more labor in preparation, would not be as easily understood by the public in general as the one now in use, and would save no labor except to those actively engaged in illuminating engineering work. It is therefore quite likely that the present polar-candlepower diagram will continue in common use.

PHOTOMETRY.

A great deal of attention has been given during the past year to the comparison of lights of different color, or as it is called, heterachromatic photometry. It is well known that it is impossible to accurately estimate an equality of brightness between lights of different colors, and hence when such illuminants as the mercury vapor lamp and the flaming arc came into use, ordinary photometric methods proved inadequate. However, with low intensity of light, it is possible to get a light sensation on the retina practically independent of the wave length. By means of an instrument known as a flicker photometer, in which a brief flash of the light is observed instead of a steady beam, it has been considered possible to compare lights of different color. Recent experiments have brought out some hitherto undiscovered effects in this connection which seem to indicate the inaccuracy of this method at certain intensities and active investigation is now in progress along this line.

LIGHT SOURCES.

There has been, with possibly one exception mentioned later, no startling developments during the past year in connection with light sources. We appear to be passing through a period of refinement and development following the production of the metallic filament, the luminous arc, and the vapor lamp. The wire drawn tungsten filament incandescent unit has been extensively introduced and is rapidly making this lamp almost as easily handled as the older types. The tungsten lamp has been lately successfully developed in 10 and 15 watt sizes but the demand for these sizes has been small compared with what might have been predicted. While this is partly due, no doubt, to the reluctance of the central station to introduce the low wattage lamps, yet the writer believes it has also been the result of the general increase in the standard of illumination brought about by the general use of the tungsten lamp. For some time the 25 watt lamp was the smallest unit obtainable, the public has thus become accustomed to better light and without a question there are many 8, 10, and even 4 and 6 candle power carbon lamps in use today that will eventually be replaced by 25 watt tungsten lamps, especially since the change will involve little if any increase in current consumption.

The carbon arc is slowly disappearing with the introduction of the magnetite arc, and the tungsten lamp in street service. It is still used for mill work, however, on account of its low upkeep, yet in this field is beginning to be crowded out by the flaming arc and the mercury vapor lamp. Several minor improvements have been made on the luminous and flaming arcs, especially in the regulating mechanism. The attempts to make a long burning flame arc have not been entirely successful, although a number of them are in use. The most promising development in this line appears to be a magazine lamp containing several pairs of carbons, each to be automatically thrown into circuit as needed. There have been no improvements in the vapor lamps, although experiments are now being made on the new Neon tube.

The exception mentioned in the first sentence under light sources, deserves comment at this point in connection with the arc units. During the month of July of this year an announcement was made of the development of a large candle power tungsten filament lamp (around 1500 c. p.) operating on a current consumption of 6 amperes and the remarkable efficiency of 0.5 watts per candle power. This unit contains a specially shaped tungsten filament and is filled with an inert gas, such as nitrogen, at a pressure of about one atmosphere. A unit of equal efficiency was announced by a German manufacturer at the same time. While these lamps are not as yet in commercial existence, it is generally believed that they will be a strong competitor of the arc lamp and in the field of series street lighting have the field very much to themselves.

LIGHTING SYSTEMS.

The bone of contention just now appears to be in regard to the merits of indirect and semi-indirect systems. It is an accepted fact that present light sources are too brilliant to be placed in the line of direct vision. While in many cases they may be placed high enough to obviate discomfort from this cause, yet very frequently due to low ceilings or other architectural limitations, this cannot be done and it is necessary to screen them in some way. The best results in direct lighting are now secured by the use of a bowl shaped prismatic reflector. This arrangement is highly efficient and can usually be made to give satisfactory diffusion. However, to still further avoid the possibility of glare the system of indirect lighting was introduced. The first systems of this kind concealed the lights in a cove, giving a beautiful effect but with a heavy wattage consumption. The later systems use an especially designed fixture which throws the light directly upwards against the ceiling, and with much greater efficiency. Objection has been made that such lighting, due to absence of shadows, gives everything a flat appearance, and tires the eye. Such argument however has appeared to be exaggerated, the general report from those using these systems being very favorable. There is however a strange appearance to a room with no visible light sources, and to relieve this the semi-indirect system has been devised. In this case the bowl in which the lights are concealed is made translucent, the idea being that the eye perceives a source of light taking away any strangeness of appearance of the illumination due to the lighting units.

It is true that indirect illumination requires more watts expended than direct for equal illumination, in fact usually about twice as much. Since however the eye can work in comfort at lowest intensity where there is no glare, the indirect system is relatively more efficient than the above proportion would indicate. Cases are found where a change made from direct to indirect resulted in a saving in watts, but it is likely that in these cases the direct system was not of the most efficient type. Again the semi-indirect system is apt to be lower in efficiency than the wholly indirect system, unless the efficiency of transmission of the light shining thru the unit is as great or greater than the efficiency of reflection of the balance of the light from the ceiling. For instance a good reflector might throw 90 per cent of the total light flux to the ceiling, of which 45 per cent would be returned as effective. A semi-indirect might absorb 30 per cent in the bowl, letting 10 per cent through and reflecting 60 per cent upward, of which say 30 per cent would be returned, making a total of 40 per cent effective. The writer favors from point of efficiency, units for indirect lighting provided with a totally opaque reflector, having a few low candle power lamps to illuminate the base made up of a transparent bowl under the reflector or by the use of lamps exposed in some part of the room to simulate the light sources.

FIXTURES AND REFLECTORS.

The commonplace lighting fixtures, so long endured are quietly passing away, and in their places we have the "art noveau," the "arts and crafts," "mission designs," and "renaissance," and others. We are also glad to be relieved of the combination fixture, which was never anything but a makeshift, for now the necessity for a duplicate system is no longer felt. We now have the delicate chain effects in showers, mission domes and lanters, dainty clusters, elaborate "chandeliers" and other beautiful creations.

In line with fixture design has come a great activity in glassware. For a time every effort was bent towards efficiency, culminating in the prismatic reflectors of well known make. Lately, however, artistic considerations are receiving more attention, and without serious loss of efficiency several new and beautiful lines, such as "iris," "veluria," "calla," "pyro," "alba" and "melelite," are coming into extensive use.

PROGRESS IN LIGHTING FIELDS.

Naturally we find the greatest advances being made in commercial and industrial lighting. Practically all large stores, theatres, churches, railroad stations, office buildings and the like now being erected, will be lighted according to the specifications of expert illuminating engineers, representing the results of elaborate tests. In most of this work the tungsten lamp is now and will be prominent, and great care is being taken to either diffuse the light, or in some way entirely remove the source of light from the line of vision.

In industrial work where the effect of good lighting on the efficiency of production and the percentage of accident is realized, adequate lighting is being insisted upon. The carbon arc is still used to some extent with the flaming arc and the mercury vapor lamp being rapidly introduced.

The installation of ornamental street lighting systems goes on apace, having nearly doubled in the past year. Such systems promise to soon become the standard method of lighting the principal streets of towns and cities. The ornamental post with 3 and 5 tungsten lamps in diffusing globes has become almost classic for this kind of work. Lately however, there has been some interest taken in the use of the luminous arc lamp with an ornamental standard.

The illumination of outdoor sporting spaces is also becoming more common. Electrically lighted tennis courts are quite popular, while huge hippodromes for outdoor performances, lighted by 40 or 50 flaming arcs are features of large cities. Football, and even baseball can now be played at night. Spectacular displays in which cities blaze forth in light and enormous batteries of search lights sweep the heavens introduce us to occasions such as New York's sane

Fourth, at which time 17,000, 8-candle power lamps enlivened th parks and squares of the metropolis. Spectacular signs, of the flasher kind and great slogans, shining forth their welcome afar, are going up in large numbers and of a size to require hundreds of lamps and tons of structural steel for a single sign.

Probably the most important work of the whole year has been the least sensational. The writer refers to the widespread and increasing interest taken in the conservation of vision, the study of the physiological effect of light upon the eyes and the movements on foot to secure the proper lighting of factories and especially of school houses. The constantly increasing need of glasses for children shows clearly that we have neglected the care of the eyes, and that further neglect will seriously hamper the coming generations in their work, if it does not endanger vision itself. Eyestrain is now recognized as being a contributing factor to several affections especially functional nervous disorders, headaches, and even apparently unrelated disorders.

At present the steps being taken towards securing good lighting in schools and factories are, the avoidance of glare, the removing of polished surfaces reflecting streaked light, such as highly calendered paper and glossy ink. The Illuminating Engineering Society is helping in this campaign through extensive literature. This, like other reforms, is essentially a matter of education, and we are glad to note that as the people of our country are realizing the necessity of conservation of fuel, timber, water powers, and in fact all natural resources, that there are hopeful signs of an awakening to the necessity of conservation of vision.

Reflectors for Tungsten Lamps in Industrial and Office Lighting

(Contributed Exclusively to Electrical Engineering)

BY A. L. POWELL, ILLUMINATING ENGINEER.

A Discussion of Nature and Application of Designs, Illumination Secured and Efficiency of Reflectors.

AN account of the large number of reflector types now offered by various manufacturers, it is quite proper to devote some space to a survey of the field and its requirements. In what follows, therefore, an endeavor will be made to present an engineering analysis of the available varieties of reflectors that will aid in selection for a particular use.

DIVISION OF SUBJECT.

From a standpoint of construction and utility, commercial reflectors may be divided into two general classes: Metal and glass.

The metal reflectors are usually found in the factory, mill or workshop, and are often rightly termed, "industrial." Glass reflectors find their primary application in the office, store, public building and residence, and might be classified as "decorative."

As with almost any classification, exceptions are to be found; for instance, metal reflectors are sometimes used for localized desk illumination in offices; again, prismatic glass reflectors have been adopted by one large manufacturing corporation, as a standard for general illumination in their factories.

The primary functions of a reflector are: (*a*) To shield the eye of the worker; (*b*) to redirect the light in a useful direction; (*c*) to afford protection to the lamp and socket.

The high brilliancy of the modern light sources make some sort of a diffusing device necessary, if the lamps are hung where they are likely to come within the field of vision, and if we wish the eye to work at its maximum efficiency and not experience fatigue or discomfort. The maximum candlepower of the incandescent lamp is in the horizontal direction, and approximately half the total volume of light is in the upper hemisphere. In most cases, we desire to illuminate some plane near the horizontal, for we see objects by the light reflected from them; and it is obvious that the upward light must be directed downward, to reach the so-called "working plane."

The last function, namely, that of protection, applies more particularly to out-of-door and industrial service, where exposed parts might be attacked by the elements, fumes, etc.

BASIS OF REFLECTOR DESIGN.

In many applications of lighting, we desire approximately even illumination on some definite horizontal plane, as the desk or bench level. When we consider that symmetrical (*i.e.*, not angle types) reflectors send forth a sort of cone of light, it is obvious that by overlapping these cones of light of the proper contours, we can get even illumination for almost any hanging height and spacing. Experience has shown that the ratio of height of lighting unit above the working plane, to distance between units, is most likely to assume the following values: 1 to 2; 4 to 5; 4 to 3, and 2 to 1.

Reflectors have, therefore, been designed to give even illumination at these ratios; and the vertical distribution curves of these, as determined with a photometer, have been designated as follows:

Ratio Height to Distance	Type of Curve
1:2	Extensive
4:5	Intensive
4:3	Focusing
2:1	Concentrating*

Another distribution is obtained with a type which is known as "widely distributing." This, while it will not give even illumination on the 1 to 2 ratio of the extensive type, has more light flux near the horizontal, and can be used on wider spacings and lower hanging heights, than the extensive type, without having serious dark spots between the units.

*As an example of the use of this ratio: Intensive reflectors hung 8 feet above the desk must be spaced (8 divided by X equals 4 divided by 5) or 10 feet apart, for even distribution of light.

Industrial Lighting.

A few years ago, the application of incandescent lamps, to industrial lighting, was confined almost entirely to local or individual machine lighting. Carbon lamps were used, either bare with a wire guard, or equipped with a painted "tin" shade. Two forms of this shade were very widely used; the first, a flat disc about 6 or 8 inches in diameter, affording no protection to the eye and having but little redirecting power; the second, a cone about 8 inches in maximum diameter, which, while it afforded eye protection, concentrated the light strongly beneath the unit.

Now, however, many forms of scientifically designed reflectors are offered to the plant engineer. Desirable distributions of light are produced by these, and much attention has been paid to the finish, metal used, workmanship, etc. Careful investigators have determined the relative depreciation of the various reflecting surfaces employed and light factors, which will determine the ultimate success of the lighting installation. These developments are a direct result of the perfection of the drawn wire tungsten lamp. This illuminant, with its high efficiency, low maintenance cost, slow depreciation, simplicity, ease of cleaning, and simple replacement of burned out units, combined with the ability to withstand moderate shocks, or jars, has led modern practice to provide a good general illumination throughout the entire shop. Oftimes, locating the units with reference to the machines, so that the maximum light is directed where most needed, with lower intensities in the aisle. This system is known as localized general, or group lighting. It is true that certain processes demand a local light, as for instance, the examination of the interior of deep borings, and the assembling of very fine parts, as in the watch industry, where it is obviously impractical to supply general illumination of sufficient intensity.

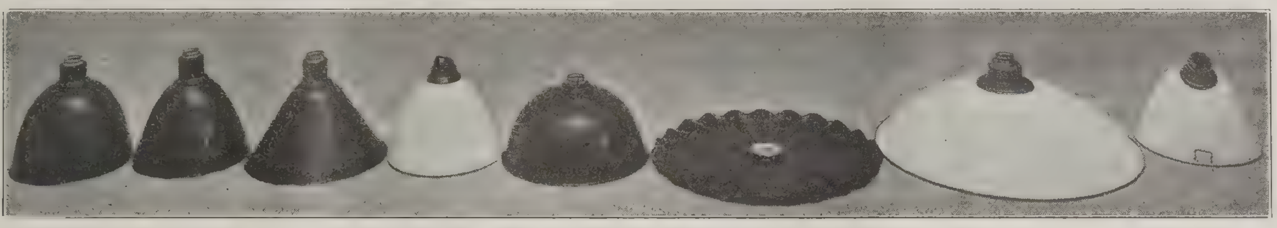


Fig. 1. A Group of Various Types of Industrial Reflectors Discussed.

The machine shop and factory, with comparatively low ceilings, are lighted with medium size units, hung above the line of vision; the foundry, erecting bay, etc., are lighted with high candle power lamps, hung above the crane travel, or with slightly smaller lamps, equipped with angle reflectors, located on a column at the two sides below the crane tracks.

At first glance it would seem that the use of small lamps, hung close to the machine, or local lighting, is the more economical proposition, but a careful analysis of all the elements tending toward a high over-all plant efficiency, shows this to be a fallacy. Good general, or localized general illumination, costs but a very, very small portion of the plant operation, and a larger output is the result, the product contains fewer imperfections, supervision by foremen easier, eye protection is assured, employes are better satisfied, and most important of all, many accidents are prevented. In addition to all these good qualities, many plants that have been using the inefficient types of lamps for local lights, show a great reduction in lighting costs, when the tungsten filament lamp with proper reflector is correctly located for general illumination.

Industrial Reflectors.

We may divide industrial reflectors into groups, as to finish, which may be white enamel (paint or porcelain) or aluminum; second, as to shape—deep bowl, shallow bowl, flat dome, radial fluted, and angle are the common designations of the various shapes available. Sheet metal is now almost universally used as a base metal.

Finish. Porcelain enamel is practically an opal glass surface applied to the steel blank. The better grades have three or more coats. The process of applying the enamel requires much care to give an even finish, without cracks. The purchaser of this type of reflector should examine the finish carefully as the efficiency depends to a great extent on the character of the enamel. The most efficient finish is white, with a tendency toward yellow. A blue white is undesirable, for this often results from thin coating, through which the base steel shows. The bluish tint reduces the light reflecting power remarkably. The metal of the reflector should be quite stiff. At its best porcelain enamel is more or less brittle, and a bending of the metal will produce minute cracks, through which moisture and acid fumes will creep, ultimately destroying the surface. The edges and joints are most likely to be poorly covered, and should be examined.

Since enamel acts largely by diffuse reflection, the light distribution cannot be controlled as well as with a regular reflecting device, but it has certain inherent advantages which make it especially adaptable for industrial service. There are no pores to collect dust and grime, it is easily cleaned, and on cleaning becomes as efficient as a new reflector. It resists moisture, acid and heat.

Paint enamel is much cheaper than porcelain enamel, and when new has about the same efficiency, but since it doesn't possess the advantages listed above, it is rapidly being superceded by the more permanent finish.

Aluminum finish (unpolished) acts by what is often termed "spread" reflection. This might be described as "diffuse reflection, with a regular tendency," and with this

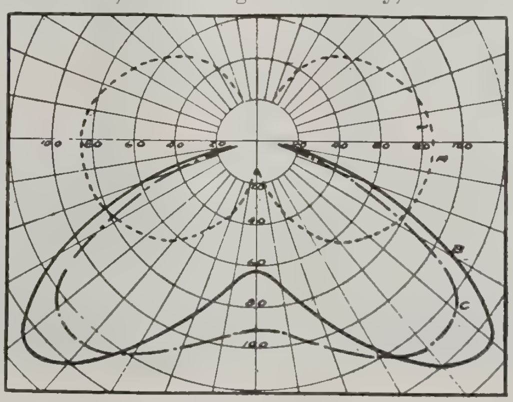


Fig. 2. Vertical Distribution Curve of a Deep Bowl, Aluminum Finished, Extensive Steel Reflector With 100 Watt Tungsten Lamp at 1.18 Watts per Candle: (a) Clear, Bare Lamp; (b) Clear Lamp and Reflector; (c) Bowl Frosted Lamp and Reflector.

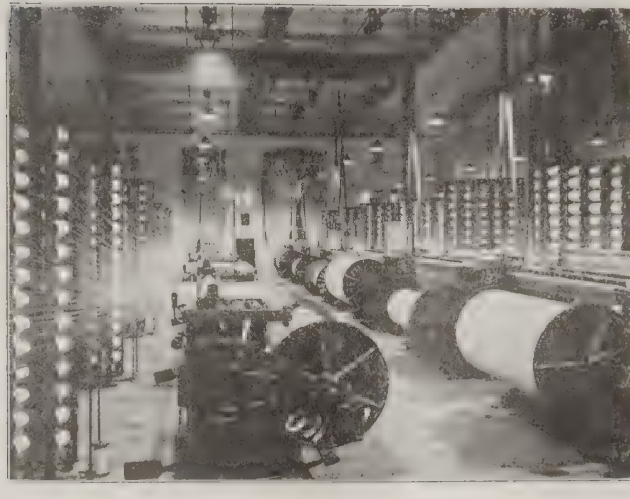


Fig. 3. Night Photograph of Illumination in Warp Room of Cotton Mill, Showing General Illumination With Deep Bowl, Aluminum Finished, Intensive, Steel Reflectors and 60-Watt Tungsten Lamps.

characteristic it is possible to vary the distribution from focusing to widely distributing. There are no streaks or striations in the light, due to regular reflection, as is the case with polished metals. As formerly manufactured, however, there was depreciation in efficiency, due to the wearing away and scratching of the surface in cleaning, and the lodgment of dust particles in the minute pores, when used in dirty surroundings. There are prospects now of a more permanent finish, for one of the leading manufacturers is applying a coat of hard lacquer to the surface, which it is claimed overcomes these faults.

Shape—Deep Bowl. While this type of reflector is not as efficient as the flatter types, it is very useful in affording eye protection, since the lamp is completely surrounded. With the porcelain enamel finish, extensive and intensive distributions are obtainable. (To obtain the intensive curve requires the use of a slightly larger reflector than for the extensive. Aluminum finish, deep bowl reflectors are made to give extensive, intensive and focusing distributions, by varying the contour of the reflector. Typical examples of these three types are shown at the extreme left of Fig. 1, in the order named. Next to these is an extensive porcelain enamel, bowl reflector.

Fig. 4. Night Photograph of Illumination in Inspection Department of Manufacturing Plant, Showing Localized General Illumination With Bowl Shaped, Porcelain Enamel Finished, Intensive, Steel Reflectors and 100-Watt Tungsten Lamps.

Fig. 5. Night Photograph of the Finishing Department of a Knitting Mill, Showing Localized Illumination With Deep Bowl, Aluminum Finished, Focusing Steel Reflectors and 25-Watt Tungsten Lamps.

The extensive and intensive types are applicable for general or localized general illumination, giving even illumination when spaced in accordance with the rules set forth in the opening paragraphs. Fig. 3 shows the aluminum finish intensive deep bowl reflector, as used for general illumination in an industrial plant. Fig. 4 shows the intensive porcelain enamel deep bowl reflector used for localized general illumination in an industrial plant.

The focusing distribution is more particularly applicable for local lighting. Fig. 5 shows the use of these reflectors with relatively small lamps, close to working plane.

Shallow Bowl. This type is shown in the center of Fig. 1 and is manufactured with the aluminum finish, and gives a widely distributing curve. Since less of the light flux strikes the reflector (with resultant decrease of absorption) it is more efficient considering total lumens, than the deep bowl, but the filament of the lamp is exposed at a greater angle, and the eye protection is reduced. This type is very useful for general illumination on wide spacing

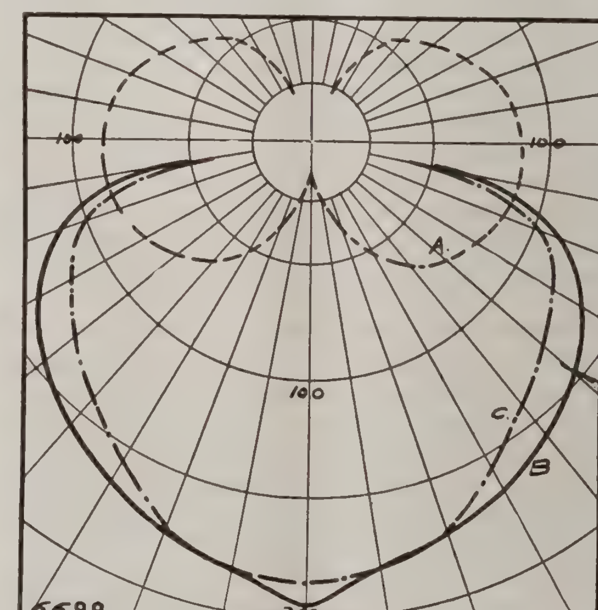


Fig. 6. Vertical Distribution Curve of a Porcelain Enameled, Flat Dome Type, Steel Reflector With 100-Watt Tungsten Lamp at 1.18 Watts per Candle; (a) Clear, Bare Lamp; (b) Clear Lamp and Reflector; (c) Bowl Frosted Lamp and Reflector.

where a slight difference between maximum and minimum illumination is not objectionable; or for localized general lighting, where the machines, or rows of machines, are widely separated and yet the lamps for the machines must light up the intervening spaces.

Flat Dome or Shallow. Porcelain enamel is the standard finish for this type and a widely distributive curve results, as shown in Fig. 6. The reflector from which the curve was obtained is shown second from the right in Fig. 1. If aluminum finish is used, to obtain the desired curve, that is, high candle power in the 45 to 75° angles, the lamp must project so far, that it is likely to be objectionable from the standpoint of glare, and also inefficient, as a great deal of the light goes in the upper hemisphere. A correctly shaped, porcelain enamel, flat dome reflector, if finished in aluminum, gives a concentrating distribution.

The larger the diameter of the flat dome reflector, the greater the downward candle power with any given lamp (as a greater percentage of the light rays is intercepted and reflected downward) but the greater the size, the higher the cost, so that a compromise is usually made between cost and efficiency. As the edges of the flat dome type are bent downward, approaching the bowl shape, the lumens in the zero to 60° zone, are increased.

This type has the same applications as the shallow bowl aluminum finish, and both are useful where considerable light is desired on oblique or vertical surfaces. Fig. 7 shows the use of this type of unit for localized general illumination in a wood working shop, where considerable light is needed on the sides of the room.

Radial Fluted. This type is made in the porcelain enamel, for its primary use is out of doors, in street or yard lighting. It is sometimes of use in interiors, on very wide spacings, where brilliancy of filament is not of consideration. The angle of distribution is very wide, the maximum candlepower is at 75°, and a little light above the horizontal. For reasons explained above, the greater the diameter, the greater the downward light. Fig. 8 is characteristic of the distribution and the reflector is shown in Fig. 1.

Fig. 7. Night Photograph of Wood-Working Shop, Showing Localized-General Illumination With Porcelain Enameled, Flat Dome Type, Steel Reflectors and 250-Watt Tungsten Lamps.

Angle Types. Frequently these are merely symmetrical reflectors with the holders set at an angle; other types are made from special forms and are truly asymmetrical. Both aluminum finish and porcelain enamel are used. In the smaller sizes they are very applicable to localized machine lighting. The larger types are rapidly finding favor for foundry and shop lighting, locating the units at the sides below the crane tracks. Excellent distribution of illumination is obtainable and they are readily accessible for cleaning and replacement.

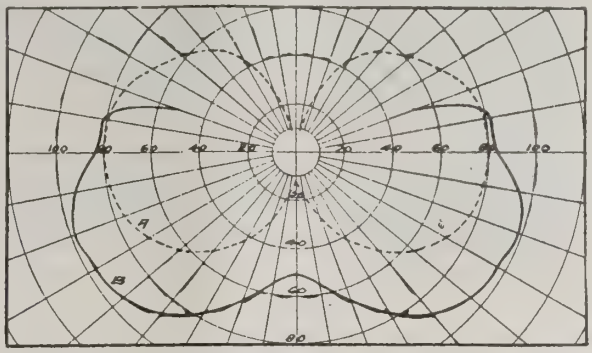


Fig. 8. Vertical Distribution Curve of a Radial Fluted Porcelain Enameled, Steel Reflector With 80 Candlepower Series Tungsten Lamp; (a) Clear, Bare Lamp; (b) Clear Lamp and Reflector.

The distributions produced by the angle reflectors are so varied that it is impossible to discuss these in the space available. One point must be borne in mind, however, that is the fact that the angle at which the holder is set does not determine the angle of maximum candle power for the greatest light flux is usually at a higher angle. Fig. 9 shows the distribution of one of the numerous types now on the market; a view of this is shown at the extreme right of Fig. 1.

Office Lighting.

The practice in the early days of the art was to furnish a low intensity of general illumination, by means of clusters of clear lamps under a flat milk glass shade; and a localized lamp in some sort of conical shade, for each desk or worker. This system has the following disadvantages: Inefficient, poor distribution of general illumination; high maintenance cost, loss of time in shifting local light; glare (reflection from desk surfaces and unshaded lamps in clusters) and severe contrast between the brightly lighted desk area and darker surroundings.

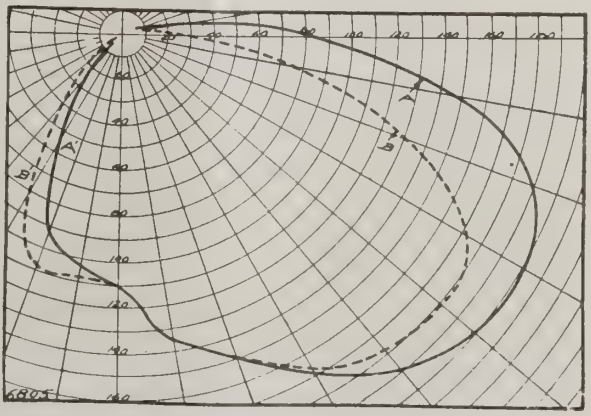


Fig. 9. Vertical Distribution Curve of a Porcelain Enameled, Angle, Steel Reflector With the Holder Set at a 30° Angle. "A" is Taken in the Plane of Maximum Candlepower and "B" in the 45° Plane (Figuring Horizontally) from This Curve.

Modern recommendations for general offices where clerks, bookkeepers, stenographers, etc., are working, are as follows: Provide a relatively high intensity of evenly distributed, general illumination throughout the entire room, from properly placed overhead or ceiling lighting units. No desk lamps are necessary. The advent of the tungsten lamp and scientific reflecting devices, has made this system efficient and a well designed system will give very even distribution with no annoying shadows. The maintenance cost is lower, as a few large units are used rather than a great number of small. Employes lose no time. The eyes are shieleded from the lamps by diffusing shades, removing one of the causes of glare and the eye is not constantly forced to change its pupilary opening, to accommodate various degrees of illumination.

This general illumination is produced by one of three methods of lighting, direct, semi-indirect and totally indirect.

In direct lighting, a bowl shaped, glass reflector is usually used, sending the greater part of the light, at once, to the desk level with a small portion diffused through the glass, reaching the ceiling, and from there partly reflected downward. Economy of current often causes the use of this system, without consideration of the others.

In semi-direct lighting, a translucent diffusing and reflecting medium is placed between the lamp and the desk. Most of the light flux is reflected to the ceiling, and from there redirected to the desks; a smaller part is diffused through the unit and reaches the working plane direct.

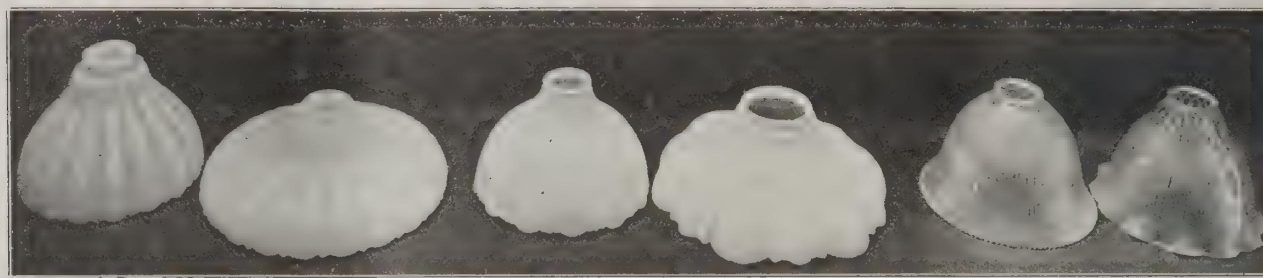


Fig. 10. Group of Opalescent and Prismatic Reflectors of the Types Discussed in the Text.

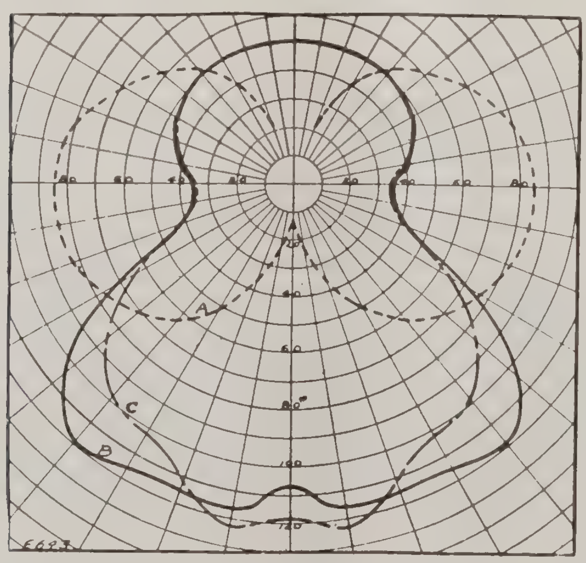


Fig. 11. Vertical Distribution Curve of a Bowl-Shaped, Light Density, Opalescent Glass Reflector With 100-Watt Tungsten Lamp at 1.18 Watts per Candle: (a) Clear, Bare Lamp; (b) Clear Lamp and Reflector; (c) Bowl Frosted Lamp and Reflector.

In totally indirect lighting, an opaque reflector is placed below the light source, all the light being sent to the ceiling, and from there redirected where needed.

The use of the last two systems necessitates a light colored ceiling, white or light cream, to obtain maximum economy.

In the private office, a slightly different condition sometimes exists. Work is usually confined entirely to one desk, and it may be preferable to use a local lamp here, with a correctly designed reflector, avoiding glare, and some sort of a decorative fixture, to provide a low intensity of general illumination.

The main question to be discussed here, however, is the general office. The efficiency of the indirect system is to such a great extent dependent on the condition of the walls and ceilings, that an analysis of the reflecting devices used in these systems is of but little use, for data which can be used in calculation, must result from illumination tests with all factors which affect the results carefully noted. Therefore, our attention will be confined largely to the direct lighting office reflectors. These may be classified as to shape and as to kind of glass.

Shape: Of the open type reflectors, there are, in general, two shapes, (bowl and flared) with sometimes an intermediate type known as "semi-flared." As with the industrial reflector, the bowl shape is usually to be preferred above the flared, for even though the latter is more efficient, in point of downward light, the lamp is more completely covered with the bowl type and hence, greater eye protection is assured. Space will not permit an analysis of the totally enclosing glassware.

Glass: Two types are commercially available: opalescent (or white glass) and prismatic.

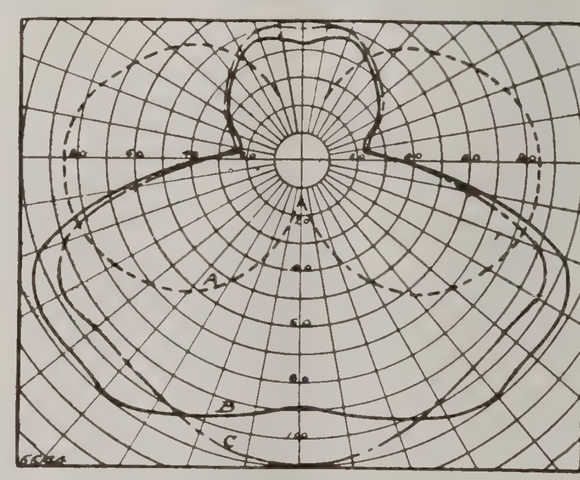


Fig. 12. Vertical Distribution Curve of a Flared Shaped, Light Density, Opalescent Glass Reflector With 100-Watt Tungsten Lamp at 1.18 Watts per Candle: (a) Clear, Bare Lamp; (b) Clear Lamp and Reflector; (c) Bowl Frosted Lamp and Reflector.

Opalescent Glass. One would not expect these reflectors to be as efficient in redirecting the light, as the prismatic glass, mirrored glass, or opaque reflector, but they have a considerable field of application, where a decorative appearance is of importance, and where a well lighted ceiling is desirable.

Opalescent glass reflectors act largely by diffuse reflection, and a variation of the contour will change the distribution but slightly. This is particularly true if the interior surface is depolished, for the directly reflected light comes from the glazed surface. Diffuse reflection is obtained from the opal particles in the glass, and from the outer surface, if the ray impinges at less than the critical angle.

For the sake of convenience, we will divide the opalescent glasses into light density and heavy density. In the light density we will include the reflectors of the "Alba" type glass. This glass appears to have innumerable opaque, white particles suspended in clear glass, whereas the other opals appear homogeneous. The "cased" or "alabaster" glass reflectors might also be called light density. This glass has a flash or film of white glass, or crystal glass, as a base. Under heavy density, we will consider all the true opals which, while they vary slightly in density, yet have the same general characteristics.

Light Density Opalescent. These reflectors must be quite thick, or the surfaces etched, to produce good diffusion, and to prevent the edges and hollows from being alternately dark and light, which makes an unattractive reflector. As usually made, however, the diffusion is excellent, but it varies almost directly with the thickness of the glass. Absorption is quite low, and non-selective, that is, color of the light transmitted through the glass is the same as that of the light source. As stated, the distribution of the light is practically the same with the various contours, and Fig. 11 is quite typical of the distribution of the light density bowl type, and is a mean between the extensive and the intensive. The bowl frosted lamp is seen to concentrate the flux a slight amount. Fig. 12 shows that the light density flared type gives a widely extensive curve. Two types of different makes are shown at the left of Fig. 10.

On account of the light density of wide separation of the opal particles, the reflective power is quite low and a considerable portion of the light flux is transmitted into the upper hemisphere, serving to illuminate the ceiling and side walls. A large part of this light reaches the working plane indirectly, if the surroundings are light in color.

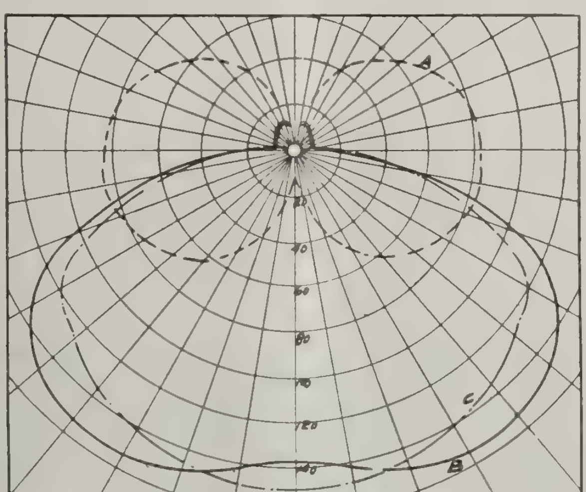


Fig. 13. Vertical Distribution Curve of a Bowl Type, Heavy Density, Opalescent Glass Reflector With 100-Watt Tungsten Lamp at 1.18 Watts per Candle: (a) Clear, Bare Lamp; (b) Clear Lamp and Reflector; (c) Bowl Frosted Lamp and Reflector.

Heavy Density Opalescent. In opal glass which we consider under this heading, the white particles are so minute and close together, as to be invisible to the unaided eye, and the glass appears uniformly white. With the dense opals, the reflective power is good, but the absorption rather high and generally selective. Figs. 13 and 14 show that the downward candle power is much higher than with the light density. The bowl type curve is usually extensive and the flared, widely distributing. Two of these are shown at the center of Fig. 10.

Prismatic Glass Reflectors.

This type of reflector was really the first scientific reflecting device offered for use with modern illuminants. The principle of changing the angle of light and at the same time obtaining diffusion by means of prisms, was first worked out in France. Reflectors made on this order sprung rapidly into favor and a large number are to be seen in every class of service. It must be borne in mind that to obtain good results, each prism must be calculated with reference to the correct position of the light source; hence, a prism reflector should always be used with the holder recommended for a certain lamp and reflector combination.

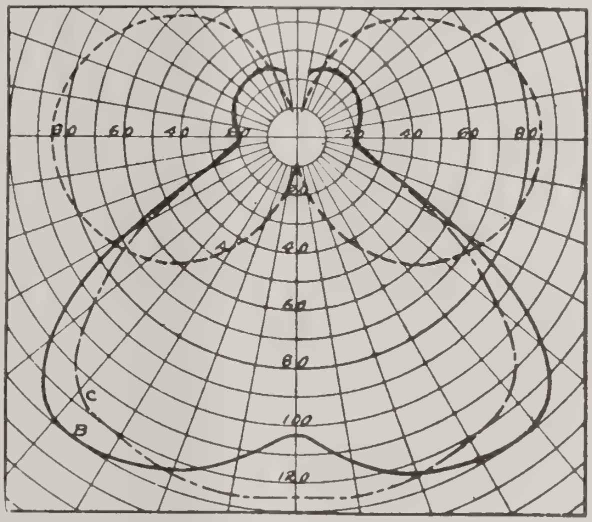


Fig. 14. Vertical Distribution Curve of a Flared Shaped, Heavy Density, Opalescent Glass Reflector With 100-Watt Tungsten Lamp at 1.18 Watts per Candle: (a) Clear, Bare Lamp; (b) Clear Lamp and Reflector; (c) Bowl Frosted Lamp and Reflector.

As the prismatic reflectors act entirely by direct reflection, any desirable distribution may be obtained. One manufacturer in America carefully redesigns its line for any change in lamp size or filament position, and presents a very complete series of all sizes and distributions. Fig. 15 shows the vertical distribution of a carefully designed intensive type prismatic reflector, shown at the extreme right of Fig. 2, and an installation of these units for general office illumination, is shown in Fig. 16.

There are other types of prismatic reflectors on the market which appear, from test, to have been incorrectly calculated, and acting by direct reflection, widely different distributions are given by reflectors which appear very similar. Fig. 17 shows the results of a test on a unit supposed to give the same distribution as the reflector shown in Fig. 15. This reflector is also shown in Fig. 10.

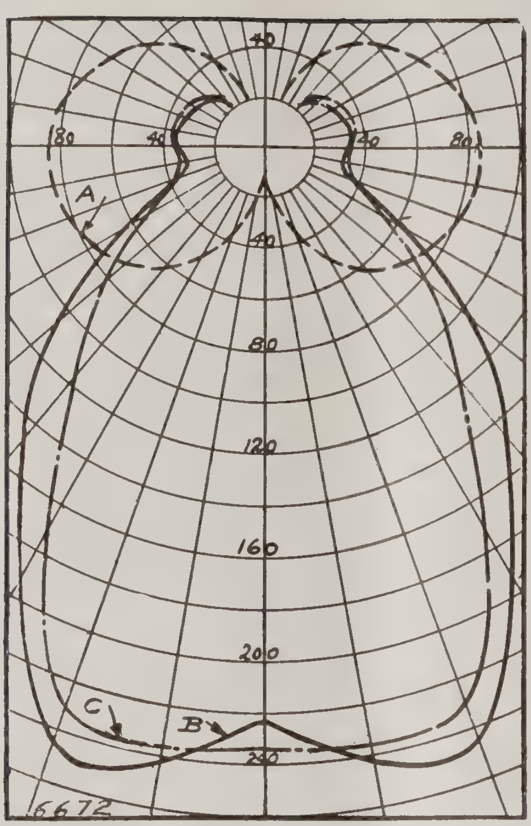


FIG. 15. VERTICAL DISTRIBUTION CURVE OF A BOWL-SHAPED, CLEAR PRISMATIC GLASS REFLECTOR, INTENSIVE DISTRIBUTION, CORRECTLY CALCULATED PRISMS WITH 100-WATT TUNGSTEN LAMP AT 1.18 WATTS PER CANDLE: (A) CLEAR, BARE LAMP; (B) CLEAR LAMP AND REFLECTOR; (C) BOWL FROSTED LAMP AND REFLECTOR.

SEMI-INDIRECT REFLECTORS.

These are generally found in one or two forms. First, several pieces of shaped white glass were leaded together to form a bowl of the desired contour, and suspended from the ceiling by a chain or simple pipe fixture. They are usually designed to accommodate one lamp, hung pendent. They act largely by diffuse reflection, but as the opal glass employed is quite dense, a slight variation may be produced by change of contour. The distribution is usually quite wide, resembling that of the bowl-shaped, heavy density opal. Fig. 18 shows an office illuminated by these units.

The second type consists of a large dish of pressed light or heavy density opalescent glass, suspended by three

FIG. 16. NIGHT PHOTOGRAPH OF ILLUMINATION IN A CLERICAL OFFICE, SHOWING GENERAL ILLUMINATION WITH BOWL-SHAPED PRISMATIC CLEAR REFLECTORS AND 100-WATT TUNGSTEN LAMPS.

or more chains, usually designed to accommodate a group of lamps burning in a horizontal position. The distribution of light is very wide, and with most types a considerable portion of the light is diffused downward through the units.

One system which has recently been introduced and which has several advantages consists of a holder which carries the lamp pendent, and at the same time holds in place, below the lamp, any of the standard types of bowl shaped opalescent glass reflectors of the size used with the lamp for direct lighting. This is an inexpensive and effective method of securing semi-indirect illumination.

TOTALLY INDIRECT REFLECTORS.

Two types of these are on the market which are radically different. The pioneer in this line consists of a onepiece mirrored glass reflector, with a slightly corrugated surface, to break streaks, enclosed in some sort of a decorative housing. These act by direct reflection, and are made to give various distributions. They are used singly with the lamp upright, or several reflectors in one housing, with the lamps horizontal. An installation of the single lamp type is shown in Fig. 19.

The other type consists of a flat dome enameled steel reflector, used inverted with the lamp hanging pendent. Acting largely by diffused reflection, the distribution cannot be readily controlled, and in general, is similar to the unit used directly. Fig. 20 shows an installation of these reflectors.

RATING OF TUNGSTEN LAMPS.

Tungsten lamps are rated in watts consumption with an efficiency or specific consumption rating of watts per mean horizontal candle power; hence the mean horizontal

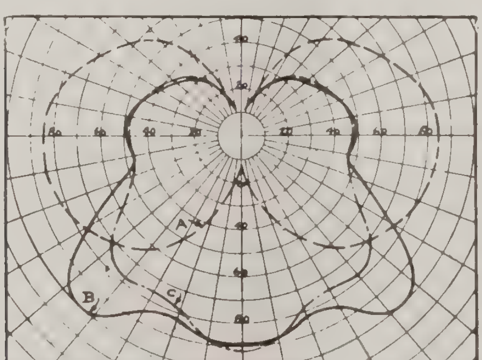


FIG. 17. VERTICAL DISTRIBUTION CURVE OF A BOWL-SHAPED, CLEAR PRISMATIC GLASS REFLECTOR, INCORRECTLY DESIGNED PRISMS, WITH 100-WATT TUNGSTEN LAMP AT 1.18 WATTS PER CANDLE: (A) CLEAR, BARE LAMP; (B) CLEAR LAMP AND REFLECTOR; (C) BOWL FROSTED LAMP AND REFLECTOR.

FIG. 18. NIGHT PHOTOGRAPH OF THE ILLUMINATION IN A GENERAL OFFICE, SHOWING GENERAL ILLUMINATION WITH LEADED GLASS, SEMI-INDIRECT LIGHTING UNITS AND 250-WATT TUNGSTEN LAMPS.

FIG. 19. NIGHT PHOTOGRAPH OF THE ILLUMINATION IN A GENERAL OFFICE, SHOWING THE USE OF SINGLE LAMP, MIRRORED REFLECTORS, TOTALLY INDIRECT LIGHTING UNITS WITH 250-WATT TUNGSTEN LAMPS.

candle power may be determined by dividing the watts by the efficiency. Tests have shown that for the clear tungsten lamp of standard construction and filament shape, the mean spherical candle power is 78 per cent of this mean horizontal candle power. This value is called the "spherical reduction factor."

From the primary definitions, we know that the total lumens are equal to (mean spherical candlepower) $\times 4\pi$; hence, the total lumens equals $4\pi \times 0.78 \times$ watts $\div$ W.P.C. For most of the sizes of tungsten lamps, of this total amount of light, approximately 52 per cent is in the lower hemispherical (0 to 90°), 48 per cent in the upper hemispherical (90 to 180°) and 21 per cent in the zone from 0 to 60°.

EFFICIENCY VALUES OF THE TYPES OF REFLECTORS WHOSE PROPERTIES HAVE BEEN DISCUSSED.

Sample reflectors of all known makes, of the sizes intended for use with the 100 watt tungsten lamp, were secured in the open market and carefully tested. This size was chosen as it was the one most frequently met in general industrial and office lighting, and since it is a medium size, the results obtained from it will give an approximation of what can be expected of the other sizes. The values given are the average for total reflectors tested of any group.

Considering the total lumens emitted by the clear, bare lamp as 100%, we get the following results:

FOR THE BARE LAMP.

	Clear Lamp.	Bowl Frosted Lamp
Total lumens	100 %	94.3%
Downward lumens	52.4%	43.7%
Lumens flux 0 to 60 degree zone..	20.9%	16.3%

DEEP BOWL—ALUMINUM FINISH (Four reflectors of three makes tested.)

	Clear Lamp.	Bowl Frosted Lamp.
Total lumens	57.0%	52.5%
Downward lumens	57.0%	52.5%
Lumens flux 0 to 60 degree zone..	49.0%	46.0%

DEEP BOWL—PORCELAIN ENAMEL (Four reflectors of four makes tested.)

	Clear Lamp.	Bowl Frosted Lamp.
Total lumens	60.0%	50.6%
Downward lumens	60.0%	50.6%
Lumens flux 0 to 60 degree zone..	51.0%	44.1%

SHALLOW BOWL ALUMINUM FINISH. (One reflector of one make tested.)

	Clear Lamp
Total lumens	69.9%
Downward lumens	60.9%
Lumens flux 0 to 60 degree zone..	43.6%

FIG. 20. NIGHT PHOTOGRAPH OF THE ILLUMINATION IN THE ACCOUNTING DEPARTMENT, SHOWING THE GENERAL ILLUMINATION WITH PORCELAIN ENAMELED, SINGLE UNIT, TOTALLY INDIRECT LIGHTING FIXTURES AND 400-WATT TUNGSTEN LAMPS.

FLAT DOME—PORCELAIN ENAMEL. (Ten reflectors of seven makes tested.)

	Clear Lamp.	Bowl Frosted Lamp.
Total lumens	82.0%	74.1%
Downward lumens	78.5%	71.5%
Lumens flux 0 to 60 degree zone..	47.9%	44.0%

RADIAL FLUTED—PORCELAIN ENAMEL. (Two reflectors of two makes tested.)

	Clear Lamp
Total lumens	91.3%
Downward lumens	68.8%
Lumens flux 0 to 60 degree zone..	33.9%

LIGHT DENSITY OPALESCENT—BOWL SHAPED. (Eighteen reflectors of fourteen makes tested.)

	Clear Lamp.	Bowl Frosted Lamp
Total lumens	90.0%	83.0%
Downward lumens	54.8%	48.2%
Lumens flux 0 to 60 degree zone..	35.8%	32.0%

LIGHT DENSITY OPALESCENT—FLARED SHAPED. (Twelve reflectors of twelve makes tested.)

	Clear Lamp.	Bowl Frosted Lamp.
Total lumens	91.1%	87.5%
Downward lumens	63.0%	58.3%
Lumens flux 0 to 60 degree zone..	37.5%	33.0%

HEAVY DENSITY OPALESCENT—BOWL SHAPED. (Thirteen reflectors of ten makes tested.)

	Clear Lamp.	Bowl Frosted Lamp.
Total lumens	80.6%	74.8%
Downward lumens	60.0%	47.8%
Lumens flux 0 to 60 degree zone..	43.0%	37.7%

HEAVY DENSITY OPALESCENT—FLARED SHAPED. (Nine reflectors of eight makes tested.)

	Clear Lamp.	Bowl Frosted Lamp
Total lumens	87.2%	79.5%
Downward lumens	69.6%	62.9%
Lumens flux 0 to 60 degree zone..	42.8%	39.2%

CLEAR PRISMATIC GLASS—BOWL SHAPED REFLECTORS (Prisms accurately calculated. Four reflectors of one make tested)

	Clear Lamp.	Bowl Frosted Lamp
Total lumens	90.8%	85.5%
Downward lumens	71.7%	65.1%
Lumens flux 0 to 60 degree zone..	54.0%	48.5%

CLEAR PRISMATIC GLASS—BOWL SHAPED REFLECTORS. (Inaccurate prisms. Twelve reflectors of seven makes tested.)

	Clear Lamp.	Bowl Frosted Lamp.
Total lumens	76.0%	79.3%
Downward lumens	59.0%	51.5%
Lumens flux 0 to 60 degree zone..	37.1%	32.8%

The values given above may be made use of to obtain approximate results on any size lamp with any given reflector. Suppose we desire to know the zero to 60° lumens of a 250 watt tungsten lamp operating at one watt per candle. We will proceed in the following manner: $250/1 \times 0.78 \times 4\pi = 2440$ total lumens.

For the flat dome, porcelain enamel industrial reflector, the average results from the tests of ten reflectors showed that 47.9 of the total lumens of the clear, bare lamp were emitted in the zero to 60° zone; hence an approximation shows 1170 lumens as the answer to our query.

Some of the Essential Features of Factory Illumination

(Contributed Exclusively to Electrical Engineering)

BY J. G. HENNINGER, ILLUMINATING ENGINEER, NATIONAL ELECTRIC LAMP ASSOCIATION.

Humanitarian Side of Good Lighting and Considerations in Natural and Artificial Illumination.

THE importance of good illumination in factory operations has not been realized until the last few years. Recently however, a consistent effort has been made to utilize efficiently and thoroughly both natural and artificial light. The astonishing insignificant cost of good artificial illumination is not always apparent until it is figured up and compared with other costs, and the man who pays the light bill is only too apt to see the total amount of the bill without comparing it with any other cost items.

One 100-watt tungsten lamp, equipped with a good reflector, will provide excellent illumination for a space 10 feet by 10 feet, an area of 100 square feet. Since it is not unreasonable to allow 100 square feet of floor space to each employee in an industrial plant, for a factory operating 10 hours a day, 300 days a year and paying an average of 35 cents per hour, the cost of good illumination, at the rate of 3 cents per kw-hr. for energy, is only 1.41 cents per day per man, including all maintenance charges, interest, cost of cleaning, etc. This is a cost equivalent to 2.4 minutes of a man's time—certainly a very small outlay. It is thus evident that a very small amount of lost time would, if saved, pay for a great deal of light.

There are several other points that should be considered. It is authoritively stated that $30,000,000 could be saved yearly by good illumination on account of decrease of spoilage. Such an enormous sum of money would provide good illumination for a great many plants. On the other hand, consider the effect upon the earning capacity of a man. Poor lighting makes him strain his eyes; this in turn causes headaches and other discomforts. Obviously a man who is not in the best of health and spirits cannot work as efficiently as the man who is happy and comfortable. Man is naturally optimistic—he likes things bright and cheerful. Dark uncomfortable surroundings therefore cannot have any other result than to cut down a man's ability to do good work. Good lighting also prevents accidents. One of the largest insurance companies states that "the greatest number of accidents occurs during the months of diminishing light." Illumination in most plants is sadly under-rated as a means of accident prevention and this point is not lost sight of in legal matters dealing with accidents. A prominent official of one of the largest manufacturing companies is authority for the statement that insufficient illumination is frequently held by juries to be "contributory negligence."

So much for the humanitarian side of factory illumination. It is essential in this connection also to mention the following points: That each serious accident completely demoralizes a shop; that this demoralization may last for a day or a week; that during this period of excitement the operatives are inefficient; that production drops while spoilage and "seconds" due to nervousness increase.

Taking up natural lighting considerations, full advantage should, of course, be taken of daylight. This is done by the use of large windows and skylights, prism glass, white walls and ceilings, white outside walls and cleanliness. Saw-tooth roofs are used to very good advantage in wide buildings. The use of prism glass often increases the illumination 300 or 400 per cent. Whitewash and water paints are easily put on and the expense is small. Light wells should always be painted white. All windows and skylights should be kept clean. Many times lamps are being used where simply cleaning the windows would supply enough illumination. The expense of cleaning windows in a factory is so little as to be negligible. It is, in fact, lost among the other expenses.

For efficient and effective artificial lighting, white walls and ceilings, efficient light sources and proper placing of same together with proper reflectors are necessary. There are available a number of very excellent light sources, but the incandescent lamp is by far the most generally useful and adaptable. The distribution of light about any lamp is such that in most cases the light cannot be efficiently used without a reflector, for a reflector places the light just where it is wanted and protects the eye from glare. The tungsten lamp of today, generally known under the trade name Mazda, is the most efficient incandescent lamp made, yet it converts into light only 0.6 of one per cent of the energy originally represented in the coal pile. This is but one more reason why we should endeavor to get the highest possible utilization out of our light sources, and this can only be done with the assistance of an efficient reflector.

Localized lighting is ordinarily the simplest means of applying artificial illumination. This method is exceedingly adaptable and there are some processes which cannot be economically lighted without applying such a system as, for example, machining the interior of tanks, etc. In general this style of lighting is economical where small, widely seperated areas are to be lighted. It is essentially an incandescent lamp proposition.

General illumination refers to that type of lighting in which a uniform intensity of illumination is desired throughout the workroom. Usually a greater quantity of light is required than with the localized lighting, but the highest efficiency illuminants can be utilized and the minimum installation and maintenance expense secured. It is particularly adapted for large, high, open workrooms, where manufacturing is reasonably condensed.

In selecting the lighting unit, the height and spacing must be considered in connection with the candle-power value and distribution of light from the lamp and reflector, so as to insure a reasonably even intensity of light in various parts of the workroom. Lamps of 100-watt energy consumption or more are generally used for this system of lighting.

There are two other forms of factory lighting in general use; combined general and localized lighting, which afford general illumination with localized lighting where intense light is needed, and localized general illumination, which provided general illumination for the entire plant but the units so placed as to give the maximum intensity where needed. The former method is suitable for large rooms where small isolated areas require much higher intensity of illumination than the rest of the room; the latter is suitable for machine shops, weave rooms, etc., where the spacing of the machines is fairly uniform.

As has been stated, the reflector is a very important part of any lighting installation. There are three general types on the market today; prismatic glass, translucent glass and steel reflectors. The first two classes are applicable to offices, drafting rooms, etc.; steel reflectors being most generally useful and desirable about a factory. Generally speaking the enameled steel reflector is preferable to the aluminum-finished one as the surface is more permanent and more easily cleaned. The narrow bowl is generally applicable where the mounting height is low, while the dome type is more desirable with larger units and greater mounting height.

Everything possible should not only be done to aid in the conservation of our country's natural resources, but in the conservation of the earning capacity of workmen as well by supplying them with sufficient light, thus saving their eyes, and in the prevention of accidents by providing sufficient light for safety, for light is very cheap when compared to the cost of other things about a factory and invaluable in results produced.

Recent Progress in Incandescent Lamp Manufacture

(Contributed Exclusively to Electrical Engineering)

BY R. W. SHENTON, ENGINEERING DEPARTMENT, NATIONAL ELECTRIC LAMP ASSOCIATION.

SINCE the introduction of the wire-drawing process of producing tungsten filaments, the tungsten lamp has continued its trend toward higher efficiency, greater ruggedness and better life performance. These advances are the results of steady improvements and the continual development of factory processes rather than of specific inventions. During the past year the efficiency of the draw-wire tungsten lamp has been improved by an average of about 0.15 watts per candle. This has been accomplished mainly through the use of chemicals to retard the blackening of the bulbs and thus prolong the useful life of the lamps. Before the wire-drawing process for forming filaments came into use the ability of the pressed filament to hold together generally determined the hours life of the lamp, but now that the rugged wire type is used altogether, the blackening of the bulb has been the limiting factor in the length of useful life.

After a great deal of experimental work, a method has been evolved whereby the black deposit on the bulb is prevented to a great extent, that deposit which does form being light in color or limited to a portion of the bulb which does not seriously affect the light distribution. This method consists in using certain chemicals carefully placed in the bulb in such a manner that only the desired effect is produced.

Another factor that has entered into lamp manufacture in the past year is a more complete and definite standardization of dimensions of the bulbs and their parts. This means that the products of the factories will be more uniform and hence more satisfactory since there are now more definite dimensions for the size and position of every part in the lamp bulb. This increase in uniformity will mean an increased efficiency in their general use with reflectors since a great deal of the efficiency of a lighting unit depends on the relative position of the light source with respect to the reflector. The reflector manufacturers and the manufacturers of incandescent lamps have been cooperating with a view

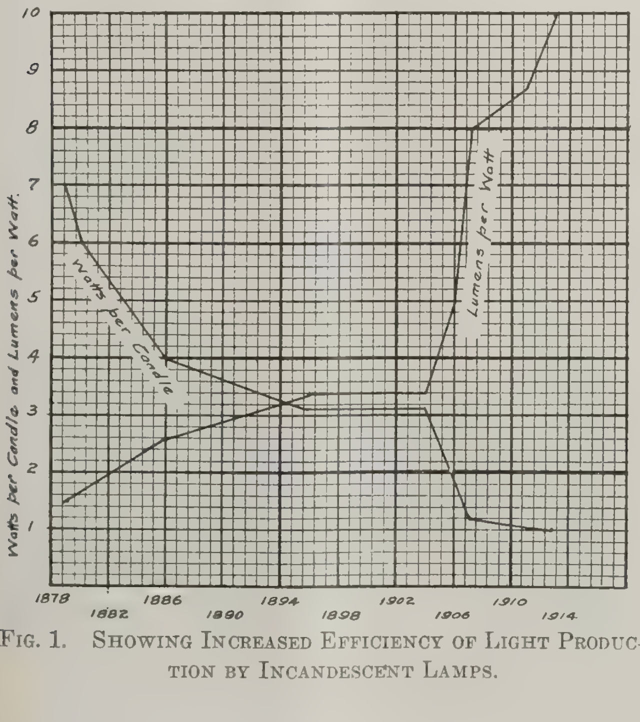
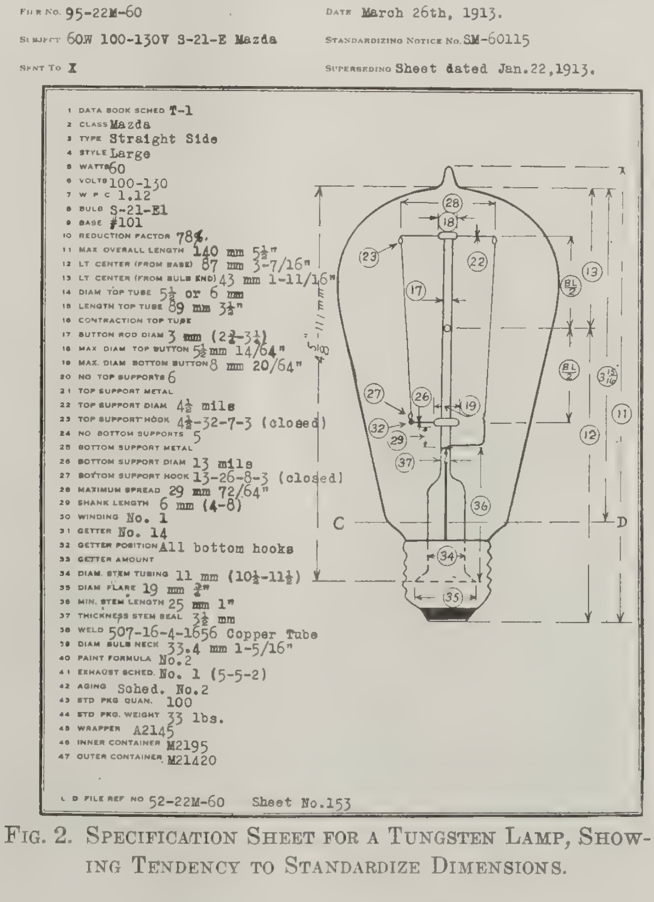


FIG. 1. SHOWING INCREASED EFFICIENCY OF LIGHT PRODUCTION BY INCANDESCENT LAMPS.


FILE NO. 95-22M-60 DATE March 26th, 1913.
SUBJECT 60W 100-130V S-21-E Mazda STANDARDIZING NOTICE NO. SM-60115
SENT TO X SUPERSEDING Sheet dated Jan.22,1913.

1 DATA BOOK SCHED T-1
2 CLASS Mazda
3 TYPE Straight Side
4 STYLE Large
5 WATTS 60
6 VOLTS 100-130
7 W P C 1.12
8 BULB S-21-E1
9 BASE #101
10 REDUCTION FACTOR 78%.
11 MAX OVERALL LENGTH 140 mm 5½"
12 LT CENTER (FROM BASE) 87 mm 3-7/16"
13 LT CENTER (FROM BULB END) 43 mm 1-11/16"
14 DIAM TOP TUBE 5½ or 6 mm
15 LENGTH TOP TUBE 89 mm 3½"
16 CONTRACTION TOP TUBE
17 BUTTON ROD DIAM 3 mm (2¾-3¼)
18 MAX DIAM TOP BUTTON 5½ mm 14/64"
19 MAX. DIAM BOTTOM BUTTON 8 mm 20/64"
20 NO TOP SUPPORTS 6
21 TOP SUPPORT METAL
22 TOP SUPPORT DIAM 4½ mils
23 TOP SUPPORT HOOK 4½-32-7-3 (closed)
24 NO BOTTOM SUPPORTS 5
25 BOTTOM SUPPORT METAL
26 BOTTOM SUPPORT DIAM 13 mils
27 BOTTOM SUPPORT HOOK 13-26-8-3 (closed)
28 MAXIMUM SPREAD 29 mm 72/64"
29 SHANK LENGTH 6 mm (4-8)
30 WINDING No. 1
31 GETTER No. 14
32 GETTER POSITION All bottom hooks
33 GETTER AMOUNT
34 DIAM. STEM TUBING 11 mm (10½-11½)
35 DIAM FLARE 19 mm ¾"
36 MIN. STEM LENGTH 25 mm 1"
37 THICKNESS STEM SEAL 3½ mm
38 WELD 507-16-4-1656 Copper Tube
39 DIAM BULB NECK 33.4 mm 1-5/16"
40 PAINT FORMULA No.2
41 EXHAUST SCHED. No. 1 (5-5-2)
42 AGING Sched. No.2
43 STD PKG QUAN. 100
44 STD PKG. WEIGHT 33 lbs.
45 WRAPPER A2145
46 INNER CONTAINER M2195
47 OUTER CONTAINER M21420

L D FILE REF NO 52-22M-60 Sheet No.153

FIG. 2. SPECIFICATION SHEET FOR A TUNGSTEN LAMP, SHOWING TENDENCY TO STANDARDIZE DIMENSIONS.

to making the dimensions of their product such that illumination will be produced most efficiently.

The use of chemicals to decrease or prevent blackening has also made possible the use of smaller bulbs. For example, the 60-watt mounting is now placed in the same size bulb as was formerly used for the 40-watt lamp and the 40-watt mounting is in turn placed in what was formerly

Fig. 3. Small Sizes—15 and 25-Watt Tungsten Lamps.

the 25-watt bulb. This decreases the space required for storage and packing and greatly facilitates the handling of lamps. The reduction in size also makes more practical the substitution of the 60-watt tungsten for the old 60-watt carbon lamp, since these two lamps are approximately the same size, and reflectors designed for use with carbon lamps will serve the tungsten just as well. This enables the central station man to push his campaign of substituting tungsten for carbon lamps.

One of the new types of lamps that has been developed this year is the concentrated-filament lamp. It has been found that the tungsten wire can be wound in a very close helix of small diameter and thus a great length of wire may be

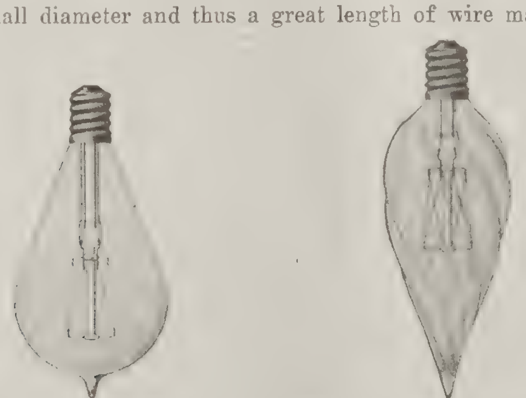


Fig. 5. New Candelabra Types of Tungsten Lamps.

concentrated in a small space. In this way there are so many turns that the voltage per turn is very small and there is no trouble from short circuiting or the current jumping across the spaces between the wires. The development of this type of filament construtcion has made possible the satisfying of the demand for a high candle power incandescent lamp with approximately a point source of light, for use in stereopticans, projectors and head-light lamps, whose efficiencies depend on a point source of light of greater brightness than has formerly been obtainable.

In the manufacture of the concentrated-filament lamps the fine tungsten wire is wound into a helix on another wire as a form. This helix itself can be wound in the same manner as a simple filament and due to its small over-all length can be used in very confined or restricted spaces if necessary, as, for instance, in the case of the stereoptican lamps.

The fact that this concentrated filament can be placed in a

Fig. 4. Medium and Large Sizes of Tungsten Lamps.

small bulb has made it possible to manufacture decorative lamps of the candelabra type with tungsten filaments of the 100-130 volt range. Two of these lamps are shown in the illustrations presented here. It will be readily seen that the winding of about eighteen inches of filament in bulbs of this size without short-circuiting is not an easy matter.. By concentrating the filament into a small helix, its over-all length is reduced to about three and one-half inches which makes it possible to wind the entire half yard in a space sufficiently small to place in the bulbs shown.

While the above developments are in no way spectacular nevertheless they are important changes and add much to the progress of incandescent lamp manufacture. Illustrations Figs. 1 and 2 are taken from a report read at the Chicago convention of National Electric Light Association last June.

Go ahead! And if you make mistakes, do not toll the bell, or hang crepe on your ambition to try again. Do several small jobs at a time. It will fit you to do some great, big job. Be a booster. Be a kindler of the fire of enthusiasm in others. Keep right on going. Going is the word. Measure your own results and not your expectations. Keep up your expectations by getting results.

There are three sets of men. One set always fails to follow directions. Another set does as instructed. The third set does more than it is told to do. These three degrees represent the hazy-minded, who become slaves; the uncertain-minded, who work hard; the creative-minded, who are eventually called as managers.

The Lighting of High Class Stores by the Indirect System

(Contributed Exclusively to Electrical Engineering)

BY HARVEY B. WHEELER, CHIEF ENGINEER, NATIONAL X-RAY R EFLECTOR COMPANY.

A Study of the Requirements for Satisfactory Illumination of Stores by the Indirect System.

ALTHOUGH this article deals with the lighting of specific stores, the writer has endeavored to select examples that illustrate the application of the essential principles to produce an efficient and satisfactory illumination under conditions fairly representative of the class of interiors discussed. The illuminating engineering profession has still a great deal to do to cause merchants to realize that what they need is illumination and not simply lighting fixtures. The managements of large stores realize this, and have in many cases conducted exhaustive tests on all kinds of lighting fixtures before coming to a decision on any particular system of illumination. The majority of the examples mentioned in this article were decided in this way.

In selecting a system of illumination, the following points should be considered: 1. Advertising value; 2. Comfort to the public; 3. Initial cost; 4. Maintenance.

In considering the illumination as an advertising asset, the main floor demands particular attention. The intensity should be considerably higher than for ordinary illumination, an average of about five to six foot candles as against 3½ to 4½ on the other floors. Also the lighting fixtures should be attractive, and with an indirect system the bowls should be illuminated to an intensity equal to or less than the ceiling as shown in Figures 1, 3 and 5. For other than the main floors, with the indirect system, opaque bowls finished in light colors and equipped with efficient indirect reflectors, are preferable, because after the merchant has the public inside his store, he desires to concentrate their attention to the goods displayed, and not on the lighting fixtures. Further, being finished in light colors, they blend with the interior decorations.

A lighting system to be satisfactory, must make the goods displayed attractive, bring out the artistic treatment of the interior, and give an atmosphere of comfort and refinement. An efficient indirect system does this, as exemplified by many of the best stores in the country.

Large sums are expended to give the public modern conveniences, elevators, sanitary toilet facilities, rest and tea rooms, etc. In other words, high class service. It is essential therefore to be in keeping with this tendency, that glaring light sources be avoided, a feature often overlooked in the past. A considerable argument in favor of indirect illumination then is that it keeps the service at a high standard and makes all the other comforts more pleasing with its soft and evenly diffused light.

From the standpoint of initial cost a well designed and efficient system of indirect illumination should cost no more than direct lighting. As regards maintenance, in any system the cost of cleaning lamps and reflectors is the important factor. Numerous tests over long periods have shown a decrease in illumination on an average of 10 per cent per month. The intervals of cleaning depend upon the locality, but for average conditions once a month should be sufficient. Also to keep the system of illumination at a high standard, reflectors of permanent efficiency are necessary.

The requirements of the four points mentioned in the selection of a system of illumination are fulfilled by prismatic and heavy density opal glass for direct and one piece silvered glass reflectors, with a green elastic backing, for the indirect system, or for the show window, non-symmetrical one piece silvered glass reflectors, covered with a green elastic backing, should be used.

As regards decorations, light colors are preferable, this being especially true with indirect lighting, where the ceilings should be of flat white or a very light cream. The upper part of the walls should be in the medium shades down to the dado, which can be almost any color desired.

FIG. 1. ILLUMINATION OF MAIN FLOOR HUB STORE, CHICAGO.

FIG. 2. ILLUMINATION OF BASEMENT HUB STORE, CHICAGO.

In what follows the illumination features of several stores are given the references being to the illustrations shown here. Fig. 1 shows the illumination of the gents' furnishings department on the main floor of the Hub Store in Chicago. This store consists of eight floors and basements of the new 18 story Lytton Building, and is one of the finest of its kind in the country. Indirect illumination is used throughout. The fixtures on the main floor are

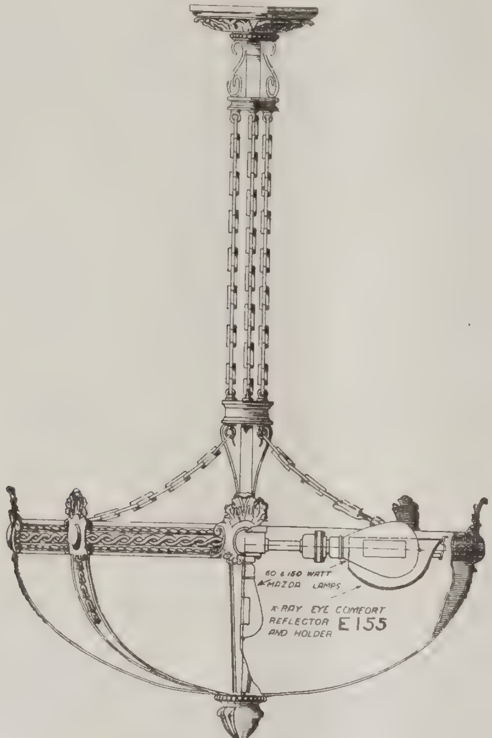


Fig. 3. Indirect Fixture Used on Main Floor Hub Store, Chicago.

not the so-called "semi-indirect" as may appear, but contain opaque silvered glass reflectors to throw the light to the ceiling and diffuse same throughout the store. One 60-watt lamp affords ample illumination for the entire glass bowl. A section of this fixture is shown in Fig. 3.

The center bays on the main floor average 22½ feet square, the ceiling height is 20½ feet, the wattage per

Fig. 4. Illumination Barnum Trunk Company's Store, Minneapolis, Minn.

Fig. 5. Illumination Display Room Detroit Electric Co., Chicago.

square foot is 2.38, and the average intensity is 6-ft. candles. The balconies are illuminated with indirect pedestals, and under the mezzanine, a shallow type of indirect fixture is used.

On the remaining floors of the Hub Store, the 22½ x 22½-ft. bays have four ceiling outlets in which are suspended single 250 watt units. The bowls are finished in a matt-white to harmonize with the decorations, and contain a concentrating type of one piece silvered glass reflector with a green elastic backing. To obtain the correct distribution throughout the room, the top of the indirect reflector is suspended 36 inches from the ceiling. The watts per square foot are 1.98, and average illumination 4½ foot candles. Along the South side of the building the bays are 22½ x 33 feet and contain two additional outlets. The reflectors and lamps are the same as in the smaller bays.

The main floor indirect fixture of the Hub store is shown in Fig. 3. Fixtures constructed along these lines give efficient indirect illumination and at the same time are artictic looking units. The reflectors control the light in a scientific manner, and the small lamp that illuminates the bowl can be regulated to keep the illumination of the bowl below the ceiling brightness. Attention is called to the arrangement of lamp and reflector, which permits of a very shallow type of bowl if desired. This style of reflector is very distributing, the top of the fixture being hung 42 inches from the ceiling to give the right effect.

Fig. 6. Illumination of Show Windows Cable Piano Company, Chicago.

Fig. 4 shows the illumination of the leather goods department of the Barnum Trunk Company at Minneapolis, Minn. Attention is called to the sharp, clear detail of all the objects in the illustration. In this installation the indirect lighting does a great deal to make the goods naturally dull in color, stand out in their true tone values.

The illustration, Fig. 5, shows the automobile display room of the Detroit Electric Company in Chicago. This was one of the first automobile salesrooms in the country to adopt indirect illumination. With direct lighting the specular reflection from the polished surfaces was very bad and annoying to a prospective purchaser in judging a car. Today in passing down Michigan Avenue (Automobile Row) any number of similar installations will be noted. Wherever efficient indirect lighting is installed, the installation stands out from all the rest—it makes the salesroom a big show window.

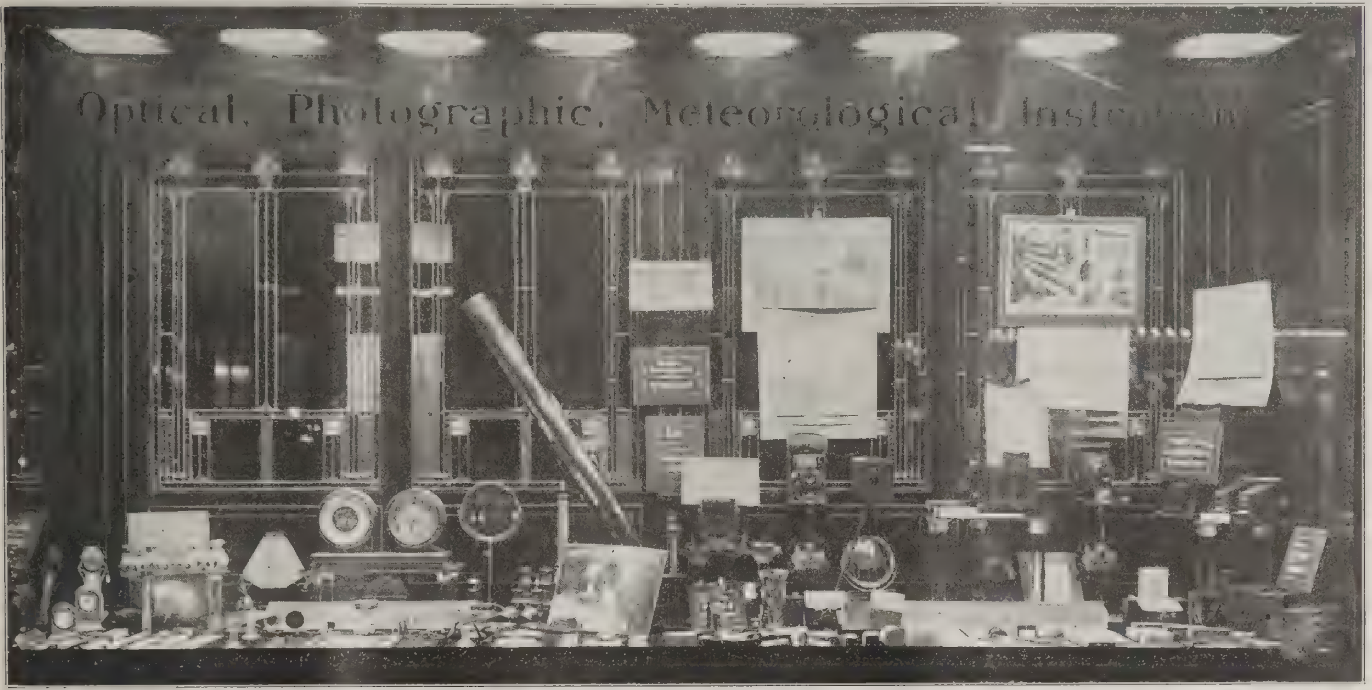


FIG. 7. ILLUMINATION OF SHOW WINDOWS ALMER COE AND COMPANY, CHICAGO.

The Detroit Electric Company's salesroom is 44 x 45 feet with a $13\frac{1}{2}$-ft ceiling. The room is divided into eight equal rectangles each containing one ceiling outlet. Each fixture contains 4 100-watt tungsten lamps in a concentrating type of one piece silvered glass reflector, top of same being suspended 30 inches from the ceiling. The average illumination is 3.75 foot candles. Attention is called to the open work in the bowl, which is lined with an old rose silk. The reflected light from the ceiling is sufficient to give these bowls a very pleasing appearance.

FIG. 8. ILLUMINATION SHOW WINDOWS CHAS A. STEVENS AND BROS., CHICAGO.

In Fig. 6 is shown a window illumination of the Cable Piano Company in Chicago. Here, as in the display of automobiles, indirect illumination has supplied a satisfactory illumination. The reflectors along the transom bar at the left of the illustration extend around the entire window front. They are used solely for making the pianos along the window fronts stand out at night. It happens that the Elevated Railroad runs along one front of this store, and at night the indirect fixtures on the main and second floors are left burning. Passers-by cannot fail to be attracted by this evenly illuminated interior.

In Fig. 7, an illumination of optical goods is shown in the window of the Almer Coe and Company, at Chicago. The illustration shows the detail obtained with one piece concentrating silvered glass reflectors placed directly above the glass bulk-head. This company maintains three high class stores all of which are illuminated with indirect lighting, with one piece silvered glass reflectors for the interiors, and reflectors of the same material designed for window requirements.

The illustration in Fig. 8 shows illumination of the ladies furnishing department of Chas. A. Stevens and Bros., Chicago. Here great care was taken in the illumination of the high and shallow windows, in order to provide efficient results. The illustration shows what has been accomplished with one piece non-symmetrical silvered glass

FIG. 9. ILLUMINATION DISPLAY ROOM WM. MEYER AND COMPANY, NEW YORK CITY.

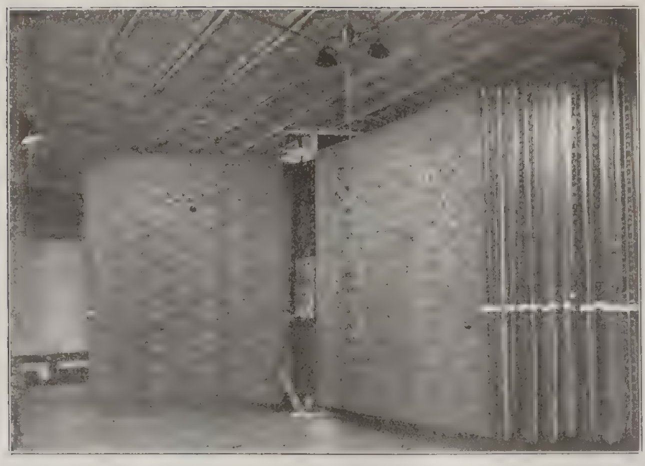


Fig. 10. Illumination of Rugs in Sales Room.

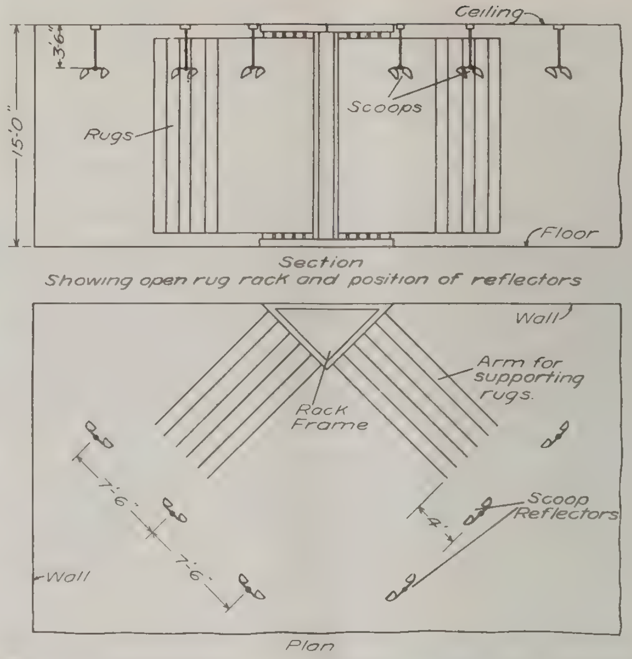


Fig. 11. Arrangement of Lighting Units for Lighting Rugs.

reflectors. 100 watt lamps are used in 24-inch centers, placed directly at the front and top of the window.

Fig. 9 shows another example of satisfactory display room lighting in the light goods department of Wm. Meyer and Company, New York City. Here one piece silvered glass indirect reflectors are used installed according to correct engineering principles.

Many schemes have been advocated for satisfactory illumination of large rugs. In Fig. 10 is shown a system that is working out very well with the use of one-piece nonsymmertical silvered glass reflectors. The details of arrangement of lighting units are shown in Fig. 11.

Fig. 12 shows the illumination of one of the 30 stores of the National Tea Company, of Chicago. Indirect illumination is used for the store proper and direct lighting non-symmetrical, one-piece silvered glass reflectors for the windows in all of these stores. Attention is called to clearness of the labels and price cards on the goods in the window.

In Fig. 13, the illumination of the candy store of Burr Brothers, Rockford, Ill., is shown. This lighting effect has made this store the sensation of the town. No expense was spared in making the store modern in every way. The

Fig. 12. Indirect Lighting for Stores and Direct Lighting for Windows of National Tea Company's Stores, Chicago.

Fig. 13. Illumination of Candy Store, Burr Bros., Rockford, Ill.

mission globes on the soda counter contain low candle power lamps, purely for decoration. The size of the store is 20 x 120 ft. Six indirect fixtures are suspended, one each in the center of equal rectangles. A concentrating type of one piece silvered glass reflector is contained in the bowls, the top of same extending 36 inches from the ceiling. Each fixture contains 5 100-watt clear bulb tungsten lamps. Watts per square foot 1¼, furnishing an average illumination of about 3 foot candles.

All the indirect reflectors described in this article as one piece silvered glass covered with a green elastic backing are known under the trade name of "X-Ray Eye Comfort" reflectors and all the window and non-symmetrical silvered glass reflectors as "X-Ray" reflectors designed by the National X-Ray Reflector Company, of Chicago, Ill.

Lighting Developments in England During the Past Year

(Contributed Exclusively to Electrical Engineering)

BY R. E. NEALE, B. SC. LONDON, A. C. G. I.

General Trend of Lighting Developments, Types of Lamps, Fittings, Etc.

THE general trend of lighting developments can best be summarized as more light and better lighting. The cheapening of metal filament lamps and the availability of lighting fittings designed on scientific lines have led to great improvements in residence lighting, and it is safe to say that the educative work of illuminating engineering societies is commencing to bear fruit, though much yet remains to be done. Vast improvements have also been effected in street lighting practice during the last year or two—in city areas by the use of flame arcs and in other cases by the substitution of metal filament clusters for old-fashioned open and enclosed arcs and of single, twin or triple metal lamp fittings for carbon and gas lamps. Great progress has been made in the good illumination of public halls of every kind and in industrial lighting. Owing to the tremendous importance of the latter, a considerable part of this article will be devoted to its construction.

TYPES OF LAMPS.

Mention must be made of the continued increase in popularity of metal filament lamps, and for domestic and certain branches of other services, these lamps are unrivalled. The prices of these lamps in the Continent are as follows: 26 cents for 5 to 10 c.p. lamps; 42 cents for 10 to 50 c.p. lamps, and 60 cents for 100 c.p. units. These prices came into force last April, but are not yet available in England, owing to the different patent situation in this country. Something in the nature of a price war is now in progress and doubtless a number of the smaller companies will be unable to stand the competition and will either fall out of business or join existing or new syndicates.

The availability of metal filament lamps recently announced to consume only 0.5 w. per hefner, (in units of 1,000 hefner), should do much to further popularize the use of these lamps in street and industrial lighting. Despite the great increase in popularity of metal lamps, one of the largest firms in this country reports that it is making and selling more carbon filament lamps than ever before. It is certainly to be wondered where these lamps go and it is equally certain that this state of affairs can only be temporary. The tungsten, of all filament lamps, is alone likely to be in extensive use in the course of a few years.

No outstanding development appears to have occurred in the arc lighting field beyond steady improvement of detail and economy of working. The magnetite arc—though highly developed in the States—remains practically unknown on this side. As Dr. Bell has pointed out, one reason why European practice in arc lighting is radically different from American is that street lighting in the States is almost invariably on the series system, requiring small current lamps, whereas in Europe parallel wiring and comparatively heavy current flames arcs are generally employed.

In the industrial lighting field, the extended application of metal filament lamps is merely following out the path of progress clearly foreseen for this type of illuminant, but there has been a remarkable development in the use of mercury vapor lamps—a development which the writer ventures to think was less confidently anticipated in most quarters but which appears to be quite likely to continue. No doubt in many applications, the objection to the color of mercury vapor light is largely a matter of prejudice, but where a more usual color is really required, the mercury lamp is often used in conjunction with a fluorescent reflector, adding red rays. Combinations of mercury and filament lamps are less satisfactory and much yet remains to be done in the way of blending efficiently differently colored lights.

To overcome the serious color disadvantage of the ordinary Cooper Hewitt lamp, Dr. Wolfke employs an alloy of cadmium with a small percentage of mercury in a quartz glass container. Cadmium alone gives distinctly red light, and cadmium-mercury alloy is said to give a very close approximation to white light. If both electrodes are of cadmium and mercury, it is claimed that the specific consumption is 1 watt per hefner in 100-watt lamps and as low as 0.2 watt per hefner in 500 to 600-watt sizes. The 3 ampere lamp has been built for voltages as high as 100 volts.

Among the gaseous discharge lamps for which the future appears to hold commercial possibilities must be noted the Moore and the Neon lamps. The Moore light is now to be seen in several parts of London on cinematograph hall facades and in "tube" subways, etc., but its development has not yet realized the hopes which were entertained for it.

LIGHTING GLASSWARE AND REFLECTORS.

At least as important as the improvement in lamps themselves in the past year or two have been the improvements in lighting fittings and the extended application of the improved types. The excellent maxim that, (barring display or advertising illumination), lighting should be unobtrusive, both as regards source and effect, has led to much better results than were obtained in the days when merit instead of condemnation was attached to "glare." The modern lighting fittings used in this country are essentially the same as those employed in the States and no space need be devoted to their detailed description.

In domestic and office lighting, the optically crude opal or "artistic" glassware formally employed without regard to the light distribution given by the illuminant or the lighting effect ultimately required, is giving place to prismatic glassware which prevents glare and makes possible any required distribution of light from any type of lamp. Fortunately it is becoming generally realized that the ultimate illumination required is the point from which to start in laying out a lighting scheme and that a lighting fitting comprises a lamp and a suitable globe or reflector. Good prismatic glassware is comparatively costly, and this has undoubtedly hindered its utilization by ordinary householders. The technical man, of course, realizes that the additional outlay required is more than compensated by the lower cost of the lamps and energy required to produce a desired result and indeed by the mere fact that this result can be attained at all.

The interesting system (designed by Cooper Hewitt) of grooving metallic filament lamp bulbs by chemical etching so as to form a system of prisms—thus essentially making the lamp bulb a self-contained holophane fitting—appears to offer great possibilities, but the writer has not yet met with such lamps in this country. The use of half frosted lamps undoubtedly entails considerable loss of efficiency, and it is a question as to whether or not the use of these is desirable, except where cheapness is important. The aim in view, *viz.,* diffusion of light and prevention of direct-ray glare appears to be attainable by better means.

INDIRECT AND SEMI-INDIRECT LIGHTING.

Although indirect lighting schemes continue to make rapid headway and are in many applications ideal, there is prevalent an opinion that the advantages claimed for this system have in many cases been too sweeping, and that semi-direct lighting is the proper system to adopt in many cases formerly claimed by the advocates of indirect lighting. There can be no doubt that purely indirect illumination often gives "flat" and depressing results. The entire absence of shadow, which is easy to secure by indirect lighting, is all adapted to the needs of the home and wherever appreciation of "relief" is required, however admirable it may be in drawing offices and similar places. Semi-direct lighting—by fixtures which are essentially indirect lighting fixtures with a translucent bowl in place of the opaque bottom reflector—has undoubtedly a great future before it and many ingenious and efficient types of semi-direct lighting fixtures have recently come from the Continent.

Purely indirect lighting is subject to the losses of double reflection. The cleaner the ceiling or top reflector, the higher the efficiency of the secondary reflection and to secure high efficiency in the primary reflection, "X-ray" reflectors use silvered glass with spiral and vertical corrugations to prevent striation. The advocates of indirect lighting claim that though the luminous efficiency of the system is comparatively low, it is higher than that of most direct lighting installations and is comparable in point of visual efficiency with the best direct lighting systems. The great merit of indirect lighting is that, from a single point, a more evenly distributed illumination can be obtained than from a much larger number of direct lighting units. By using fixtures of the eye-rest type, shadows are not completely eliminated but are merely softened, and it is claimed that eye-rest lighting uses 20 per cent to 70 per cent less current than direct lighting for similar intensity of uniform illumination. In a certain indirect lighting installation in a village hall in this country, the average lumens per watt = 4.83, and the effective = 56 per cent of the total lumens. Indirect lighting equipments have been installed in many dozens—probably hundreds—of important stores, public buildings and places of amusement (particularly moving picture halls), during the past twelve months.

STREET LIGHTING.

Improvements continue to be made in the design of street lanterns for use with metal filament clusters, and it is probable that some of the best types of pillars perfected in the States during the past few years will soon become popular in this country. The reason that they are, as yet, practically unknown here, is to be found in the essential difference between an "old" country and one less committed by time and outlay to a conservative policy.

Important developments have taken place in the street lighting of Manchester, several improvements having been developed in the design of dioptric globes for use with flame arcs and in the method of frosting the outer globes so as to secure the desired light distribution with maximum efficiency. These matters and the results of competitive trials between high pressure gas lamps and flame arcs were dealt with fully by Messrs. Pearce & Ratcliff before the Institute of Electrical Engineers, and their paper is well worth studying by all street lighting engineers.

INDUSTRIAL LIGHTING.

It is at last coming to be generally realized that good lighting is just as important as good tools and other material equipment, and yields as good returns on investment as the latter. The design of a modern workshop is a tacit acknowledgement of the economic value of good lighting, but there is a common lack of knowledge of the general principles on which lighting schemes should be based, and even where daylight illumination is satisfactory, the arrangements made for artificial lighting are often defective. Bad lighting in passages and on stairways, etc., is becoming rare, but broader and more important problems and less flagrant but equally serious defects remain.

Among the special recommendations made by factory inspectors in this country during the last year have been the use of frosted globes and better placing of lamps in printing establishments to reduce glare. Large numbers of mercury lamps are now used in these plants.

In the course of an investigation of the lighting in forty iron foundries in this country, Mr. D. R. Wilson recently collected considerable valuable information, well worth while to reproduce in abstract. In this service, the actual intensity of illumination is of little importance so far as the work itself is concerned since, at the moment of pouring, ample light is emitted by the molten metal itself. The chief requirement is sufficient general lighting to prevent men falling into molding pits and other obstacles. The coefficient of reflection on the flooring material being only 2 or 3 per cent, (10 per cent in steel foundries where a light-colored sand is employed), and there being much dust and dense smoke, conditions are about as bad as they could be from the illuminating engineer's standpoint. Best results are obtained by using high hung, high candlepower lamps, yielding uniform illumination and short shadows. A precaution which should not be neglected is the frequent limewashing of the walls; if the latter are clean, obstacles can often be seen by silhouetting when it would be difficult to see them by reflected light. Lamps should obviously be placed over points where shadows are particularly undesirable and, for the rest, the aim should be a comparatively high and uniform general illumination. Generally speaking, two 1,000 c.p. units are preferable to a 2,000 c.p. lamp.

Mr. Wilson's conclusions are that the illumination in this class of work cannot be considered adequate unless the minimum lighting on a horizontal plane one foot above ground level is at least 0.33 foot-candles. This minimum will be 0.5 in a well-lighted foundry, (rising to 1.5 foot candles in many cases); 0.3-0.4 foot candles in a fairly lighted foundry; 0.2-3 in a moderately, 0.1-0.2 in a poorly and less than 0.1 in a badly lighted foundry.

INSPECTION AND TESTS ON ELECTRICAL MACHINERY.

(*Contributed Exclusively to* Electrical Engineering).

BY HUGH T. WREAKS AND R. L. SHEARER, OF T. E. I. BUREAU.

Section 5. Transformer Tests.

Tests on transformers consist of polarity, ratio, core loss, impedance, heat runs at normal and overload and insulation.

The polarity test is made to determine the connections required for transformers in bank, that is, several transformers in parallel. With direct current passing through one winding of the transformer, connect a voltmeter across the terminals of the other winding and break the circuit in the first winding. If the polarity is correct, a positive kick in the voltmeter will be obtained. Sufficient resistance should be used in series with the voltmeter so that it will not be damaged.

Ratio. The ratio of a transformer is ratio of the primary voltage to the secondary voltage. The method used is to apply about 100 volts to the secondary winding and read the primary voltage, using a suitable potential transformer. At least five readings should be taken and results carefully calculated. The ratio of the potential transformer should be nearly that of the transformer under test, and should be operated at normal frequency and voltage, otherwise the ratio will be unsatisfactory. If the ratio, by test, varies more than one per cent from the ratio of voltage, check the ratio of turns. If the ratio of voltage and turns agree, repeat the ratio test with the same meters, check this with other meters and potential transformers, and if still out, the transformer is wrong.

Impedance. The impedance of a transformer is measured by short circuiting one of the windings and impressing an alternating emf on the other winding and taking simultaneous readings of amperes, volts, watts and frequency. Thermometers should be placed in the coils to obtain temperatures. Connect the alternator through a suitable transformer, alternator to be operated as near normal voltage as possible when normal impedance is taken. Take ten readings, starting at fifty per cent, run up to 125 per cent full load, holding the speed of generator constant and taking simultaneous readings of amperes, volts and watts. It is essential that the speed be exactly right, as the reactance varies directly with the frequency. In plotting a curve, use volts as ordinates and watts and amperes as abscissæ. The volt-amperes curve should be a straight line and the volt-watts curve should be a parabola.

Core Loss. In a transformer connected to a source of alternating electromotive force, a loss of energy takes place in the iron, due to cycle reversals of magnetic flux. This loss of energy is called the core loss, which depends on the wave form of the impressed emf. The core loss test is somewhat similar to the impedance test except that the voltage is applied to one winding and the other open circuited instead of closed circuited. Voltage is always applied to the low potential winding to avoid reading meters in the high potential circuit. In taking a core loss curve, start at 50 per cent rated potential, and take about ten points to 25 per cent above rated potential. Hold the frequency constant and vary the voltage, taking simultaneous readings of the excitation amperes and watts core loss. In plotting curve, divide watts by cycles and plot as ordinates, and cycles as abscissæ.

Normal Load Heat Run. Consists of connecting a transformer to a suitable load and running until all parts are at a constant temperature, then shut down and take resistance measurements. During heat run a careful inspection should be made for loose laminations. If transformer rattles or buzzes, it is probably due to the latter cause. Sometimes a short circuit run is required on a transformer. This is done by short circuiting the secondary windings and applying normal current to the primary. When the temperatures of copper become constant and test is finished, final temperatures and hot resistance are taken. Open circuit the primary windings and apply normal voltage at the proper frequency to the secondary winding until the iron temperatures are constant.

Overload Heat Run. This test is ordinarily limited to two hours, and is taken after normal load heat run. All temperatures are taken during the normal load heat run, primary resistance being measured hourly. All data is then ready for normal load heat run except hot secondary resistance, which is usually omitted until after the overload heat run. Thus time is saved, otherwise lost reconnecting secondary and heating to normal load temperatures.

Insulation Test. Double potential is applied to test the insulation between turns and between sections of the coils. As it is impossible to obtain double voltage on a transformer at normal frequency, due to high density in the iron, the frequency must be increased. This is the only method for determining whether the dielectric strength is sufficient for continuous operation. Mechanical examination amounts to little, and measurement of insulation resistance is equally valueless since insulation may show high resistance when measured with low voltage, but offers comparatively little resistance to the passage of a high tension current.

Society for Electrical Development Progress.

Comments from two prominent electrical men were presented in the last issue of *Electrical Engineering* outlining the promising features of the society from a particular viewpoint. We present in what follows abstracts of the views of others:

Mr. L. A. Osborne, vice-president of Westinghouse Electric & Mfg. Co. has the following to say in behalf of the Electrical Manufacturer:

"It may doubtless appear unusual to some that the electrical manufacturers should have so readily agreed to make liberal contributions to the funds of the Society for Electrical Development. In fact the readiness of the manufacturer to support the movement has led some to suspect that it was planned primarily in the interests of the manufacturer. Reflection, however, will show that the attitude of the manufacturer is merely co-operative in the broadest sense of the word and is an evidence of his appreciation that that which is truly co-operative is, in the last analysis, profitable. Speaking as a manufacturer, we expect that our return will accrue after the central station, jobbers, dealers and contractors have begun to enjoy a measure of return as a result of the activities of the Society.

"The ideals of the Society are ambitious but attainable, and when carried out should, within a reasonable time, bring measurable returns to all branches of the industry. If, through co-operative advertising, the architect, the contractor and the builder might be educated to the point that in all dealings, regardless of cost, outlets for the use of electrical appliances should be plentifully provided, the business of the dealer in electrical appliances would be increased, as well as the work of the electrical contractor, and it goes without saying that there would be a corresponding increase in demand for current through which the central station would profit. The manufacturer secures his reward through an increased demand for his manufactured products, and, in the broader aspect of the case, in the ultimate increase in generating and distributing aparatus."

From the standpoint of the Electrical Contractors, Ernest Freeman, president of the National Electrical Contractors Association, has the following to say:

"The Society for Electrical Development exemplifies to my mind the ideal of team work for the development of the electrical industry—and for the immediate and ultimate profit of all engaged. The very broadness of the plan makes it perhaps difficult—for one who has not been gifted with what might be called "a national vision"—to grasp just how the individual smaller interest will secure a direct profit from the work. That is, until the whole scope of the various plans are considered—then it is very clearly to be seen where the dotted line works directly into one's own profit sheet.

"The complete plans of the Society have been published. We as contractors believe that the work will be of direct benefit to the industry and to us individually as contractors, and beyond the national advertising, the publicity work in newspapers, magazines, the moving picture, electric sign exchange and other ways as planned, and in the field work, do we see a certain and direct individual profit very much in excess of the relatively small proportionate share which we are subscribing to the movement. Beyond all this we have a vision—a vision of harmony in its highest form. Harmony as we see it is a distinctly practical business proposition, to not only ourselves, but to the central station, the jobber and the manufacturer, who go to make up the industry in which we are all doing a distinctly related business.

Mr. Henry L. Doherty, a pioneer in the work of the N. E. L. A., and a prominent financier, gives some reasons for joining the Society for Electrical Development. He says: "The Society for Electrical Development provides the only place where it is really feasible for every branch of the electrical business to meet on common ground to bring about the greatest application for electricity. In other words, it is the focal point at which the manufacturers' associations, the central station associations, the contractors' associations, the jobbers' associations, and others can meet and cooperate.

"The electrification of our steam railroads is not as remote as it seems to many people, and yet little is being done with this vast opportunity, compared to what might be done. The Society for Electrical Development will exert a powerful influence for progress in this direction.

"The society can meet, negotiate and cooperate with other national bodies, such as the architects and the various manufacturers. This would be impossible for an individual or a company. This one field of work alone, intelligently and aggressively handled under the society's plan, justifies the support required by the society."

Frank E. Watts, reigning Jupiter of the Jovian Order, has the following to say from the standpoint of help to the individual: "The plans formulated by the Society for creating a greater demand for the use of electricity have been pronounced feasible and sound by many men competent to judge of their effectiveness. If these plans are carried out, let us trace the results and benefits to the individuals connected with the various branches of the electrical industry affected. A greater demand for electricity means that more houses will be wired, more apparatus for generating electricity will be installed, and more appliances for consuming electricity will be purchased. This, in turn, means that the contractor or individual working for the contractor will have more work to do; therefore, the contractor will purchase more electrical supplies and the jobber or jobber's salesman will sell him more material and the jobber will necessarily purchase a greater quantity of electrical goods from the manufacturer through his representatives. In the final analysis the central station will sell more current, and every man in its employ should benefit thereby."

Steven L. Coles, acting treasurer of the Society for Electrical Development, says in regard to its place, its object and its benefits: "Until the incorporation of the Society for Electrical Development, Inc., there was no non-technical association whose membership was open to companies and corporations doing business in all branches of the electrical field. Strange as it may seem, every organization heretofore formed by electrical men has been designed to benefit them inside their own particular class of work. The ultimate consumer of the goods and service produced by the best engineering and inventive skill and most highly developed manufacturing processes the world has known has been to a great extent ignored. All electrical development heretofore has been largely selfish; and the public upon whose support the whole industry is dependent, has never been taken seriously into close affiliation. In other words, the real vital element of a great problem has been overlooked, while detailed development has received minute and careful attention.

"The Society has but one object—to promote and increase the use by the public of electric current for all useful purposes as an end in itself and as a means for increasing the demand for apparatus and supplies. The Society is a money-spending organization, and can under no circumstances, become a money-making scheme. Its board of directors receives no remuneration and pays its own expenses. The only salaried officials are the general manager and the secretary-treasurer, who report to the executive committee, appointed from the board of directors, who hold office through the votes of the membership."

J. W. Wakeman, general manager of the Society for Electrical Development explains its campaign as follows: "The campaign for membership now being conducted by the Society for Electrical Development has raised widespread interest among the electrical fraternity. Responses have been extremely numerous, and the number of applications for membership now being received daily is very gratifying, indicating as they do both the ability to grasp the situation and the willingness to cooperate existing among the men engaged in this industry. Some men have said that the electrical industry develops itself automatically, yet the facts remain—that 80 per cent of the houses within serviceable reach of the central stations are not even wired, and not 1 per cent of those which are wired are equipped for complete electric service.

"It is also a fact that in spite of electric current costing less today than ever, and electrical appliances being cheaper and better than ever, the popular belief exists that electric service is expensive.

"The work which this society will do is a kind which needs doing, and which no individual or corporation can afford to do for themselves. It will directly stimulate the public demand for electric service, which means the development of the industry as a whole, which in turn means increased prosperity to every individual engaged in it. The campaign will be nation-wide. It will remove the mistaken opinion regarding the extravagance of electricity. It will show that electricity is the only commodity of daily use which has constantly been reduced in price at a time when the cost of every other necessity in life has increased. The Society for Electrical Development is a proposition that with a small individual expense will bring big returns in increased business, better prices, and larger profits to those who participate. It is collecting funds to enable the men engaged in the electrical industry to put some of their dollars to work cooperatively to develop in a big, broad spirit the latent market. Every man engaged in the industry owes it to himself, as well as to every man in the industry, to put into actual operation as quickly as possible, a machine so carefully designed to work for the profit of all."

The Society for Electrical Development, Inc., has received the endorsement of practically all the national electrical associations and societies and has been assured of the active assistance of the 12,000 members of the Jovian Order. The plans of the Order distinctly specify that no active work shall be undertaken until the subscriptions of members amount to $200,000. About $150,000 of this amount has been subscribed by 300 members and an active campaign is now in progress in all branches of the electrical field in an effort to raise at the earliest possible date the subscriptions necessary to complete the $200,000 fund.

It is believed that it is a question of but a short time until this will have been accomplished. The ultimate plans of the Society involve an annual expenditure approximating $500,000.

The possibilities of increasing the use of the electric current by the general public through a yearly outlay of half a million dollars under the well-matured plans of the Society and by the authority of its perfectly representative board of directors, should make a strong appeal to the practical and progressive business man who is in any way interested in or dependent upon the development of the electrical industry.

Conference of Electrical Men at Association Island.

The holding of a conference of electrical men interested in the various branches of the electrical industry, including representatives of manufacturing companies, central stations, electric jobbers and contractors, at Association Island on Lake Ontario, is now an annual affair and one of growing importance. The meeting was held this year September 3 to 6, and was characterized by special sessions at which important addresses were made by prominent engineers, financiers, and chairmen of public service commissions, the sessions being presided over by J. B. McCall, president of the National Electric Light Association.

Among the speakers were Hon. Willard Howland, chairman of the Massachusetts State Commission of Affiliation and Arbitration. Mr. Howland spoke on, "Government in Relation to Business." Mr. Samuel Insull, president of the Commonwealth Edison Company, of Chicago, spoke on, "The Distribution of Electrical Energy, Present and Future," giving considerable data on the development of the Chicago system and compared central station statistics of Great Britain with those in the Chicago territory. Dr. Charles P. Steinmetz, of the General Electric Company, delivered an address on, "The Future Technical Development in the Electrical Business." In the course of his remarks, he stated that although transmission systems cover distances greater than 200 miles, and operate at voltages as high as 150,000, these are not the limits in either length of circuit, or voltage that can be used. He touched upon developments in steam turbine plants, and upon the economical features in the utilization of electrical energy.

Hon. John H. Roamer, chairman of the Railway Commission of Wisconsin, delivered an address on, "State Commission Control." The speaker explained the fundamental features of the Wisconsin public utilities law, and the principles upon which the uniform indeterminate franchise has been drafted. He also discussed methods of valuation and accounting, provided by the Wisconsin Commission, and the attitude of the Commission as regards the regulation of service and rates.

Frank A. Vandelip, president of the National City Bank, New York City, spoke on, "Financiers and Utilities Securities," mentioning the fact that with normal needs the electrical development during the next five years will require two billion dollars new capital. He touched upon capital needs in all fields, and features of the financial outlook. He also took up other features in connection with holding companies and central station properties. F. P. Fish, of Fish-Richardson, Herrick & Neave, of Boston, Mass., spoke on, "Principles of Resale Control."

The Society for Electrical Development came in for its share of discussion during the meeting, those closely connected with the organization of this society giving interesting information in regard to its progress and explaining fully their hopes for its future accomplishments.

J. Robert Crouse, J. M. Wakeman, W. E. Robertson and H. L. Dougherty, spoke on this subject. Frank W. Smith, vice-president of the Electrical Vehicle Association of America, also outlined the cooperative advertising campaign conducted by this association.

The following speakers, representing various other societies, also touched upon cooperation with the Society for Electrical Development. Norman Macbeth, vice-president of the Illuminating Engineering Society; D. L. Gaskill, secretary of the Ohio Light Association; W. E. Robertson, of the Electrical Supply Jobbers' Association; Ernest McCleary, of the National Electrical Contractors' Association, and F. E. Watts, Jupiter of the Jovian Order.

The result of the meeting was such that those attending expressed the belief that much good will come from it. Cooperation was strongly emphasized, and the good that can be secured from a general "get-together" spirit brought out so forcibly as to make this meeting one that will be looked to as an important step forward in establishing such a spirit.

Convention of American Electric Railway Association.

The annual convention of the American Electric Railway Association is to be held this year at Atlantic City, October 13 to 17. This association now represents practically all the important electric traction interests in the United States, the member companies operating over 36,000 miles of track, some 76 per cent of the total mileage in this country. The coming convention is one of special interest on account of the subjects to be discussed. The preliminary program indicates a growing tendency of electric railway companies and all public service corporations to give the matter of relations with the public and employes due attention.

This year the report of a committee composed of representatives of its own organization, the National Electric Light Association, the American Institute of Electrical Engineers and the American Telegraph and Telephone Company will be presented on a form of agreement and a code of practice for the joint use of poles in city and village streets. "Profit Sharing With Employes," "The Relation of Carriers to the Development of the Territory They Serve," "The Relief of City Congestion," "Present Tendency of Public Service Laws and Regulations," "Valuation" and "Electric Railway Securities from the Investor's Viewpoint," are other subjects to be discussed.

Among the speakers will be Frank Hedley, vice-president of the Interborough Rapid Transit Company, of New York; Paul Shoup, president Pacific Electric Railway Co., Los Angeles; C. S. Sergeant, vice-president Boston Elevated Railway Co.; J. J. Burleigh, vice-president Public Service Corporation of New Jersey; W. F. Ham, vice-president of the Washington (D.C.) Railway & Electric Co.; C. L. S. Tingley, vice-president of the American Railways Co., Philadelphia; C. N. Duffy, vice-president, The Milwaukee Electric Railway & Light Co.; Richard McCullough, vice-president United Railways Co., of St. Louis, C. W. Beall, of Harris, Forbes & Co., New York; A. D. B. Van Zandt, Detroit United Railway Co.; David W. Ross, vice-president Interborough Rapid Transit Co., New York; Frank Bergen, general counsel Public Service Corporation of New Jersey; C. M. Rosecrantz, general counsel The Milwaukee Electric Railway & Light Co., and Assistant Surgeon General W. C. Rucker, of the United States Bureau of Public Health.

Changes in List Prices and Discounts on Rigid Iron Conduit—Explanation of Pittsburg Basing Discounts.

BY F. S. MONTGOMERY, SOUTHERN SALES AGENT, NATIONAL METAL MOLDING CO., ATLANTA, GA.

For some years, several of the leading manufacturers of rigid iron conduit have been purchasing conduit pipe exclusively of the National Tube Company. This company, however, decided on August 1st, to enter the rigid conduit field itself and contracted with the National Metal Molding Company and the Safety Armorite Conduit Company, both of Pittsburgh, to manufacture the finished product and act as exclusive selling agents. The National Metal Molding Company will continue to manufacture and market, under their own trade names, "Sherarduct" Sherardized iron conduit and "Economy" black enameled conduit, while the Safety Armorite Conduit Company will do likewise with their "Galvaduct" electro-galvanized, and "Loricated" black enameled conduits.

Probably the most radical changes resulting from the entry of the National Tube Company into the conduit field was the adoption by them and subsequently by all the leading manufacturers of conduit, of "Pittsburgh Basing Discounts" to govern the sale of rigid iron conduit. This system, which has governed the sale of "merchant" pipe for the past thirteen years, while possibly confusing at first glance, is, in fact, much more simple than that in effect prior to August 1st, as it eliminates the cumbersome "combination discounts," and the equally cumbersome and confusing "freight allowances."

List prices have also been changed and are as follows:

RIGID CONDUIT COUPLINGS AND ELBOW CONDUIT.
Weights and Dimensions are Nominal.

Sixe	DIAMETERS		Thickness	Weight per foot	per in. Threads	Price foot
	Externa	Internal				
¼	.540	.364	.088	.425	18	.08½
⅜	.675	.493	.091	.568	18	.08½
½	.840	.622	.109	.852	14	.08½
¾	1.050	.824	.113	1.134	14	.11½
1	1.315	1.049	.133	1.684	11½	.17
1¼	1.660	1.380	.140	2.281	11½	.23
1½	1.900	1.610	.145	2.731	11½	.27½
2	2.375	2.067	.154	3.678	11½	.37
2½	2.875	2.469	.203	5.819	8	.58½
3	3.500	3.068	.216	7.616	8	.76½
3½	4.000	3.548	.226	9.202	8	.92
4	4.500	4.026	.237	10.889	8	1.09
4½	5.000	4.506	.247	12.642	8	1.27
5	5.563	5.047	.258	14.810	8	1.48
6	6.625	6.065	.280	19.185	8	1.92

Size	COUPLINGS		ELBOWS			
	Wt. per 100 in lbs.	Price each	Wt. per 100 in lbs.	Radius inches	Offset inches	Price each
¼	6.0	.05	42	4.250	7.500	.19
⅜	9.5	.06	53	4.250	7.500	.19
½	11.6	.07	75	4.250	7.375	.19
¾	20.9	.10	120	5.375	8.375	.25
1	34.3	.13	200	5.750	9.500	.37
1¼	53.5	.17	300	7.250	10.875	.45
1½	74.3	.21	427	8.250	12.625	.60
2	120.8	.28	700	9.500	15.250	1.10
2½	172.0	.40	1300	10.500	17.375	1.80
3	249.8	.60	1700	13.000	19.500	4.80
3½	424.1	.80	2300	15.000	21.250	10.60
4	474.1	1.00	2700	16.000	22.500	12.25
4½	550.0	1.50	3100	18.000	24.375	18.55
5	700.0	1.65	5500	24.000	32.000	25.75
6	750.0	2.40	9000	30.000	39.750	32.00

Conduits in 10 foot lengths, threaded on both ends with one coupling.

Conduit pipe is known and spoken of by its nominal inside diameter.

It will be noted from the above that, with the exception of sizes less than one-half inch, the list prices also indicate the weight. For example: the weight of ½ inch conduit, approximates 85 lbs. per 100 feet, and the list price is 8½ cents per foot; ¾ inch conduit weighs approximately 115 lbs. per 100 feet, and is listed at $11\frac{1}{2}$ cents per foot; and so on throughout the list. All quotations, while now made on the basis of f. o. b. Pittsburgh, regardless of point from which shipped, are at the same time made delivered to destination and in almost every case, at a net price of so much per foot. For example: if the "Pittsburgh Basing Discount" on ½ inch enameled conduit—car loads—is 64% off list, and the freight rate on car loads to Atlanta is 46c per cwt., to arrive at the car load price, delivered to Atlanta, it is only necessary to add the car load freight rate, from Pittsburgh to Atlanta, by deducting, from the basing discount, one point for each ten cents freight per cwt., or 4.6% from 64%, giving as a resultant a delivered discount on car loads to Atlanta of 59.4%. Using this discount, reference to Net Price Tables, which can be obtained of the manufacturers, will show a net price on ½ inch enameled conduit, car loads, delivered to Atlanta, of .0345 per foot.

The same general system applies to less-than-carload shipments. If, for instance, the "Pittsburgh Basing Discount" on less-than-carloads ½ inch enameled conduit is 59% and the l. c. l.) freight rate to Meridian, Mississippi, is 55c per cwt, the net discount, delivered to Meridian, will be 59%, less .055, or $53\frac{1}{2}$%, giving as a resultant a net delivered price of .0395 per foot. It will be apparent from these examples, therefore, that to obtain the net delivered price, it is necessary to have only the "Pittsburgh Basing Discount" applying to quantity desired, and the freight rate from Pittsburgh to point where delivery is to be made, on carloads or less-than-carloads, as the shipment may be. Delivered prices on couplings and elbows are arrived at in the same manner, and from invoices for both conduit and fittings, the usual additional 5% cash discount is allowed.

New Business Methods and Results

Representing Interests of Central Station, Electrical Jobbers, Dealers and Contractors.

Commercial Considerations in the Installation of Ornamental Street Lighting.

During the past few years the standard of street lighting has been greatly advanced. The original plan of having an arc light at each corner is now regarded as unsatisfactory, both for commercial and residence districts. For the business section of a busy town it is entirely inadequate, and for the residence section unsuitable, the dazzling light at the corners rendering the intervening spaces "pitch dark" by contrast. The problem of lighting residence streets has been practically solved by using series tungsten lamps at frequent intervals, while the shopping centers have been successfully converted into "white ways" through the combined effects of intensified street lighting, electric signs and brightly illuminated show windows.

In connection with better lighting, a demand has arisen for a system that would not only illuminate but beautify, and the result has been the development of the ornamental street lighting systems which have taken no small part in making the "city beautiful." Not only is the installation of such systems an indication of civic pride, but it is a real asset to any town, because it is indicative of prosperous conditions and a progressive spirit.

From some points of view we are becoming a nocturnal race. People like to walk about in the evening and crowds throng brightly lighted streets seemingly as the moth flutters about the candle These crowds, of course, give the merchants a good chance to display goods, and the advertising secured naturally increases the volume of sales. Further, the improvement in business raises the value of property and encourages improvements, vacant store rooms fill up and building is stimulated. A recent article on this subject in the business man's magazine, *System,* is significantly entitled, "The Light Cure for Dull Trade."

Asa specific example of the enthusiasm and public spirit produced by an installation of this kind, we refer to the city of New Haven, Conn. In this town the business men of the city made possible, installed and are maintaining the complete white way system. An assessment was made on the basis of frontage, each merchant paying $3.00 per foot to cover the cost of installation and $1.60 per year for maintenance, the total cost of the system being $17,000 initial cost and $9,000 per year maintenance. The population of New Haven is about 135,000. On the night the lights were turned on, 10,000 men took part in a parade, while it is estimated that over 100,000 were on the streets. The effect on the business and on the street railway traffic was immediate, and other neighboring cities have hastened to follow the example.

The preceding paragraphs embody important lines of argument which may be put forth by central station interests for the adoption of ornamental street lighting. Such a system is probably the best local advertising that the central station can have. It tends to foster the good will of the community, especially in cases where the cooperation of the company has made the installation possible, and indirectly it tends to improve the general standard of lighting in the business districts.

Turning to commercial methods, we find at the start that different conditions are confronted than in other lines of business. We have here to deal with public sentiment. The appeal is not made to individuals, corporations, or even entirely to the municipality, but to the public. The merchants, the property-owners, the city council and the taxpayers are each vitally interested. Any failure in cooperation or lack of enthusiasm will effectually put a damper on the whole scheme.

Deferring for the present any discussion as to who should logically bear the burden of the installation, we find that ordinarily the first ones to take an active interest in ornamental street lighting are naturally those who are most directly benefited, namely, local merchants. In most towns of any size we find either a board of trade, a commercial club or a merchants' association, and in such a case these bodies usually take up the propagation of the idea. To secure the unanimous consent of a number of different merchants or property-owners in a given district, for the introduction of such a lighting system, is difficult at the best, as there are some who are sure to hold back, and on this account representatives of a merchants' association are in a better position to win such ones over than the representative of the central station. In cases where no such body exists, it is usually possible to organize a small committee of merchants in each block who will take up the proposition, the contract agent standing by to help out when needed. In some cases these conditions have been undertaken by the merchants without the advice or assistance of the central station; this, however, often results unsatisfactorily, on account of lack of technical knowledge. In short, while the cooperation of the business men is a great benefit in handling the commercial end of the scheme, the engineering can best be done by the central station.

The actual procedure, while varying somewhat with local conditions, is usually something on the following order: First, arouse the public interest. There are several plans for doing this. The cooperation of the newspapers should be secured from the beginning. Prominent merchants should be induced to favor the scheme, and should be interviewed, and the result of these interviews published in the papers. At the same time, the matter should be introduced to the Board of Trade, if one exists, for preliminary discussion. If the public sentiment seems to be favorable, the next step should be to secure and install a few sample posts, as the effect of these will do more than much solicitation. In the meanwhile, a vigorous advertising campaign should be commenced and continued as long as may be necessary. If it is proposed to ask the city to maintain the system, the matter should be brought up at an early date in the city council.

The next step is to provide for the installation. If this is to be done by the merchants or the property-owners, it is usually covered by an assessment based on the frontage, and in order to equitably distribute the expense, the consent of every owner or tenant is necessary. For reasons which we have previously given, the local merchants' association is particularly fitted to take up this work. In some cases the city is willing to bear part of the installation cost, and this undoubtedly makes it easier to get the merchants or owners signed up. In a few instances the city has borne the total cost of installation. This eliminates any trouble with unprogressive merchants, but in this case the greatest task is in getting the matter approved by the council. In any case, the influence of the Board of Trade is invaluable. In some cases the abutting property-owners and in other cases the merchants have borne the cost, and in still others it has been divided. The property-owners are usually better able finanically to carry the burden, more permanently located and cause less confusion in the case of vacant properties. On the other hand, the merchants are more directly interested, easier to see, and are more affected by local enthusiasm.

In some cases the central station installs the system, making no direct charge therefor, but entering into contract for a term of years either with the merchants or with the city at a rate which includes the cost of installation. In other cases, the central station installs and retains the ownership of the entire system. These plans, while putting the entire burden upon the lighting company, have certain advantages which we will mention later.

The maintenance of these systems is usually assumed by the city, but sometimes by the merchants. A good deal depends upon the prior conditions of lighting. It is plainly the duty of the city to light the streets, and in cases where the new system displaces the former system of lighting, it is only right that the municipality should bear the expense. In cases where the present lighting is adequate for traffic requirements, and the ornamental system is simply an addition thereto, it is reasonable that those most directly benefited should finance the proposition.

An analysis of 21 typical installations shows the division of installation and maintenance costs as follows:

DIVISION OF INSTALLATION COST.

	No.	Per Ct. of Interest.
Property Owners	8	47½
Merchants	3	21½
Property Owners and Merchants	4	
City	4	21½
City and Property Owners	1	
Central Station	2	9½

DIVISION OF MAINTENANCE COST.

	No.	Per Ct. of Interest.
Merchants	7	33
Property Owners	2	9½
City	12	57½

The tendency so far seems to be for the owners to take the lead in installing the system and for the city to keep it up. With the great number of arrangements possible, this matter should be threshed out early to avoid subsequent dissatisfaction.

There are some very good arguments in favor of the central station putting in and keeping control of the entire system. This gives the company the entire control of the construction work, the arrangement of circuits and other engineering features. The company also usually selects the type of post which is to be used, subject to the approval of the Board of Trade or similar organization. The committee of the N. E. L. A. on decorative street lighting very strongly recommends the ownership of these systems by the central station, pointing out that any other plan might be at some time a favorable opportunity for municipal ownership or operation of all lighting facilities. Further than this, the installation of such a system by the central station is in a sense a gift to the community, at least it is the result of an expenditure for the benefit of the community and when such a gift is made it may rightfully be made the occasion of a celebration in which the central station should come in for a great deal of favorable comment.

A. G. Rakestraw.

Co-Operative Advertising of Electrical Signs and Vehicles Used by C. A. Knight, of Meridian Light & Railway Co., Meridian, Miss.

Another use is now being made of the electric sign. The Meridian Light & Railway Company, of Meridian, Miss., recently placed in service some General Vehicle trucks for their construction and maintenance work, and the idea originated by Mr. C. A. Knight, of that company, to place on each side of one of these trucks a small electric sign operated from the truck battery, advertising the electrical vehicle business and, at the same time, the use of electric signs.

These signs were made in small panels, four feet long and twenty inches wide, reading in two lines of 6-inch raised electric letters, "Use the Electric." These letters were fitted with candelabra receptacles and small tungsten lamps, connected to the vehicle battery in such a way as to be controlled by the driver of the car. These signs were installed on a thousand-pound General Vehicle truck, and

Electric Sign on Electric Vehicle of Meridian Light & Railway Company.

the idea has proved to be a neat advertisement and has been the cause of more than a little discussion which, of course, was favorable to the central station in Meridian.

Mr. Knight writes that the next signs of this character that he installs will be designed with fewer lamps if possible, as the only drawback to the scheme is that it is similar to the Mississippi river steamboat with the big whistle. When the boat runs, they can't blow the whistle, and when they blow the whistle, they can't run the boat. This difficulty has been overcome, however, by lighting the signs whenever the truck comes to a standstill, and turning them off when starting.

The signs were furnished by the Greenwood Advertising Company, of Knoxville, Tenn., and finish of same matches the maroon body, coach finish, used on the truck.

Educating the Public in the Use of Light.

Within the past months, the Illuminating Engineering Society has printed for several large lighting and manufacturing companies throughout the country, an edition of more than a quarter of a million copies of its illumination primer, "Light; Its Use and Misuse." This little publication, which has been referred to several times in this journal, presents in a brief and popular form the priciples of good illumination. It is being widely circulated by these companies for the purpose of creating an appreciation and demand for more and better light. The Consolidated Gas Company of New York has issued 100,000 to its customers; the New York Edison Company, 50,000; the Edison Electric Illuminating Company of Boston, 26,000; the Philadelphia Electric Company, 10,000; and the Commonwealth Edison Company, of Chicago, the same number. Several other companies have sent out editions of from 2,000 to 10,000 copies. In a way, this large distribution of the primer constitutes an educational and business campaign which is both interesting and unique.

The recent edition of the primer, which contains a few minor changes in the original one, was published in a very inexpensive form so that it might be circulated widely at a small cost. For the companies which are going to issue this pamphlet to their customers during the coming lighting season, the society is arranging to publish two new large editions, which will be available at prices that merely cover the publication costs involved. Sample copies may be obtained by interested companies upon application to the general offices of the society, 29 West 39th street, New York.

Sizes of Meters for Lighting and Power Used by the Winchester Lighting Company, Winchester, N. Y.

In order to select the proper size of meter for an installation, the Winchester Lighting Company has the following rule:

Residence lighting, 33 per cent of total connected load.

Store lighting, 75 per cent of total connected load.

Motors, 1 Kw of meter capacity per Hp of motor.

The meter setter connects the meter in such a way that the grounded wire of the transformer secondary is not connected to the series coil of the meter so that in case of a ground on the house wiring, it will register on the meter and be easily discovered. All meters are read monthly except a few specials, the meters being read on what is known as a 25 working day month, making the period covered by the bill 30 or 31 days.

Mr. L. W. Carnagy, District Meter and Transformer Specialist, General Electric Company, Atlanta Office, Discusses Ozone and Its Production.

Of the many so-called current-consuming devices now familiar to the central station manager, the ozonator is least understood in principle or use, yet of all other devices it has one of the best reasons for profitable promotion, namely, improvement of living conditions whether it be in the home, office, store or factory. In view of this situation, it is proper to ask what ozone is and how it is produced. Mr. Carnagy has been asked to answer this question, and in what follows he has ably done so.—Editor.

The modern man recognizes, as his ancestor never did, his need of nature. Although this is generally attributed to an appreciative attitude, the original sponsor was necessity. The annual exodus to mountains and seashore is instictive from the clean freshness of it all and the return to city occupations is dreaded not especially for the occupation, but because the real man wants to exert his powers to the fullest, yet instinctively realizes that his body and mind are benumbed by the foul air of the indoors. Open windows are dangerous in winter, and few if any systems of ventilation are alone adequate to destroy the bulk of obnoxious odors and bacteria resulting from industrial processes or proceeding from the human organism.

Right here cleanliness claims consideration. It is as important to have clean air in contact with the delicate throat and lung tissue, as to have clean hands. Chemical disinfectants only complicate the situation. Nature's method of purification is by oxidization, and oxygen is, therefore, her life-guarding element. Ozone—the most active form of oxygen—is abundant in the healthful resorts of pine forests, mountains and seashore. Although it is

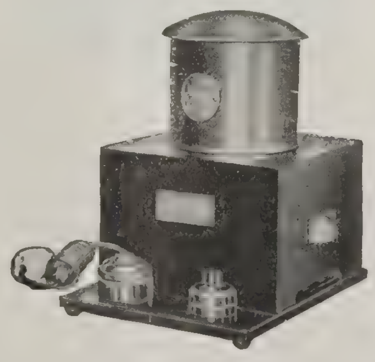


Fig. 1. The Household Type Ozonator.

incorrect to attribute the beneficial effects of these surroundings to ozone alone, the fact that such localities have purity of air, freedom from bacteria, health-giving properties and ozone, is an indication that ozone performs a valuable function in the establishment of the ideal conditions encountered.

The foregoing should eliminate any belief that the use of electrically produced ozone creates an artificial condition. It is really reverting to nature and re-establishing a condition which was very prevalent before deforestation had cut down the production of ozone and dense population and air contamination increased its consumption.

Let us consider, then, a very natural question: "What is ozone and how is it produced?" Ozone is an extremely

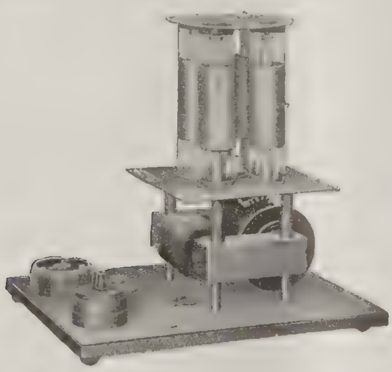


Fig. 2. Inside View of Ozonator in Fig. 1.

active form of oxygen and is produced chemically, by the action of the air on phosphorus; by the electrolysis of water; and by the passage of air through an electrostatic field such as is produced during a thunder storm and manifests itself by the electric discharge from the clouds. This last method suggests the only practical one for the artificial generation of ozone and forms the basis on which most ozonators are designed. It is next very natural to ask: "What are the properties of ozone?" As should be expected, the properties and functions of ozone are the same, but differing in degree from those of normal oxygen. Ozone is an intense oxidizer. It attacks and destroys many organic bodies not actively attacked by normal

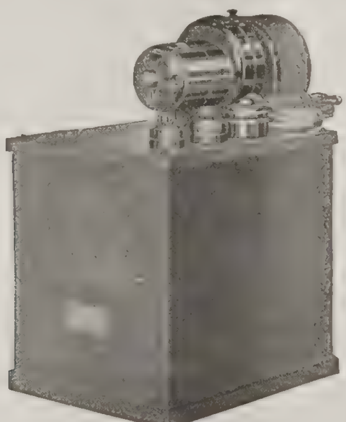


Fig. 3. The Universal Type of Ozonator.

oxygen. In general, all noxious gases and substances are organic or at least oxidizable. From the above it is patent that the presence of ozone is an index of healthful surroundings; the absence of ozone is an indication that all of nature's purifier having been utilized, the air is contaminated and will become increasingly so until a fresh supply of ozone be introduced.

Ozone is recognized as one of the vitalizing constituents of atmospheric air. It is one of the most rapid and powerful oxidizing and purifying agents known to science. Until recently it was produced only by natural process; but again the "electrical engineer" records another triumph in designing what is known as the ozonator. This device is made in several different types known to the trade as produced by the writer's company as the "Utility," "Household" and "Universal," and their applications are as follows: The "Utility" type is a small machine intended for use in out-of-the-way places, such as basements, closets, kitchens, lavatories, etc. The "Household" type, as its name implies, is for general application in the home. The "Universal" type is a more powerful machine, equipped

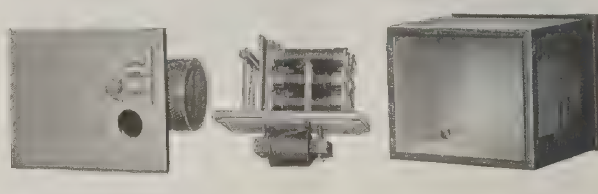


Fig. 4. An Exploded View of Ozonator in Fig. 3.

with blowers and intended for installation in large dining rooms, cafes, theaters, etc.

In conclusion, ozone is not of recent discovery; it has been with us since the days of Adam. The general introduction of ozone for purposes of sanitation has gained a firm foothold in Europe and during the last few years has attracted considerable attention in America. Wherever ordinary methods of ventilation are incapable of destroying prevalent odors or where for any reason adequate ventilation is unprocurable, ozone will be found a valuable adjunct and powerful ally. On this basis, therefore, its extensive use is to be commended.

Smallest Central Station in the United States.

The town of Sacramento, Nebraska, has a grand total population of one dozen inhabitants. However, Sacramento is progressive, as evidenced by the fact that it already has a central station. Mr. E. G. Anderson, proprietor of this embryo lighting company, operates a 3-horsepower Fairbanks-Morse coal-oil engine. The total connected load consists of 30 tantalum lamps.

Courtesy.

Courtesy pays more than legal interest. It pays in *human interest.*

Courtesy is the poor man's capital, the workingman's guarantee of a higher position.

There is always time to be civil, always opportunity to be polite, always chances to be considerate.

The public regard *you* as the personal representative of the corporation you serve. And this corporation is weighed by your actions on the scale of *public sentiment.*

Your manners mean much to the success of this company.

If you are constantly having trouble with the public, *look within.*

A community that taxes industry or the products of industry can not hope to compete with a neighboring community that taxes neither.

A concern that is honest gets three times the result from half the advertising and selling effort than a concern whose honesty is questioned.

Questions and Answers from Readers

Readers are invited to make liberal use of this department for discussing questions, obtaining information, opinions or experiences from other readers. Discussions and criticisms on answers to questions are solicited. However, editors are not responsible for correctness of statements of opinion or fact in discussions. All published answers and discussions are paid for.

CHANGING SERIES ARC TO SERIES TUNGSTEN SYSTEM.

Editor Electrical Engineering:

(403.) The writer is planning to change a series arc system to a series tungsten system for street lighting. A 6.6 ampere Thomson-Houston machine is now used. Can this machine be used with no change for the tungsten system and if so how do you calculate its capacity? J. W. Neff.

METER CONNECTIONS WITH TRANSFORMER SECONDARY GROUNDED.

Editor Electrical Engineering:

(404.) The inquirer has heard it said that when a transformer secondary feeding a house circuit is grounded, that care must be taken to not connect the series coil of the house meter to the grounded wire of the transformer. The reason given was that in case a ground occurs on the house wiring, it will show up on the meter. If this is true what would be the action when the series coil is connected to the grounded wire? H. A. S.

FUSING CAPACITY OF WIRE.

Editor Electrical Engineering:

(405.) The writer would like to know how to calculate the fusing capacity of any size of copper wire. Will some reader give a formula or other method? H. E. F.

CALCULATION TO DETERMINE SIZE OF WIRE FOR MOTOR CIRCUIT.

Editor Electrical Engineering:

(406.) When a line is to be run for a small motor load what conditions determine the size of wire to use? What is the smallest size of wire advisable to install on poles and also inside buildings from standpoint of the strength of the wire? Suppose 25 horsepower in small motors, two 10 horsepower and one 5 horsepower are to be installed, 200 feet from the supply circuit, which is 220 volts, a. c., what size of wire should be installed from service line to building entrance at service box? Also, what size from the service box to the different motors in case each is run on a separate circuit? I desire to know the method of calculation and if enough conditions are not given, supply same for the calculation. W. E. C.

USE OF GROUND CONES.

Editor Electrical Engineering:

(407.) The writer would like to know if any reader has used the Paragon ground cone for making grounds and with what success. Please outline also proper protection, showing diagrams, for station equipment, arc lighting circuits, high tension lines and low tension a. c. distribution. W. A. R.

TRANSFORMER CONNECTIONS FOR DIFFERENT VOLTAGES.

Editor Electrical Engineering:

(408.) Please publish in your columns diagrams of transformer connections showing how to get different voltages by means of changing connections. Also give connections for getting single-phase from three-phase as well as changing two-phase to three-phase. H. A. D.

Lighting Equipment and Station Apparatus for a Small Plant. Ans. Ques. No. 354.

Editor Electrical Engineering:

The questions of C. R. K. are of interest to the writer, as they are almost identical with the condition in a small plant, in the completion of which he was interested last summer. As to the advisability of using A. C. or D. C. would say that if conditions are such as usually found in small towns of 2,000 to 3,000, would advise A. C. for economy of distribution, flexibility of use, and the ease with which extensions may be made for future growth.

Some electrical salesmen recommend D. C. where they think it will possibly serve the present needs and where it may be installed cheaper for first cost, regardless of future growth or combinations with other systems. While D. C. may perhaps serve your needs now, do not be led to install same, if you anticipate any growth of the city, for unless the town of which you speak is very compactly built, there will be considerable loss of current in distributing D. C. at the present time, and this loss will grow with every extension unless a great amount is expended on large copper to keep down the loss due to line resistance.

Aside from the above, if your plant is ever absorbed by a central station distributing at a high potential, you could not realize its full value, for the central station in taking over the D. C. plant would have to install rotary converters to convert from A. C. to D. C., or would necessarily have to change much of the apparatus being used by the consumers on the D. C. system.

The output or size of the alternator would be limited, not only by the probable demand at present, but by the increased demand in the future, unless, as in some small cities, a duplicate generating set is to be provided to cover the growth. A good idea is to estimate as carefully as possible your maximum load for the next five years, and install a generating set that will fully care for this load. If the plant is a steam plant, and we assume such, it is wise to arrange the boiler capacity, room and fittings, to take care of another unit of the same size, for as your load grows, you may add this unit, thus doubling your capacity.

If you are to have no power load, the question may arise as to hours of operation, as some small plants suspend operation at midnight. This saves some operating expense, but is a poor way to gain custom, either municipal or private. A good way to offset the expense of a large engine pulling an idle or almost idle generator from midnight on, is to install a small direct connected steam unit to operate from the same boiler. If your largest unit is of, say, 75 Kw. capacity, your full load for the first year may not amount at any one time to over 35 or 45 Kw. In a city of this size I have always noted a falling off of the load until midnight or thereabouts, when the minimum is reached. This may not be a load of over 8 or 10 Kw. in a plant of this size. Here is where the small engine and generator begin to pay for themselves.

It is well to install three-phase generators, with an engine of good overload capacity, and in case you do not care to install a complete 3-phase system to begin with, the machines can be operated very economically as a single phase machine, and if later your load includes a few motors, the system can be converted to 3-phase cheaply and without disturbing the equipment of your consumers, in use at the time.

As to the street lighting system, much might be said. While from a point of cheapness and ease of operation, the low voltage series tungsten might be preferable, the arc might be desired by the city, but will be more expensive to operate and maintain. Many towns of this size are adopting the series tungsten incandescents, as they give a very good light if placed so that they may distribute well. They would be my preference under the assumed conditions. A tungsten filament lamp operating at 6.6 amperes in series, and at a potential of 15 volts is now standard. This lamp is rated at 80 c.p. and 100 watts, and is a durable and economical and very satisfactory unit for small town lighting. Fifty of these in series would require 50 × 100 watts or 5 Kw. disregarding small line losses. Each lamp using 15 volts, the voltage on the line would be slightly in excess of 750 volts.

Twenty-three hundred volts is a very desirable primary voltage for a plant in a small town, and this voltage with a series regulator installed lends itself very well for distribution on the series circuit of 750 volts.

A series panel should be supplied on the board for control of this circuit. If the regulator is rightly designed for its load, the only reading instrument necessary on this panel will be an ammeter reading to about 15 amp. The voltage being held to the proper place by the regulator, a lamp going out will show an increase in amperage on this circuit, and if more than one go out, or so many as to disturb the current materially, a little more resistance may be plugged in on the series panel, until the ammeter again stands at 6.6, and the lamps can be replaced at any convenient time. These lamps are provided with sockets having two clips separated by a very thin mica washer or of some very fragile insulation, which is punctured by the excess voltage when the lamp breaks, thus closing the circuit and leaving the other lamps uninterrupted.

A necessary precaution is to know that the regulator is not overloaded by the series circuit, as under those conditions it would heat with the result that the insulation would probably give away. These regulators are without weights and dashpots, depending upon an internal balance of coils against the core.

The price per Kw. depends upon the hours of operation and the price of coal in your territory. As the series circuit would use but little in excess of its rating 5 Kw., your price for street lights could easily be determined.

As to the machinery installed, would say that unless I could get a generator of the phase, frequency, voltage and type wanted, I would buy new machines and get exactly what I wanted with a specific guarantee as to its efficiency, workmanship, material and design. If you buy a new bucket, you certainly would not take a leaky one, and a generator operating at a low efficiency is not only leaky, but is not dependable, and if your customers cannot depend upon service, you cannot depend upon customers. Any rebuilt machinery should have a dollar and cents guarantee, or the chances are, ten to one, you will lose.

Roy C. Fryer (Mich.)

Three-Wire System From 3-Phase Generators. Ans. Ques. No. 360.

Editor Electrical Engineering:

The diagram shown by Mr. Wallis is the best standard practice at the present time. There are slight modifications of it, but there is nothing better. Motors under 5 horsepower should in general be taken from the single phase.

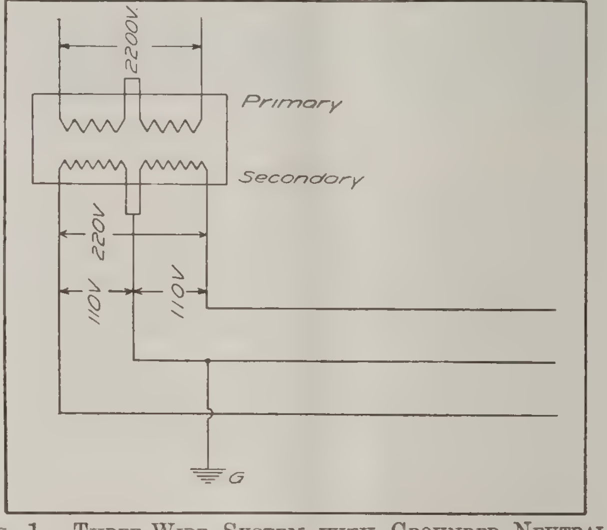


Fig. 1. Three-Wire System with Grounded Neutral.

Kw. and Kva. Ratings. Ans. Ques. No. 365.

The difference between Kw. and Kva. is the same as between the true and the apparent watts. The Kva. multiplied by the power factor will give the true Kw. Transformers used to be rated in Kw. and a transformer capable of carrying 50 amp. at 2,000 volts was called 100 Kw., whereas, due to a low power factor, it might be furnishing 50 amp. at 2,000 volts and yet be carrying 75 Kw. of true power. The Kva. is therefore the apparent power.

Economical Size of Conductor.—Ans. Ques. No. 373.

As the efficiency of a 30 H.p. motor is about 90 per cent, we will assume that 33 electrical H.p. must be transmitted to develop 30 mechanical H.p. The power in a 3-phase delta connected circuit with 100 per cent power factor is $\sqrt{3}$ times the current per wire, times the voltage across phases. Solving in this case and multiplying by 80 per cent power factor, we get 161 amperes. In figuring the drop, we may consider this circuit to be a combination of three single phase circuits, shown as *Aa, Bb, Cc,* in Fig. 1. In practice no conductor is needed to carry the currents in the three inner wires, *a, b, c,* since their algebraic sum is zero. A drop of six volts across phases is equal to a drop of 3.5 volts from any wire to the imaginary neutral. We find No. 000 wire to give a drop of 4 volts per wire or 6.9 volts across phases, which satisfies approximately the requirements.

On the basis of economy, however, we find that a larger wire should be used. Kelvin's law for finding the economical size of wire is as follows: "The interest on the copper cost, and on the accessories which vary with the size of the wire, should equal the annual money value of the lost power." When these two are equal, the total loss will be a minimum. Table No. 1 gives the copper data for different sizes of wire. Tables 2, 3 and 4 give the voltage drop and the loss of power at 110, 220 and 440 volts, respectively,

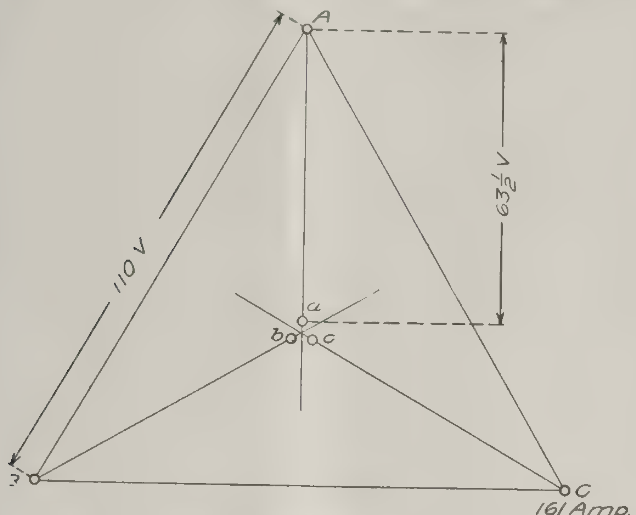


FIG. 1. VECTOR RELATIONS IN 3-PHASE CIRCUIT.

and Fig. 2 gives the curves from these figures, showing the interest on the copper, the line loss, and the total loss. It

TABLE 1. COPPER DATA FOR DIFFERENT SIZES OF WIRE.

Size B & S	Weight 1200 Ft	Cost at 20 Cts.	Interest 6 %
0000	775 Lbs.	$155.00	$9.30
000	610	122.00	7.32
00	483	96.60	5.76
0	380	76.00	4.56
1	305	61.00	3.66
2	240	48.00	2.88
3	190	38.00	2.28

TABLE 2. VOLTAGE DROP AND LOSS OF POWER AT 110 VOLTS.

Size	Drop Volts	I^2R Loss	Kw-hr. Loss per Yr.	Value at $1\frac{1}{2}$ Cts. per Kw-hr.
0000	3.08	496	1480	22.40
000	4.11	660	1980	29.60
00	5.0	806	2530	37.80

TABLE 3. VOLTAGE DROP AND LOSS OF POWER AT 220 VOLTS.

Size Wire	Volts Drop	I^2R Loss	Kw-hr. Loss per Yr.	Value at $1\frac{1}{2}$ Cts. per Kw-Hr.
0000	1.56	125	375	5.62
000	2.05	164	462	6.90
00	2.5	200	600	9.00
0	3.16	253	770	11.50

TABLE 4. VOLTAGE DROP AND LOSS OF POWER AT 440 VOLTS.

Size Wire	Volts Drop	I^2R Loss	Kw-hr. Loss per Yr.	Value at $1\frac{1}{2}$ Cts. per Kw-h.
00	1.25	50	150	2.25
0	1.58	63	190	2.85
1	1.98	79	237	3.56
2	2.52	100	300	4.50
3	3.2	128	385	5.76

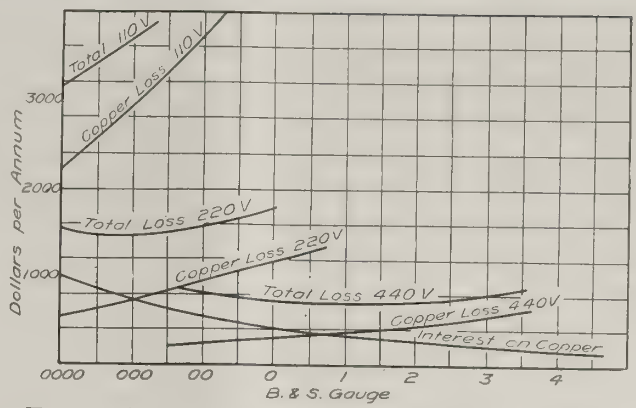


FIG. 2. CURVES OF INTEREST ON COPPER AND LOSSES.

will be noted that where the curves cross at X and Y, the total loss in a minimum. From these curves we see that the most economical size of wire at 440 volts is No. 1, at 220 volts No. 000, and at 110 volts much larger than any wire shown on the curve sheet.

It is possible to apply Kelvin's law to voltage variation as well as wire sizes, but since the insulation, etc., necessary for 440 volts above that required for 110 volts would not greatly affect the cost of the apparatus, no allowance has been made. The cost of transmission at 440 volts is so much lower, it would be recommended by all means. Above this voltage, the additional expense for insulators, etc., would probably balance any further saving in copper.

Connections for Power Factor Meter. Ans. Ques. No. 375.

If two or any other number of A.C. generators are operated in parallel, and it is desired to find the power factor of the whole station load, the power factor meter would probably be placed on the load or "totaling" panel of the switchboard if there were one. Series transformers are used for the series coils, and a potential transformer for the shunt coil. If, in addition to this, it were desired to know the power factor on the outgoing feeder circuits independently, separate instruments would be used on each feeder panel. If only occasional determinations of the power factor on the feeder circuits is desired, a portable instrument with a split type of current transformer clamping around the wires might be used, or current transformers could be placed in position permanently, and the instrument moved from place to place. The determination of power factor is not necessary in the sense that it is indispensable. It is simply a valuable indication of load conditions.

Delta vs. Star Connections. Ans. Ques. No. 395.

The statement made in question No. 395 of the August issue is true, if we are definite as to our definition of the systems. A star connected system with 2,200 volts for instance from outers to neutral, will carry three times the current with the same copper loss that the same wires will carry with 2,200 volts across outers. This simply amounts to saying that an increase of voltage in the ratio of 1 to $\sqrt{3}$ with a proportionate decrease in current, will decrease the I^2R loss in proportion to the square of the current or as 3:1. The diagram below shows a system with apparatus connected to it both in star and in delta. There is really no difference in the transmission line, but only in the way in which power is taken from or supplied to it. Single phase load can be taken from this line at 3,800 volts, the voltage across outers. If 2,200 single phase load is to be taken, a

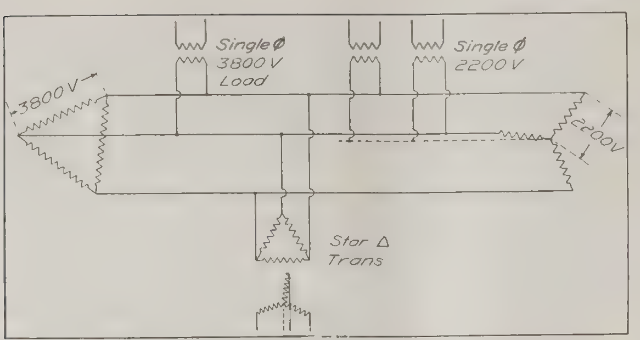


Fig. 3. Showing Delta and Star Connections.

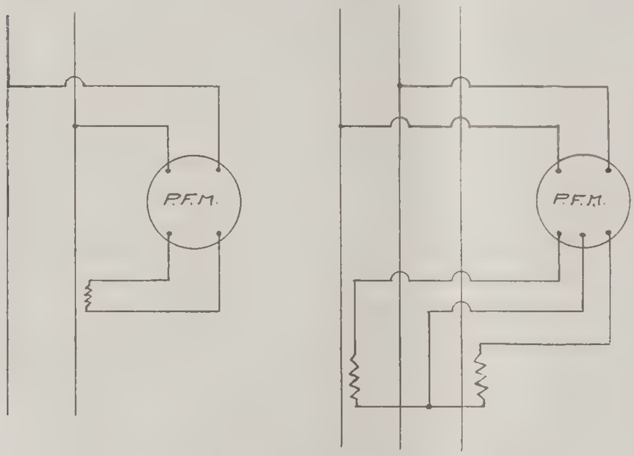
neutral wire may be run as shown, or transformers with the required voltage ratio installed.

A. G. Rakestraw (Pa.)

Use of Power Factor Meter. Ans. Ques. No. 375.

Editor Electrical Engineering:

Referring to the question of R. E. W. in the May issue on use of a power factor meter, it is becoming more and more usual to see this meter on the switchboard of large stations. To find the power factor at the station it is not necessary to refer to such an instrument if ammeters, volt-



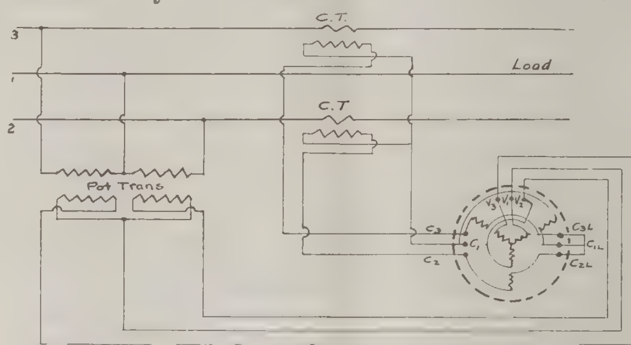
Connections for Power Factor Meter.

meter and a recording watt meter are used, yet to secure the best service from equipment where it is essential to know the power factor and keep cables and all other apparatus loaded with useful power, a power factor meter is a good investment. Single, two and three-phase power factor meters are now made, the connections for the single-phase and three-phase being given here.

Connecting a Power Factor Meter.—Ans. Ques. No. 379.

In answering question 379 by W. E. C., the writer will give some of the possible wrong connections when installing a power factor meter on a three-phase circuit and then give the remedy when such connections are made. Referring to the diagram in Fig. 1, the following wrong connections are most frequently made: (1) The transformers may be connected wrong with regard to the instantaneous relative polarity of the primary and secondary; (2) the order in which the phases attain their maximum value may not be the same as that for which the instrument has been constructed (phase rotation incorrect). This may occur on either the current side or potential side, or both; (3) a terminal or pair of terminals on the instrument which corresponds to a certain phase either on the potential or current windings may be connected to some other phase although the order of the phases mentioned in (2) may be correct; (4) the current leads may by mistake be connected to the potential terminals.

If it is thought that the wrong connections mentioned in (1) are made, measure the secondary voltages, $(V_3 V_1)$, $(V_1 V_2)$ and $(V_3 V_2)$. If these are all equal the polarity is correct. If they are not, one of the transformers must be reversed either on the primary or the secondary side. To check the current transformers, insert an ammeter in each of the leads connected to C_3, C_1, C_2. If these readings are equal, the connections are correct. If one of the transformers must be reversed, the reading in C_1 will be about 75 per cent greater than either of the other two. If there is some doubt from this test due to unbalanced loads, it is best to check still further by a more certain method. Take a coil of a



Connections for 3-Phase Power Factor Meter.

considerable number of turns of wire and slip it over the conductor to which the transformer which is supposed to have the wrong connection is connected. Connect the terminals of the coil to the secondary of the questioned transformer so that the two secondaries form a simple complete series circuit. Connect a low-reading voltmeter or test lamp across the windings so connected and watch the voltage readings when one secondary is reversed with reference to the other. When the two secondaries are connected so as to produce the highest voltage, the incoming terminal of the coil is connected to the incoming terminal of the transformer tested.

The wrong connections mentioned in (2) cannot well be checked by tracing out the connections, for the phase rotation will depend on how the generator connections are brought out. It is found best to connect a small induction motor arranged to indicate the mechanical rotation with certain phase numbering. This is the principle of the phase-rotation indicator. It is possible also to determine the phase rotation by the indications of the power factor meter. As shown in the diagram of the meter, two rotating fields are available in it. If, then, the potential winding is short-circuited on itself, while the current coils are excited, the movement will act as the rotor of an induction motor and will move in a definite direction indicating the phase order of the current coils. Similarly, if the current winding is disconnected and short-circuited, a rotation will be produced in the opposite direction. If these directions are known for the instrument, there will then be a check on the phase rotation as connected.

A check on the wrong connections in (3) can be made by tracing out carefully the connections to current and potential transformers. It must be certain the potential terminals of the instrument are connected through the transformers to the same lines from which the current coils of similar marking receive their excitation. If these remarks are carefully studied, it is believed much of the trouble in connecting the power factor meter will be avoided.

H. F. Boyle (N. Y.)

Constant for A. C. Meters. Ans. Ques. No. 385.

Editor Electrical Engineering:

In question 385 of the July issue, I presume the reading constant is the one wanted, and is found as follows: It is understood that a 200-volt instrument is to be used on a 100-volt circuit, using series transformers with the ratio of 4 to 1, and shunt transformers with the ratio of 60 to 1. In this case the ratio of the series, times the ratio of shunt transformers, which is $4 \times 60 = 240$, would be the reading constant, provided no change has been made in the 200-volt shunt coils in the meter, or of the 20 amp. coils.

Should the test constant be wanted, the make of meter, size (amperage), whether single or polyphase, disc constant, the make of standard testmeter used, voltage and etc., should be stated. A. C. Morrison (N. C.)

Constants for A. C. Meters. Ans. Ques. No. 385

Editor Electrical Engineering:

I submit the following in answer to question 385 of the July issue: Since S. C. does not specify, I assume that the meter in question is a 5 ampere, 200 volt, polyphase watthour meter, and reads directly in kw.-hrs. If such a meter were used on a 5 ampere 100-volt load the reading constant would be 1.0. When used with current and potential transformers the constant will be (1 $\times$ the current trans. ratio $\times$ potential trans. ratio) or in this case $(1 \times 4 \times 60) = 240$ = reading constant. It would be better practice to use a meter with 100-volt potential coils or use 200-volt potential transformers with his present meter.

G. J. Kiburz (Ill.)

Corrosion of Switch Blades. Ans. Ques. No. 390.

Editor Electrical Engineering:

The switch blades should be thoroughly cleaned and their contacting parts kept well lubricated with white vaseline. This will effectively prevent corrosion due to the formation of cupric-oxide ($Cu\ O_2$) from the action of the sulphur fumes. Richard Martin (Cal.)

What Is Wrong With the Refillable Fuse? Ans. Ques. No. 398.

Editor Electrical Engineering:

The vast strides that the electrical industry is taking necessitates the stringent laws set down by the National Board of Fire Underwriters. These rules are for protection against loss of life and property. To allow any electrical apparatus to have the chance of being misused by inexperienced men would defeat the very aims of these laws.

The fuse is a very dangerous device if it is not right. Any of the fuse manufacturers can tell how often they have received fuses "loaded" with copper or brass wire. The writer has personally seen copper and brass strips soldered across the fuse shells either because new fuses were not at hand or the machine had a load the fuse could not carry. There is the greatest danger to life and property attending the short circuit of fuses loaded with improper elements.

The writer has had occasion to witness a short circuit test on a 30 amp. "NECS" case "loaded" with copper wire of about 30 amp. capacity. On a dead short circuit the flash could have set fire to any inflammable material that might have been present. The case exploded with a very loud report and the shells buried themselves in the wooden covering, and the fuse clips on the cutout were melted completely away.

Fuses, as they are built today, are thoroughly inspected and must comply with the Underwriters' rules. They then become a real safety device. The "Safety First" slogan does not enter the refillable fuse field. As soon as a refillable fuse reaches the consumer's premises its mission as a real safety device cannot be fulfilled because its most vital part, the element, may be tampered with.

O. R. Blumberg, B. E. E. (Mich.)

Transformer Ground Detector Arrangement. Ans. Ques. No. 391.

Editor Electrical Engineering:

This detector scheme seems as good as any, although perhaps not so sensitive as electrostatic instruments. It does not introduce additional strain on the insulation of the system, but is of benefit since it tends to rid the line of accumulations of static electricity (from the atmosphere). The voltage ratios indicated in the diagram are not quite correct; the line voltage equals the phase voltage multiplied by the square root of three, and therefore if the phase voltage were 11,000 the line voltage would be about 19,000.

A ground detector does not indicate a ground nor the absence of a ground—it merely indicates the difference between the grounds of the different lines, for if all three are grounded alike the detector will show clear. However, if one is grounded through a lower resistance than the others, the detector will show it.

An inspection of the diagram given by T. C. M. will show that a dead ground of one of the lines will cut out the transformer connected to that line and extinguish the lamp. Also it will throw the full line voltage (19,000 volts) on the other two, and therefore cause the lamps to become very bright.

Paralleling Generators With One Field Coil Gone. Ans. Ques. No. 392.

Cutting out a field coil does not affect the frequency and there is no reason for cutting out the adjacent coil. If the pair of coils were cut out and removed, the remainder distributed equally around the circle and the armature rewound to correspond, then it would be necessary to increase the speed in order to get the same frequency, but so long as the armature winding, field coil spacing and speed remain the same, the frequency remains unaltered. The field strength must be increased in order to make the voltage of the two machines equal, for if they have unequal voltages there will be wattless current circulating between them, causing low power factor.

Why Transformers Hum. Ans. Ques. No. 393.

The loudness mentioned does not depend on the frequency or the voltage, but depends almost entirely on how loose the iron is; that is, on what chance it has to vibrate. I have seen cases where a very noisy transformer would be quieted by clamping the laminations so that they could not move. If the magnetic density is high, that is, if the ratio of voltage to number of turns is high (for a given frequency), there would naturally be more tendency to hum than in case the density is low. The frequency determines the pitch but not the loudness, thus a 60-cycle transformer sounds a note about B-flat, while a 120-cycle one would sound just one octave higher.

Trouble in Operation of Rotaries. Ans. Ques. No. 396.

The trouble is probably due to the method of wiring, as suggested. If the two wires of an A.C. circuit are passed through separate conduits, the line will act as an impedance coil because of the intense magnetism circulating through the pipe, around the wire. This impedance reduces the voltage and changes its phase angle, relative to the line voltage. When the two wires are in the same conduit they neutralize each other and there is no appreciable impedance effect. T. G. Seidell (Ga.)

Telephone Trouble on Grounded Telephone System. Ans. Ques. No. 382.

Editor Electrical Engineering:

In regard to question 382 in the June issue, it may be said that on grounded telephone lines it is quite likely that a distance of seven poles, or something over a seventh of a mile would be likely to cause cross talk although no effects would be experienced from cross signaling and inductive ringing. On country lines it is so usual for everything that is said on one line to be audible on the others that such an experience is not apt to cause comment. No cheap or satisfactory method of transposition has been discovered that will obviate the difficulty and I think that the parties will be compelled to put up with the inconvenience, or change to a full metallic system.

Now it sometimes happens that if a station is situated in a hollow where rock bends into a shape of a cup, the surrounding locality is in reality a defective ground and currents will pass from one ground rod to another and thru the lines. The ordinary 1800 or 2000 ohm bell ringer coils do not offer an impedence that will effectually prevent cross talk and often all lines can be rung from the station or speech on other lines can be heard with distinctness.

In Florida, however, there is little probability of any rock formations interfering with telephone transmission, as the deposits are mostly alluvial and without further data on the trouble it will be impossible to give definite information. E. A Woodward (Miss.)

Why a Motor Was Bucking.

Editor Electrical Engineering:

The writer was once called upon to investigate the cause of the periodical opening of a D. C. circuit breaker on a medium sized motor generator which supplied energy for a steel mill. To begin with many readers will say: "Well, that's nothing strange for a circuit breaker to open in a steel mill." That's exactly what the writer thought until he tackled the job, when he soon found that it was quite strange. A complete set of readings were first taken from the station meters, and peculiar results were obtained. The ammeter readings ranged from 75 to 300 and 1,000 amperes the voltage fluctuating accordingly; once or twice the ammeter pointer swung off scale; the generator arced over, and the breaker "stayed in." But the oil circuit breaker on the motor opened, thus shutting down the set. When the set was again started up, the generator was found to be reversed. The generator and connections were carefully examined and nothing alarming was discovered. The generator was then remagnetized and started, carrying its load O. K. A short time afterward the D. C. breaker opened and the calibration of the breaker was checked and found to be O. K.

Feeling confident that the power house apparatus was all right, the writer had tests made on all the motors which were fed from this set, and nothing alarming was found until a large compound wound motor was tested, which drove a ten-ton press used for pressing out steel pulleys from a cold flat plate. Readings were taken on this motor while driving the press at from 5 to 6 r.p.m. and good results were obtained, but when the press was speeded up to 8 to 10 r.p.m., then trouble began. Reverse currents of 400 to 600 amperes were recorded and the power went off; hence the seat of all the trouble. The following report was sent to the company's officials:

Shut-Downs of Motor Generator.—I have given this trouble considerable thought and study, and wish to state that it is a rare state of affairs. Will attempt to explain the situation in the following manner:

Conditions to Be Overcome.—The frequent opening of the main generator circuit. Reversal of the polarity of your motor generator. The generation of reverse currents by some of your mill motors.

Apparatus Which Causes These Conditions.—There is no doubt in my mind but that the whole trouble is caused by the reverse currents generated by your motor No. 372.

Explanation.—The motor in question should not, and I understand does not, cause any trouble when running the press at 5 to 6 r.p.m., because the flux or lines of force across the armature are strong—the armature current is small and the speed being slow no reverse currents are generated. But when the press is speeded up to say, 8 to 10 r.p.m., which is accomplished by weakening the fields or the flux across the armature, the counter E. M. F. is reduced and the inertia of the large moving element cannot be steadied or overcome by the motor, and consequently there are times when a reverse current of varying strength is generated by the series fields of the motor and opposes the voltage impressed upon the motor from the line. This reverse current increases the generator load on account of the generator having to oppose and overcome it by rising high enough; consequently, a peak load is reached which is of such magnitude as to trip the generator's circuit breaker. If the generator breaker does not operate on account of its being set higher in proportion than the oil circuit breaker on the main switchboard, the latter opens and of course the reverse current enters the generator and reverses its polarity.

Suggestions. 1st. A reverse current relay could be installed in the 75 H. P. motor circuit, so that when the press is speeded up and the reverse current is generated, the motor would be tripped out of circuit without effecting the other motors. 2nd. A single pole knife switch of the proper current carrying capacity can be cut into the leads of the series field, and when the press is to be operated at its high speed, the motor can be brought up to speed and then the knife switch closed, which will short circuit the series field and the motor will run as a shunt motor, and no reverse current should be generated. 3rd. Install an A. C. motor of constant speed to run at about 1050 r. p. m. and have the present D. C. motor in to carry the load when the press is to be operated on a lower speed of 800 or 870 r. p. m. An induction motor of lower H. P. could probably be installed and by running it at full rated load, you could improve the power factor of your system.

A. P. Broadhead. (Mass.)

In the field of residence lighting, the territory electrically lighted is becoming larger every year. Considerable advance has been made in the design and use of proper reflectors for residence lighting, which combine with efficiency desirable artistic features.

New Apparatus and Appliances

New Appleton Products.

The illustration shown here presents a combination cut-out and push button switchbox of double pole, 250-volt design as manufactured by Appleton Electric Company, 212-214 North Jefferson street, Chicago, Ill. This type of box offers a very convenient fitting for the cut-out and push button switch used very often on machinery run by individual motors.

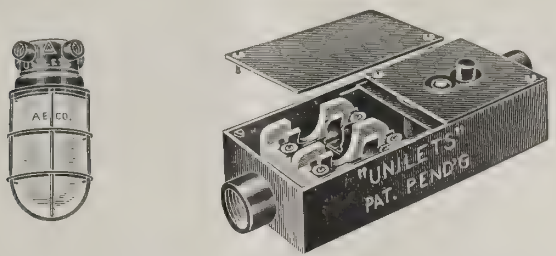


Fig. 1. A Combination Cutout and Push Button Switch Box.

There is also shown a vapor-proof fitting which is used where lamps are subject to moisture.

Indirect Lighting for a Substation.

In planning a new substation at 187th street, New York City, the United Electric Light & Power Company has given the lighting of the plant careful consideration. It was deemed necessary to provide an illumination of good working intensity and to eliminate to as great a degree as possible shadows on the switchboard and machine parts. It was also considered of highest importance that the substation never be left in darkness.

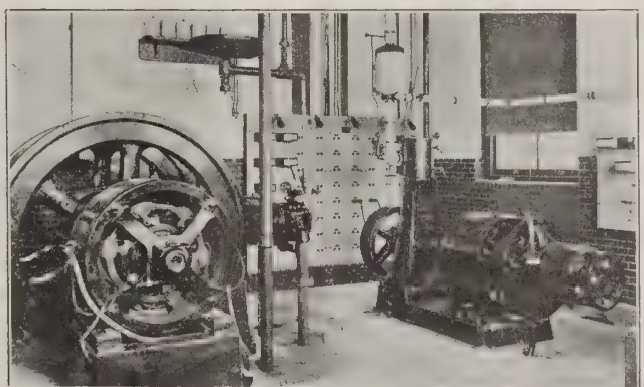
To meet these requirements the indirect lighting system was selected with an auxiliary lighting system using X-ray beehive reflectors, being a direct installation. Fig. 1 shows a night view of the control board balcony where indirect lighting is used exclusively. The ceiling height of this balcony is 13 feet, it being 82 feet long and 8½ feet wide in front of the board. Eight outlets using a total wattage of 1,200, which figures 1.72 watts per square foot, gives an idea of the low current consumption. In the main transformer and rotary room, the indirect lighting is in use practically all the time, furnished from five indirect fixtures of 500 watts capacity each. This figures 1.06 watts per square foot for the area of 2,360 square feet, which also is a very reasonable wattage consumption. The tops of the reflectors are 42 inches below the ceiling, which is painted a dull white. The auxiliary lighting system for use in emergencies is comprised of 20 beehive reflectors, each equipped with a 100 watt clear bulb Mazda lamp furnishing a total wattage of 2,000 or .85 watts per square foot.

Fig. 1. View in Substation of United Electric Light & Power Company Using Indirect Lighting.

The indirect fixtures known as the "Eye Comfort" fixtures, as well as the "beehive" fixtures were furnished by the National X-Ray Reflector Co., Chicago, Ill.

Generating Sets for School Laboratory.

The illustration here shows a corner of the electrical laboratory of the West Philadelphia High School, a new and modern structure situated on 46th street, Philadelphia. On the left is shown a Diehl 10 Kw., 120-volt, 250 rpm direct current generator coupled to an Otto gas engine. On the right is shown a Diehl 10 Kw., 400 rpm, 125-volt, 60-cycle, single-phase, AC generator mounted on the shaft extension of which is a 1 1/8 Kw. exciter. This apparatus is mounted on the same bed plate with and coupled to an A.B.C. steam engine. Students are thus enabled to study the characteristics of both AC and DC current generation and can observe the relative merits of steam and gas engine drive.



Electrical Equipment for a High School.

The switchboard shown consists of three panels on which are mounted the necessary instruments, field rheostats, switches, ammeters, voltmeters, wattmeters, etc. The panel on the left controls the output of the D.C. generating set, and the one on the right the output of the A.C. set. The central panel acts as a neutral, distributing board having receptacle inlets numbered identically with those in the AC and DC boards. The entire electrical equipment was furnished by the Diehl Manufacturing Company, of Elizabeth, N. J.

The Brascolite Luminous Unit.

The principle of illumination in the Brascolite unit manufactured by the St. Louis Brass Manufacturing Company, of St. Louis, Mo., is semi-indirect, or, in other words, all direct light rays are diffused and the indirect rays are reflected outward and downward. This unit is constructed practically entirely of glass, the canopy or reflector being made of dense white opal glass depolished on the outside, and the bowl suspended below same of Alba glass. A tripod in the reflector for attachment to the ceiling is cast malleable iron to which is attached a porcelain, flexible tongue center contact, socket. The loops below the reflector are cast brass and screwed into the tripod, thereby carrying the bowl independent of the reflector. The three aluminum chains have hooks on the lower end so that either of same

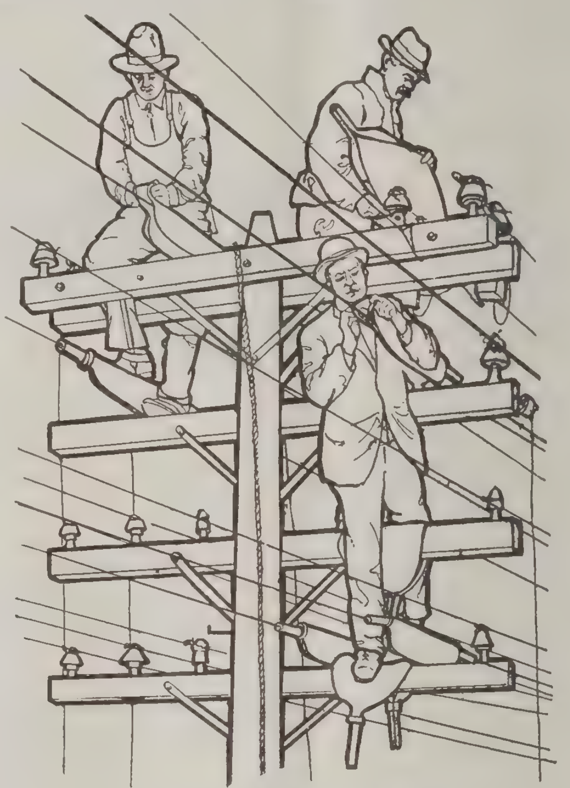
The Brascolite Unit.

can be easily unhooked, the bowl allowed to hang on the other two for cleaning and replacing the lamp. The special tripod makes it possible to install the unit to a spud; or to the side holes in the standard four-inch junction box; or to use wood screws. Insulating joints or canopy insulators are never required as the building wires are connected directly to the brass terminals of the sockets, and the reflector is a nonconductor. The socket is placed high in the reflector to obscure the skirt of the lamp. The unit is made in four sizes, for 60 or 100, 150, 250 and 400 or 500-watt lamps with 12, 14, 18 and 22-inch reflectors.

Photometric tests made in a typical office room with the 150-watt unit indicated 3½ average foot candles on a thirty inch plane. All the light rays are diffused and are reflected outward and downward, producing high efficiency. The fixture is non-corrosive, and will retain its efficiency indefinitely, and can be used in office buildings, schools, salesrooms, hotels and wherever good general illumination is essential.

Protection for Linemen.

The occupation of linemen for electric light companies is one of constant exposure to danger, so much so that it is classified by life insurance and casualty companies as "extra hazardous," but, as a rule, the public at large does not bestow upon it the recognition it deserves. Electric light companies throughout the country are now exerting every effort to reduce to a minimum the chances of any accidents happening to their linemen and with satisfactory results. The live wire has always been the chief source of danger, and many devices have been introduced for the purpose of safeguarding linemen. The Linemen Protector Company, of Detroit, Mich., has now introduced such a



Protector Shield for Linemen.

device which has decided merit. The device is known as the "Marshall's Linemen's Shield," and has the endorsement and approval of the American Museum of Safety, as also of the Fidelity & Casualty Insurance Company. It is conceded as a most practical protection against live wire dangers. The accompanying illustration shows its use.

New National Metal Molding Fittings.

A number of new and improved types of fittings, used with metal molding, are shown in the accompanying illustrations. These have recently been developed and placed upon the market by the National Metal Molding Company, of Pittsburgh.

A feature of interest is found in the fact that the base plates of fittings applicable directly to the molding have been standardized, and are now interchangeable. These fittings are all now supplied "dead-end," and can be made continuous by twisting off the scored "blanking ear" on base plates. This eliminates the necessity of contractors and dealers carrying separate fittings for "dead-end" and "continuous" work.

The molding is now being shipped nested—the capping and base separated—instead of with capping snapped on base, as formerly, which involved unnecessary labor in separating the two on the job. All cap-screws in various fittings are now slightly upset to prevent their dropping out in handling.

The National Metal Molding Company maintains a Southern office at 501 Fourth National Bank building, Atlanta, which is under the direction of Mr. F. S. Montgomery, Southern Sales Agent.

New National Metal Molding Fittings.

No. 398 Key Receptacle, No. 396 Chain Pull Receptacle, Nos. 390 and 390-a Attachment Plugs, No. 399 Keyless Receptacle, and No. 432 Two-Piece Rosette, are all of the Outlet Box type, designed for use with the No. 342-R Outlet Box, and cannot be mounted upon the molding. No. 397 Key Receptacle, No. 395 Chain Pull Receptacle, Nos. 360 and 360-a Attachment Plugs, No. 430 Combination Fixture and Drop Cord Fitting, No. 431 Two-Piece Rosette, and Nos. 391 and 392 Snap Switches are designed to mount upon the molding, and are shipped "dead-end." It is often necessary to butt two elbows for example, in breaking around some shallow obstruction like a pilaster, and No. 436 is designed for use in coupling fittings in such cases.

A New Blow Torch.

A new gasoline blow torch has recently been placed on the market by the Westinghouse Electric & Mfg. Company, East Pittsburgh, Pa., which embodies new features and improvements. These improvements, it is claimed, adapt the torch for all conditions of service and it is therefore called a "Universal Blow Torch." The burner is made particularly heavy so that it will retain its heat and keep the torch burning in cold or windy weather. The drip cup is made especially deep so that it will start the torch under bad weather conditions. These features, however, do not detract from the use of the torch for indoor work. Another feature of the torch is the self-cleaning burner valve. The needle at the end of the valve stem cleans hte hole automatically when the valve handle is turned. The valve seat need, therefore, never be injured by picking at the opening to clean it. The valve seat is a separate replacable plug.

The handle of the valve is of fibre. This handle does not get hot nor does it need a long valve stem for cooling as does an iron handle. On the other hand itwill not crack, loosen and come off as does a wooden handle. It does not char or burn. The tank, it is claimed, is of the heaviest gauge brass ever used for torch tanks and is reinforced with an extra corrugated brass disc covering the entire inner surface of the tank pot. This insures the tank keeping its shape under very rough handling.

Otis Elevator Controller Parts Cabinet.

In order to facilitate and quicken repair service in the event of unexpected breakdowns, or worn parts on elevator controllers, there has been designed by the Otis Elevator Company, for the convenience of engineers and all who are responsible for elevator maintenance, a useful device known as a controller parts cabinet. This is a compact, strongly made steel box and contains the essential parts of the type of controller furnished with the elevator machine installed. By hanging it in the engine room, the engineer may, at an instant's notice, replace a worn part of the controller, and by referring to the catalogue on the inside of the cabinet cover, order immediately a new part to replace the part removed, keeping the cabinet complete for repair work at all times. At present, these cabinets are being manufactured for direct current controllers only.

Electrical Construction News

This department is maintained for the contractor, dealer, manufacturer and consulting engineer.

ALABAMA.

ANNISTON. The Alabama Power Company is constructing a sub-station in Anniston to receive energy from the Jackson Shoal plant, the Gadsden Steam Plant and Lock 12 on the Coosa river.

BIRMINGHAM. The Alabama Power Company, now constructing several hydro-electric developments in Alabama, has merged with the Alabama Electric Co., the Wetumpka Power Co., the Alabama Power & Light Co., and the Alabama Power Development Co. Capital stock is $20,000,000, with $20,000,000 in bonds. The Alabama Power Co. has well under way hydro-electric developments on the Coosa river at Lock 12, which will generate 105,000 horsepower, the other four companies named owning power plant sites on this river which will be developed later. All of the companies have heretofore been under the management of the Alabama Traction, Light & Power Co., with James Mitchell, of London, president. The plans of the company involve the construction of developments to total 400,000 horsepwer, with a possibility of an ultimate development of 1,227,000 horsepower to be transmitted to various sections of the state. W. W. Freeman is general manager of the Alabama Power Co.

FLORIDA.

CHIPLEY. The Chipley Light & Power Company is constructing a power plant in which will be installed two 75-horsepower boilers, one 125-horsepower four-valve engine connected to a 75 Kva. 60-cycle 2,300-volt generator. Street lighting will consist of 75 one hundred eighty watt tungsten lamps. B. M. Hale is engineer.

GAINESVILLE. It is understood that an ornamental street lighting system is to soon be installed in the business section.

GEORGIA.

NEWNAN. The Municipal Electric Plant has been closed down and current is being purchased from the system of the Columbus Power Co., at Columbus.

SOUTH CAROLINA.

BENNETTSVILLE. An ornamental street lighting system is being installed in the business district. The system is being promoted by the Bennettsville Electric Light Co. D. C. Morrison is manager.

GEORGETOWN. The Georgetown Gas & Electric Co. has plans for the construction of a power house and gas plant. Plans can be secured upon application to Bachman & Co., 624 Stock Exchange Bldg., Philadelphia, Pa.

TENNESSEE.

HENDERSON. An election will be held late in October for the issue of $30,000 in bonds for improvement to waterworks system and sewers. If this bond election is carried, the Priestly-Lloyd Light & Power Co. will build a new power house.

NASHVILLE. The Nashville Railway & Light Company is planning to install 650 Kw. turbo generators switchboard and accessories.

PULASKI. It is understood that the city will soon purchase a 125-horsepower oil engine and a 125 Kva., 3-phase, 60-cycle, 2,300-volt generator and exciter. L. P. Thornberg is superintendent.

SHELBYVILLE. The Duck River Power Company, of Shelbyville, is to put in operation shortly its hydro-electric plant on Duck river. This plant is of 200 Kva. capacity, furnishing energy to Shelbyville over a 3-phase transmission line.

TULLAHOMA. The Tennessee Utilities Company is reported to be planning the expenditure of $150,000 to construct hydro-electric plant of 20,000 horsepower. P. M. Whitson is president and E. B. Blackburn secretary.

WEST VIRGINIA.

BLUEFIELD The Appalachian Power Company is considering the issuing of $3,000,000 in bonds for the purpose of developing hydro-electric plants on New river. The developments, as planned, will furnish 53,000 horsepower. The property is managed by the H. M. Byllesby Co., Chicago, Ill.

ROCKVILLE. The hydro-electric power company, of West Virginia, is planning to construct a dam and power house on the Big Sandy Creek. The plant will be of 65,000 horsepower, and will cost about five million dollars.

SPRINGFIELD. The Magnolia Power Company proposes to construct a hydro-electric plant of 13,000 horsepower to cost one million dollars on the south branch of the Potomac river. Electrical energy will be transmitted to nearby towns. F. Ernest Brackett, of Cumberland, Md., is engineer.

BOOK REVIEW.

ELECTRICITY FOR THE FARM AND HOME, by Frank Koester. Published by Sturgis and Walton Company, 31-33 East 27th St., New York. 274 pages. Price $1.00.

This work is one of thirteen that make up the Farmers' Practical Library as published or in preparation by the above named publishing company. It treats in a very general yet thorough way the application, operation and cost of electrical devices and appliances when used on the farm and in the home. The book is written for the farmer and therefore in such language as to be perfectly plain and simple. The author through a familiarity with the subject has ably handled it. The work would make a good one for distribution by central stations among possible rural customers. From this standpoint and at the price, the advertising and general interest it would create would be decidedly worth while.

ELECTRIC POWER PLANT ENGINEERING, by J. Weingreen. Published by McGraw-Hill Book Co., 239 West 39th St., New York City. 458 pages and 301 illustrations. Second edition revised and enlarged. Price $5.00.

While the price of the above book may seem at first high, a careful review of the material presented makes it appear very reasonable. This is one of a few works on power station engineering containing information that the engineer, consulting, constructing or operating, may at any time want to know. Unlike many books, besides the general information on the subjects treated, considerable space is devoted to reasons why of certain designs and arrangements, and suggestions for economy. These suggestions are supplemented by data on typical plants, which, in the author's opinion, represents high types of construction and design.

The work is valuable from another standpoint, namely, that the essential claims for different types of station equipment, whether it be oil switches, relays, regulators, lightning arresters or what not, are given a careful and unbiased interpretation, illustrations of the most satisfactory types being given. While a larger part of the apparatus shown is either General Electric or Westinghouse, the reference to the apparatus is through no prejudice of construction features but based on operating principles which seem most satisfactory in practice. The treatise is strictly confined to central and sub-station design, installation arrangements and operation of these stations and reflects very distinctly the extensive experience of the author in the design of such plants. The diagrams and plans of many typical plants form a valuable part of the work. The contents are as follows: Generators; Synchronous Converters; Mercury Rectifiers; Storage Batteries; Three-Wire System; Feeder Panels; Direct Current Motors; Direct Current Circuit Breakers; Direct Current Stations; Typical Electric Power tSations; Low-Tension Alternating Current; High-Tension Switching Arrangement and Methods of Connection; Circuit Interrupting Devices; Oil Switches; Relays; Potential Regulators; Constant-Current Systems; Starting Compensators; Lightning Arresters; High-Tension Switchboards and Wiring Diagrams; Cells and Compartments; Wall Outlets; Central Stations; Typical Central Stations; Substations and Typical Substations. In all there are 27 chapters.

PUBLIC UTILITIES, Their Cost New, and Depreciation, by Hammond V. Hayes, consulting engineer. Published by D. Van Nostrand, New York City. Pages, 256. Price, $2.00.

The author states the object of this work as follows in the preface: It brings to the minds of those who ascertain the figures representative of value, three distinct issues. First, that it is the duty of the appraiser not to ascertain the fair present value, that function belongs to the court or commission, but to ascertain with accuracy such figures as are necessary evidences of value and loss of value; second, that the original cost can be obtained without inordinate difficulty and is a figure of importance to those who must rule as to what the fair present value should be; and third, that depreciation is affected only indirectly by inefficiency, and that as a necessary consequence depreciation is dependent wholly upon the relation of the age to the life of the perishable property.

In brief, the work records the principles as far as now established, which must form the basis of valuation of the property of a public utility undertaking. It is rather encyclopedic in reference to the subject, and on account of this fact, it will be found useful even though other good works now published on valuation of properties are possessed.

THE INSPECTOR AND THE TROUBLEMAN, by Stanley R. Edwards and H. E. Dobbs. Published by Telephony Publishing Company, Monadnock Block, Chicago, Ill. 196 pages. Price, $1.50.

On account of the conversational style of this work, the numerous questions asked by Will, the green troubleman, and the complications named by him together with the answers and explanations by George, the allwise and experienced electrician, the value of this work is peculiarly great to the inexperienced telephone man, and to some who think they are experienced. The problems discussed are those that come up in small exchanges of the magneto type. It reads like a story, and every page contains much information presented so as to impress the reader.

PRACTICAL ELECTRICITY, published by the Cleveland Armature Works, Cleveland, Ohio. 460 pages. Pocket size, bound in flexible leather. Price, $2.00.

This work, now in its sixth edition, is the outgrowth of the Armature Winder, published in 1896 by the same company. The book has had a large sale, principally on account of the practical information it contains on winding armatures and the operating of electrical machines. It is plainly written and a very useful book for the electrical man who operates, installs and repairs electrical generators and motors.

ELEMENTS OF ELECTRICAL ENGINEERING, by J. L. La Cour and O. S. Bragstad. Published by Longsmans, Green & Company, 4th avenue and 35th street, New York City. 482 pages, and over 400 illustrations. Price, $5.00.

For the electrical engineer having to do with transmission systems and the layout of electrical systems and desiring to refer to engineering calculations and considerations of a mathematical character, this work will be found to serve in a way that few if any other single volumes do. For the clearness and completeness of the discussions on some of the practical phases of electrical work we cannot say too much. It is, in fact, a mathematical encyclopedia on not only some of the known theory of alternating current design, but the application of same to the larger generating and transmission systems of today in a way that enables the engineer to base his ideas and conclusions on a careful mathematical reasoning, so essential in all electrical work so new as extensive electrical systems, involving so many varying conditions and large sums of money.

Especially valuable are the sections taking up transmission features and a discussion of cables, on account of the practical discussion of inductance and capacity effects. The following heading of the various chapters indicate further the nature of treatment: Alternating Currents and their Representation; Physical Properties of Alternating Current Circuits; Analytic and Graphic Methods; Series Circuits; Parallel Circuits; General Electric Circuit; Magnetically Interlinked Electric Circuits; Capacity in Circuits; No-Load and Short-Circuit Diagrams; Load Diagram; Alternating Currents of Distorted Wave-Shape; Graphic Representation of Alternating Currents of Distorted Wave-Shape; Polyphase

Currents; Pressures and Currents in a Polyphase System; No-Load, Short-Circuit and Load Diagram of a Polyphase Current; Polyphase Currents of any Wave-Shape; Measurements of Electric Currents; Magnetic Properties of Iron; Fundamental Principles of Electrostatics; Electric Properties of Dielectrics and Constants of Electric Conductors.

This work has been translated into English by Stanley P. Smith, of London, being edited by J. L. La Cour, technical manager, Allmanna Svenska Electrical Company, Sweden.

FACTORY LIGHTING, by Clarence E. Clewell. Published by McGraw-Hill Book Company, 239 West 39th street, New York City. 156 pages. Price, $2.00.

The author of this work begins his preface as follows: "Good lighting is an aid to accurate workmanship and manufacturing output and contributes to a reduction in manufacturing costs. It has thus become a distinct feature in factory equipment." With this as the main idea always in mind, the author has discussed lighting considerations from no theoretical standpoint, but rather from the standpoint of the engineer installing the equipment, so that the desired results can be accomplished. Much of the data and information contained in the book is drawn from the actual experience of the author in design and installation of lighting systems. The practical viewpoint of the work is therefore distinctly noticeable in all considerations. Little space is devoted to lighting units, the design and installation of systems, particularly in the factory making up a large part of the book, although some space is given to office lighting, the information applying to designs for those types of offices usually found in factories and industrial plants. The arrangement of the book is excellent, and the wealth of data on lighting is fully indexed so that it can be readily referred to. The diagrams and illustrations of wiring plans, typical arrangements of lamps and spacings for lamps show at a glance important considerations and will be found of great value to the architect and electrical contractor.

The following chapter headings give a very good indication of the nature of treatment: 1. General Items and Requirements. 2. Illumination Design. 3. Lighting Installation Work. 4. Lighting Maintenance and Maintenance Records. 5. Office Lighting. 6. Drafting Room Lighting. 7. Factory Lighting. 8. Power House Lighting. 9. Iron and Steel Mill Lighting. 10. Machine Tool Lighting.

WEBSTER'S NEW INTERNATIONAL DICTIONARY. Dr. W. T. Harris, late U. S. Commissioner of Education, editor-in-chief. Published by G. S. C. Merriam Company, Springfield, Mass. 2,700 pages, 6,000 illustrations. Price, $12.00.

This work is a new creation containing over 400,000 defined words and phrases, arranged on a divided page with the important words above and the less important words below. This feature alone has created much favorable comment from prominent scholars and added much to the rapidity in the use of a dictionary. The new International is a reconstruction of the Webster's International Dictionary of 1890 with the supplement of 1900, the reputation of which needs no comment. The result of years of preparation, the dictionary in its present form embodies all that can be desired by the most critcial of users.

The principles of the revision as stated by the publishers are as follows: "A fuller application of the historical method to the old words of the language; an enlargement of the vocabulary, representing the new coinage incident to the world's advance in science, art, literature, exploration, politics; and the addition of general information concerning things as well as words, making the dictionary not only linguistic, but in its measure encyclopedic. In all these respects the aim has been to make the New International, in a much higher degree than its predecessor, at once a thesaurus for the scholar and a handbook for all who read or speak the English language."

These principles sum up in a general and accurate way the actual accomplishments that the new volume represents and we recommend it in no uncertain way to all our readers as one of the best works of the English language and one which should find its proper place in every library however large or small.

A valuable feature of this new work to the writer of this review is the presentation of certain "slang" phrases, and popular but unauthorized, terms of speech, enabling the user to know exactly the status of such terms as well as their true meaning. All in all, this is a wonderfully complete and dependable dictionary of our own tongue. D. H. B.

Personals.

EDSON O. SESSIONS, formerly of the firm of Woodmansee, Davidson and Sessions, has recently established a private consulting engineering office in the Marquette Bldg., Chicago, Ill. Mr. Sessions has had over 20 years in construction and engineering work and will handle from his new office examinations, reports and valuations on light, power, railroad and industrial properties as well as manage and supervise electrical work of all kinds in connection with such plants. He is a fellow of the A. I. E. E.; a member of A. S. M. E.; an associate member of A. S. C. E. and a member of the I. E. S.

MR. D. W. SMITH, lately with The Westinghouse Electric & Mfg. Company, has associated himself with The Robbins & Myers Company in the position of manager of motor sales.

MR. C. H. SANDERSON, who for the past several years has been engineer of switchboard and power station design for the Westinghouse Electric & Manufacturing Company at East Pittsburgh, has resigned his position to accept that of Chief Engineer of the Havana Electric Railway, Light & Power Company, Havana, Cuba. Mr. Sanderson is a graduate of Ohio State University and has been connected with the Westinghouse Company since 1900. A portion of this time was spent in the factory and drafting room from which he was transferred to the Engineering Department, and subsequently to his present position. Mr. Sanderson has been engaged on some of the largest switchboard and power station apparatus that the Electric Company has furnished.

MR. H. S. BLACK has been appointed manager of works of the Westinghouse Lamp Company, Bloomfield, N. J., to succeed R. H. Henderson, resigned. Mr. Black has had considerable experience in the engineering and manufacturing departments of the National Quality Lamp Division of the General Electric Company. For the last three years he has been directing the work of the St. Louis factory of this company in which he has been unusually successful.

MONTFORD MORRISON, of Atlanta, Ga., who has been engaged in consulting work for the past ten years on mechanical and electrical subjects has made temporary connections with the General Electric Company. He is now at the Atlanta office of this company, but will probably later be located at Schenectady, where he will act in a consulting capacity on the company's staff of physicists.

Industrial Items.

THE ARROW ELECTRIC COMPANY, of Hartford, Conn., has issued catalogue No. 16, of 96 pages, under date of September, 1913, devoted to wiring specialties. The catalogue is nearly twice the size of the last one issued, and contains much new material, such as data on interchangeable socket fittings, outlet box and sign rece tacles, snap and pull switches. Illustrations, descriptions and list prices are given for the different devices.

THE DETROIT FUSE & MFG. COMPANY, of Detroit, Mich., has issued a small folder which advocates the use of its Ironclad Fused Switch as protection to the operator of motor-driven machines. These switches can be provided with a locking device, which prevents it being thrown on by anyone who does not hold a key.

THE KERMEL APPARATUS COMPANY, 145 Main street, Cambridge, Mass., has issued a folder describing the new Kermel Portable A.C. and D.C. voltmeters, ammeters, volt-ammeters, and hotwire meters. This folder gives illustrations of the new instruments as well as descriptions and price data.

ALBERT AND J. M. ANDERSON MFG. CO., Boston Mass., has issued bulletins Nos. 29 and 30. The former is devoted to charging plugs and receptacles for charging storage batteries on electric vehicles, trucks and railway cars. The latter takes up automatic time switches.

THE U. S LIGHT & HEATING CO., Niagara Falls, N. Y. has issued bulletin 110 under date of August, 1913 which takes up in some detail independent electric light, low voltage storage battery systems. Types of plants and arrangement of equipment is given special consideration, specifications and wiring diagrams being included as well as cost data on complete equipments.

H. W. JOHNS-MANVILLE COMPANY has recently opened a branch office at Galveston, Texas. This company now has three offices in the Lone Star state, at Houston, Dallas and Galveston. At the last named place, in a modern brick warehouse of large proportions, will be consolidated the stock for distribution to the different offices and throughout the firm's Texas territory. The company plans to receive direct at this point heavy shipments by coastwise lines from New York. The steadily increasing trade with Central and South America also makes Galveston a convenient point of distribution.

THE APPLETON ELECTRIC COMPANY, Chicago, Ill., has issued a booklet fully listing and illustrating a complete line of "Unilets" switchboxes. Contractors will be interested in full information regarding these fittings and can secure a copy upon request to the company.

THE ROBBINS AND MYERS Co., of Springfield, Ohio, on August 9, held the annual picnic of its employes. The event was in charge of the "Advance Club" made up of department heads of the plant and the officials of the company. Some 2,000 people made up a long parade through the streets of Springfield, headed by a band. At the picnic grounds athletic events and other amusements were indulged in. The event was one that showed close relationship between employer and employe, a feature which is said to characterize the Robbins and Myers Company from a small factory of 100 men some 15 years ago to a modern plant of considerable size today.

THE TUNGSTOLIER WORKS o fthe General Electric Company, formerly located at Conneaut, Ohio, are now located at

Cleveland, Ohio. The plant occupied by the fixture works is known as the Ivanhoe Metal Works of General Electric Company and is situated on Ivanhoe Road in East Cleveland. Under the direction of Glenn C. Webster, general manager of the Tungstolier Works, whose genius for organization is recognized throughout the industrial world, the plant is organized and systematized to operate at highest efficiency. From the designing room to the shipping room the effort of the organization is to turn out the products in the best possible manner, in the quickest possible time, under the highest possible efficiency. The headquarters of the Tungstoiler sales organization are located in the down-town district, at Euclid avenue and 19th street, where show rooms have been equipped.

THE BECK ELECTRICAL CONSTRUCTION COMPANY, of 204 Audens Bldg., Minneapolis, Minn., has been formed with V. S. Beck at the head. Mr Beck has held various positions with several of the Stone & Webster Companies in the middle west, most recently being associated with the Mississippi River Power Company, at Keokuk, Iowa. The new company will do a general engineering contracting business, making a specialty of electric power plant and transmission line work. The company will also act as manufacturers' agents and has already secured the agency for several prominent engineering concerns. Members of this company have had considerable experience in all kinds of development work and the company should be of value to companies and cities both in investigating the feasibility of and in the construction of electric power plants.

THE WESTINGHOUSE ELECTRIC & MFG. COMPANY, has issued folder 4187 covering type KB section insulator. The iron parts of this device are sherardized, and wearing parts are renewable. It is said to be an unusually strong and light weight insulator. Leaflet No. 3569 describes and illustrates the shipment of transformers in tanks with oil. This method has become very prevalent in the shipment of large transformers, enabling them to be installed immediately upon arrival at destination.

THE GENERAL INSULATE COMPANY, 1008-1014 Atlantic avenue, Brooklyn, N. Y., has recently appointed Wm. J. McKenna Company, of No. 9 South Clinton street, Chicago, middle states representative in place of A. J. Cox Company. Ohio, Michigan and Indiana will be covered hereafter by Ralph S. Mueller, of 423 High avenue, S. E. Cleveland, as heretofore. The company has also in recent months established a Pacific Coast agency, represented in that section by H. R. Dalitz, of 622 First avenue, West, Seattle, Washington.

TESTING TRANSFORMERS. The American Transformer Co., 143 to 153 Miller street, Newark, N. J., issued under date of July this year, a comprehensive bulletin No. 570 on high voltage testing and complete testing sets. A large part of the bulletin describes high voltage testing transformers up to 50 Kva and 300,000 volts for general high voltage testing, such as large insulators, transmission line apparatus, high voltage laboratory experiments in connection with Corona and other phenomena.

ELECTRIFICATION OF RAILROADS. The Westinghouse Electric & Manufacturing Company has just issued a leaflet covering the electrification of the Pennsylvania New York extension of the Pennsylvania Railroad, and the New York, New Haven & Hartford Railroad, respectively. These leaflets cover the salient points of both roads together with a description of the more important parts of the equipment. These leaflets are well illustrated and contain maps showing the territory covered by both the electrified systems.

COMMUTATING-POLE CONVERTERS. Descriptive Leaflet No. 3517, issued by the Westinghouse Electric & Mfg. Co., covers the Commutating-Pole Rotary Converters. This leaflet describes in some detail this type of converter, explaining its advantages with particular reference to the commutating pole and the method of starting.

ELECTRIC ARC WELDING PROCESSES. The Industrial and Power Department of the Westinghouse Electric & Mfg. Co., has issued a reprint of an article recently appearing in the technical press by Mr. C. B. Auel, director of processes, standards and materials, for the Westinghouse Company. This paper, which is well illustrated, explains in an interesting manner the different processes employed in arc welding, their advantages and limitations, and gives some interesting figures of comparison of arc and blacksmith welding.

THE NATIONAL INDIA RUBBER CO., Bristol, R. I., announces the opening of a chicago warehouse with a stock of insulated wires and cables for all electrical requirements, making possible carload shipments from this point. The warehouse and Chicago office will be located at Van Buren and Clinton streets, Chicago.

HEMMING MFG. CO., Garfield, N. J., announce that owing to the steady increase in the demand for heat-resisting molded insulation, an addition will be made to their plant trebling its capacity. Contracts for the necessary buildings and equipment have been placed and will be rushed to completion.

EXHAUST FANS. Bulletin No. 246 issued by Sprague Electric Works of General Electric Company, discusses types of ventilating outfits, giving illustrations and data.

ELECTRICAL ENGINEERING

PUBLISHED MONTHLY

Vol. 45. NOVEMBER, 1913 No. 1.

PUBLICATION OFFICE
DALTON, GA.

EDITORIAL and ADVERTISING DEPARTMENTS
GRANT BUILDING ATLANTA, GA.

SUBSCRIPTION RATES

Domestic........$1.00 For Two Years

Canada........$1.00 Per Year

Foreign........$1.50 Per Year

Complaints of failure to receive ELECTRICAL ENGINEERING regularly or of any errors of any nature, should be promptly made to the Atlanta office.

Advertising copy or change orders for standing advertisements must reach the Atlanta office by the 5th of the month preceding the month of publication.

Entered at Dalton, Ga., Postoffice as Second-class Matter.

STATEMENT

of the ownership, management, etc., of ELECTRICAL ENGINEERING, published monthly at Dalton, Ga., required by the act of August 24th, 1912.

Editor: D. H. Braymer, Atlanta, Ga.
Business Manager. W. J. Rooke, Atlanta, Ga.
Publisher. Cotton Publishing Co., Atlanta, Ga.
Owners: W. R. C. Smith, Atlanta, Ga.; C. S. McMahan, Atlanta, Georgia
There are no mortgagees or other security holders.

COTTON PUBLISHING COMPANY.
W. J. Rooke, Bus. Mgr.

Sworn to and subscribed before me
this 9th day of October, 1913.
J. C. MARTIN.
Notary Public, Fulton County, Ga.
My commission expires June 24th, 1916.

CONTENTS.

Illuminating Engineering Society and the Illuminating Engineer.

When the Illuminating Engineering Society was organized in 1906, there was some ground on which to base a doubtful opinion of the need and possible future of a national society to study illumination exclusively. It was also logical to question the future success of an electrical engineer who should attempt a specialty of this work and pose as an illuminating engineer. In view of the remarkable developments during the past seven years, however, in all lighting fields and the direct results of the efforts of those engineers who had a strong conviction of belief in illumination matters, men who are still the backbone of the society's movements and been responsible for the enlistment of the aid of others and built it up along such substantial lines that now it has not only a high standing among all engineering bodies in this country but abroad as well; in view of all these facts we repeat, who can now advance or even refer in a questioning attitude to the work of one who gives his entire time to illumination matters?

During the latter part of August of this year, an International Illuminating Commission was organized at Berlin, being a reorganization of the International Photometrical Commission. At that time ten countries were represented by 44 delegates all vitally interested in the work. In America this body will have the fullest co-operation of the Illuminating Engineering Society, the American Gas Institute, and the American Institute of Electrical Engineers and it in turn will aid in the solution of illuminating problems and the carrying on of investigations to bring about some uniformity in the design and application of electric, gas and other illuminating units. Illumination is, therefore, the subject of study throughout the world. The field for illuminating engineering is a definite one, the duties of the illuminating engineer are now fairly well established, yet those who are in a position to know, give very conservative guesses of what the future holds. The truth of the present situation is ably expressed in the opening paragraph of the Illuminating Engineering Society's progress report, as follows: "During the past year the science of illumination has probably made greater progress than any other period of its history. Few radical changes or developments have been made in connection with light sources, yet improvements have been made in mechanical construction of present systems, resulting in increased efficiency, while illumination has become the subject of study by physicists, oculists, architects, legislative bodies and others as never before."

The courts are beginning to exert an indirect influence for better illumination for where large numbers of operatives are employed it is often ruled in accident cases that come before them that insufficient illumination is contributory negligence. It is well-known that many lawyers are eager to secure for their clients the largest monitary value possible for an injury, however slight, and the amount so collected in one year would go a long way toward installing and maintaining better systems of illumination in mills and factories. Who can deny that such systems would not only largely reduce accidents but improve the general health of workers through protecting their vision?

Again, the question of efficiency in manufacturing establishments is aiding in the promotion of good lighting for now it is generally recognized that poor lighting through the use of antequated or inefficient units, is responsible for a certain amount of waste and spoilage that in dollars and cents amounts to a considerable sum in a year. One authority has placed the value of spoilage in certain mills and factories at $30,000,000 annually. At the recent convention of the Iron and Steel Electrical Engineers' Association, it was shown that there is still in operation in the 76 plants making up the association membership about 24,000 kilowatts of carbon arc and carbon incandescent lamps. On the basis of the average hours use per year for this industry and an energy rate of 1½ cents per kilowatt-hour, these lamps entail an energy and maintenance cost of $1,500,000 per year. If modern systems of the best efficiency were designed for these cases and installed, a conservative opinion places the saving at two-thirds, or in other words, $1,000,000 is wasted by 76 concerns annually through the use of obsolete systems and units.

Such data is, to be sure, based upon certain assumptions, yet the average operating conditions of enough well designed and efficient systems are now at hand to make it absolutely necessary for any plant that recognizes inefficient operation as a waste, as it actually is, to investigate their particular lighting conditions with a view to making them the best possible, regardless of initial cost. If old types of units are in use with cheap and inefficient reflectors, under conditions that are peculiar either as to building construction or nature of operations carried on, here is a case where the illuminating engineer should be consulted just as truly as the physician should be consulted in a case of complicated sickness, because he should know what the trouble is and how to best remedy it.

The Illuminating Engineering Society stands for the advancement of a useful science and a practical art. Every illuminating engineer is its rightful representative, agent, promoter or what not and both should be thoughtfully encouraged and supported.

An Important Southern Convention.

The fifth annual meeting of the Southern Commercial Congress, held at Mobile, Ala., from October the twenty-seventh to the thirtieth, was the most important and interesting event in the history of this useful organization. In former conventions, the Congress has stressed the need and the opportunity of developing the South's material resources, its soil and forests and streams and mines, and of upbuilding its educational interests. In the convention just past particular emphasis was given to the question of practical means for utilizing the trade advantages soon to be offered the South by the opening of the Panama canal.

Among the other subjects of current interest was an address by President Wilson on rural credits. The American Commission of Agricultural Co-operation, which spent several months this year in Europe studying farm methods and particularly farm economics, made a report. The matter of chief consideration, however, and about which other topics were grouped, was the relationship of the great canal to Southern industry and commerce.

The Southern Commercial Congress now has a definite bearing upon this one great practical issue in which every state and every city of the South are now peculiarly concerned. From its deliberations, there will doubtless evolve some adequate plan under which all parts and all interests of this section can co-operate for their common advantage in the new commercial era that is at hand. It need scarcely be added that many Southern cities were well represented at the Mobile convention and will also be represented in the subsequent trade expedition to Latin American countries which will be conducted under the auspices of the Congress. The South must prepare for the opening of the canal, if it is duly to enjoy its share of opportunity; and the Congress offers direct means for united, effective preparation.

Electric Railway Operation, the Public and the Fare.

The interest in and discussion on, the ever present subject of a public utility's relations with the public and employees, at the recent Atlantic City convention of the American Electric Railway Association, a report of which is found elsewhere in this issue, deserves special comment and commendation. The gigantic problem that confronts the management of public utilities today and especially those undertaking the task of urban and interurban transportation of human freight, is the close connection between efficient administration and operation and commercial success. The main feature that makes this problem gigantic is the fact that there is a definite economic dividing line between profit and loss that cannot always be definitely determined for future operation on account of one important unknown quantity that frequently looms up and blurs the vision as regards other factors, namely, relations with the public. The good will of a traveling public, while a most intangible asset, is incalculable and must be fostered by every possible legitimate method and act that the public utility commands or can devise. The confidence of a public whose harmonious relations with the utility are of a mutually cordial nature, is only now beginning to be valued, respected and protected for it has become obvious that ideal operating conditions will never be attained unless these relations generally exist.

With reference to the financial aspect, and how to attain a condition of maximum commercial efficiency, which term may be considered to include "financial stability," "profitable venture" and "car service efficiency," many important factors contribute. Of great importance is a suitable fare, the lowest fare possible which will permit of an adequate financial and reasonable net return. A low fare is obviously so attractive to the traveling public that in practical operation it seldom fails to create an increased passenger traffic thus establishing the axiom that the lower the fare, the greater the traffic. This does not necessarily mean, however, that a low fare always results in increased net profits, for obviously a fare may be so low as to cause unprofitable administration. The dividing line between a low fare, increased transportation and car service, with its resulting profit or loss, is very difficult to determine, thus the importance of a more complete knowledge of the conditions involved. The best fare and car service requirements in extended districts outside of city limits, is at this time most important and deserving of a very careful statistical study.

While a low fare or increased transportation distances and facilities are most essential considerations and always attended by the greatest favor with the traveling public, on the other hand a policy in this direction that is more or less experimental is exceedingly dangerous, for an increase in fare or decrease in facilities or even a return to previous conditions is sure to sever the harmonious relations promoted by a liberal tendency of policy if it is not altogether disturbed and prevented by commission regulation. A retracing of steps already taken through reduction of fare or decreasing of facilities is next to impossible at the present time in those states having public service regulation as the files of decisions and orders of public service commissions plainly show. The exception to a decision that does not favor a complaining public is rare indeed and usually takes the form of an order to either increase facilities or reduce the fare or both. Thus it is that the public utility is expected to be exceedingly wise, prudent and thoroughly advised on their steps toward apparent progress and a penalty placed upon their desire to give the best possible service when this is at all financially problematic.

While the power placed in the control of public service Commissions is extensive and their decisions largely in favor of the public, it must be admitted that such regulation is not to the ultimate disadvantage of the public utility. No unbiased broadminded person can logically criticise the basis of their good work or claim unfair treatment at their hands, their idea being to demand an equitable adjustment between the public and the utility and their orders and acts are designed to give a square deal to both interested parties.

The proposition, therefore, before the public utility operating an electric railway now and in the immediate future, is one of a purely financial aspect as regards the establishment of a permanent and stable enterprise. How this proposition is to be worked out is yet to be determined. In regard to it, President George H. Harries of the American Electric Railway Association had the following to say in his address at Atlantic City emphasizing the need of deriving in some manner an increased revenue from fares:

"Unless there be well night miraculous intervention, and miracles which we would deem desirable seem to have no affinity with the electric railway business, there is promise that to many companies will speedily come the time when the financially "irresistible" will collide with the popularly "immovable." It will not be a synchronized general catastrophe, but a succession of more or less disastrous experiences, now here, now there, resulting, on one hand, from the broadening of city borders and the consequent extension of lines, forcible manipulation of transfer points, compulsory wage increase, conscienceless taxation, arbitrary and unreasonable service requirements and growing cost of construction and maintenance, and on the other hand, from the fixed, or rather the diminishing fare. We operate under franchises by which we are bridled, bitted and saddled, and sometimes hobbled. While we have no present power to demand at least living wages in return for our investment and labor, there is nothing to prevent us talking of the increased rate of fare which must surely come to many company treasuries if anything like justice is to prevail and we are to survive."

The important factors involved, are adequate legitimate provisions to fulfill any obligations due to a sinking fund and interest thereon, interest on bonded indebtedness and periodical redemption of bonds, depreciation, reserve, and renewal funds. Of the latter, probably the reserve fund is the most important and no management should ever neglect its provision. From the operating standpoint, the lowest possible fare, efficient transportation facilities, low operating cost, low maintenance cost, frequent and periodic inspection of all apparatus and appliances to minimize accidents and accruing damage suits, prevention and stoppage of the various leaks in administration, which are a continual drain in large undertakings, and a close study of statistics pertaining to every section of the enterprise, as well as a general allaround efficiency in organization, administration and operation, are the important problems that the future must solve.

William R. Bowker.

Securing Maximum Economy from Motor Trucks.

After replacing a horse delivery or haulage system by a motor vehicle installation, some business houses have found that they did not affect the saving, or accomplish the results which they counted upon. In a good many instances, the cases of this kind have been investigated by practical transportation men at the request of the motor truck owners and in almost all of them it has developed that the reason for the unsatisfactory service of the motor vehicles, from the standpoint of earning capacity is not inherent in the trucks, but rather in the methods which surround their use. In other words, the handling of the merchandise oftentimes before it is loaded on the truck is not properly speeded up or changed to conform with those characteristics of endurance and rapid motion which should be taken full advantage of in the use of either one motor truck or a fleet.

The motor truck needs no periods of rest. It is simply a machine which can be worked at all times to full capacity, and the work of a truck must be carefully planned with this in mind. Big earnings are secured from motor trucks only when they are kept constantly at work, carrying as nearly as possible full capacity loads. To realize greatest economies, delays must be eliminated at the loading platform. If the old methods of handling merchandise have made customary the loading of a machine slowly, piece by piece, some method should be devised for loading small packages before the machine is backed up to the shipping platform. When this is done the motor truck investment is not standing idle, and the truck may be worked in a way which will produce greatest satisfaction and maximum earnings.

As an indication of how this problem is solved by one user of motor trucks. A truck manufacturer gives the following illustration: "A large wholesale grocery house in Los Angeles has devised a unique scheme which avoids all delay at the shipping platform. This concern operates 10 vehicles, and their plan of rapid loading has increased the earning power of the fleet fully 30 per cent. Sectional half bodies of equal size are employed. These box-like sections are fitted with small wheels so that they may be trundled about on the various warehouse floors. Overhead on each of the floors are trolley beams running to and connecting with similar beams on a large elevator. After the half bodies have been loaded with various goods for delivery on the warehouse floors, they are suspended on an electric trolley which runs on the overhead beams. From positions on the different floors, the bodies are carried to the elevator, lowered to the ground floor and run out on the shipping platform. Two half bodies make a full truck load. By this plan, it is plain that all loading and routing is done within the warehouse and the entire working day of the motor trucks is employed in actual delivery operations."

It is possible to devise labor and time-saving devices, such as this, for almost every kind of business and the owner of motor trucks, looking to secure the greatest profit from his machines, can benefit by considering his own methods and determining time-saving improvements that should be brought about.

The Hydroelectric Development of Ozark Power and Water Company on the White River, Mo.

(Contributed Exclusively to Electrical Engineering)

BY GEORGE P. GARRETT.

Electrical Energy Transmitted at 66,000 Volts, Over 150 Miles of New Line, Supplying Light and Power to the World's Greatest Lead and Zinc Mining District and to Cities and Towns in Southwestern Missouri.

THE White River, rising in the Ozark mountains and fed by many living tributaries, has a fall averaging two feet per mile with uniformly steep, high banks or cliffs on either side for several hundred miles through southern Missouri and northern Arkansas, thus affording a favorable site for a fifty-foot dam to, approximately, each twenty-five or thirty miles of its length. The fuel used in this district includes coal, natural gas and fuel oil. The coal supply is expensive and uncertain, due to strikes at mines and delayed shipments; also the gas supply is short in winter and the delivery of fuel oil is not dependable in tank car shipments. This high cost and uncertain delivery of all fuel for generating electrical power by steam to supply a demand for same by the mining and manufacturing industries of southwestern Missouri, a demand that has over-taxed the capacities of the plants of the Empire District Electric Company, the chief distributor of power in this district, has caused the development of the water power sites on the White river to be investigated. The result is that some half dozen complete installations are planned, each to have considerable pondage and act as storage reservoirs for plants further down stream. The first of these developments started in April, 1912, was placed in operation August 22, of this year, and is described in what follows:

The development is located in Taney county, Mo., about three miles up-stream from Forsyth and seventeen miles down-stream from Branson, the nearest railroad station. As already stated the power from this development will aid the Empire District Electric Company, operated by the Doherty Operating Company, of New York City, particularly in the Joplin district, the power being already sold to this Company and the Springfield Gas and Electric Company at their switchboards. The H. L. Doherty and Company of New York City owns the developing company, the Ozark Power and Water Company, having purchased the site from parties who made some of the preliminary surveys and stream flow gaugings.

NATURAL ADVANTAGES.

At the site selected for the dam and power house, a vertical cliff towers two hundred feet high on one side of the stream and the land rises on the other side to an elevation of seventy-five feet some twelve hundred feet from the base of the cliff. The stream being narrow and very swift, afforded natural facilities for the tailrace. Sand and gravel, of almost exactly the correct proportions to be used without screening and re-mixing, was obtained near the site, handled with a derrick and "clam-shell" grab bucket and conveyed by inclined track to the mixing machines. The concrete made from this material is very dense, and the power house head-

MAP SHOWING ROUTE OF TRANSMISSION SYSTEM.

FIG. 1. DOWN-STREAM SIDE OF POWER HOUSE AND DAM.

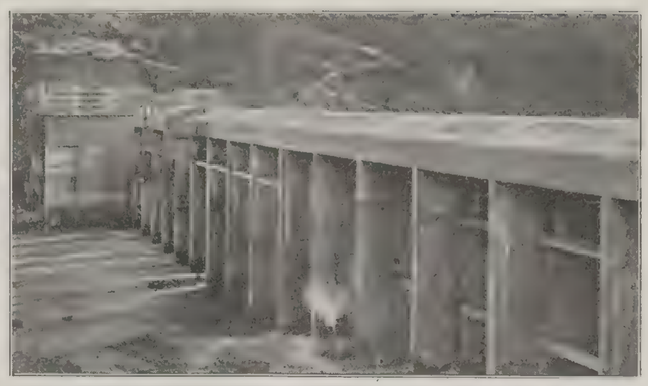


FIG. 2. DOWN-STREAM SIDE OF POWER HOUSE AND EAST SECTION OF DAM DURING CONSTRCTION, SHOWING PASSAGEWAY THROUGH DAM.

walls and dam show no leakage under pressure of the fifty foot head. Most of the timber used for building coffer-dams and other temporary structures was obtained by clearing the land to be submerged by the lake.

One of the greatest difficulties encountered during the construction of the dam and power house, was the transportation of material and supplies from the railroad, at Branson, to the site. Some of the material and erecting machinery was hauled on wagons over seven miles of rough, mountain road, crossing the river twice by ford or ferry, which, together with steep grades, made freighting difficult. By means of two sixty horsepower gasoline power boats and fourteen ten-ton barges much of the material and supplies was floated down the river, a distance of seventeen miles, during high water or flood stage. After the dam was closed, the heavy machinery for the power house was transferred from the cars at Branson on thirty-ton barges, and transferred from the barges to the power house.

DAM AND POWER HOUSE.

During the construction of the dam and power house, approximately seventy thousand cubic yards of earth and twenty thousand cubic yards of rock were excavated. The dam is of the Ambursen type, fifty feet high, and nine hundred feet in length, including the power house head-walls and the large cellular concrete abutment at the west end, which extends twenty-five higher than the spillway, or crest of the dam. From this abutment, an embankment of earth with a concrete core-wall, four hundred feet in length, extends to high ground to prevent flood waters from getting around the end of the dam.

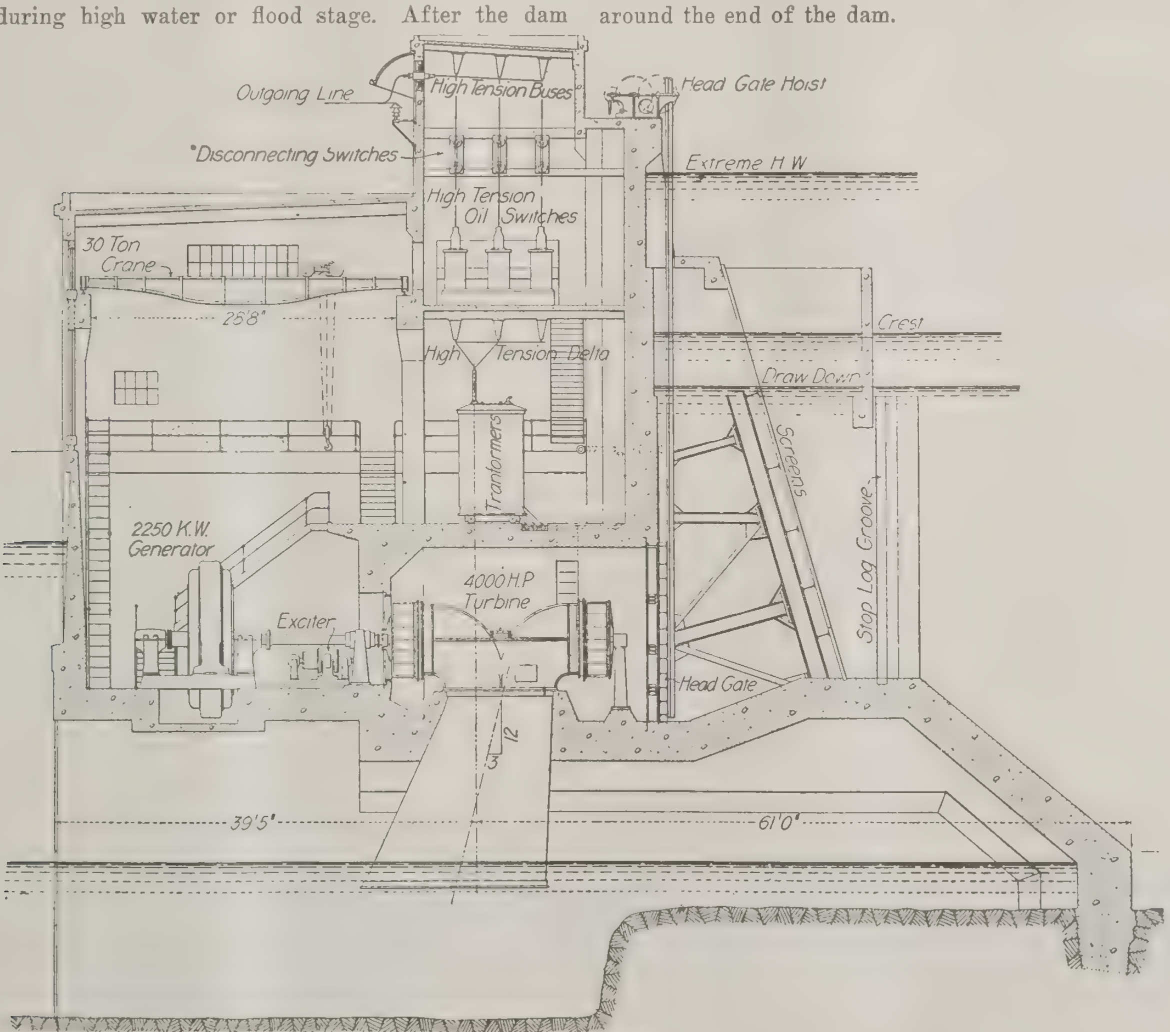


FIG. 3. SECTION THROUGH A MAIN UNIT IN GENERATING STATION.

The reinforced concrete deck, which forms the up-stream side of the dam, is supported at an angle of about forty-five degrees from the vertical, by concrete piers or buttresses seated on bed-rock, and spaced twenty feet apart throughout the length of the dam. The outline of these buttresses is practically a right triangle, and placed with the vertical line on the down-stream side, and the hypotenuse on the up-stream side. A passage-way through the buttresses serves the double purpose of a walk-way across the river and a means, through the openings, of supplying air behind the water falling over the spillway, thus breaking the insidious vacuum which is a menace to the stability of river structures.

The White River is subject to extremely high fluctuations, the floods coming with remarkable suddenness. It was, therefore, decided to provide a spillway six hundred feet in length, which is twice the width of the natural channel of the river at the site. Only a few days after the closure of the dam, it withstood a severe flood condition. A rapid rise in the river caused the water to pour over the spillway to a depth of seven feet and four inches, carrying with it an enormous amount of drift wood picked up from the banks of the newly made lake. No damage whatever has resulted from the high waters, and the dam is in perfect condition.

The dam impounds a body of water forming a lake above it twenty-three miles in length, approximately ten square miles, with an average depth of twenty feet, when the river is at normal stage. It is provided with a fish-ladder of the latest improved type, which permits game fish to pass over the structure at any time of the year. Should it become necessary to close all the head gates, at a time when no water is going over the crest of the spillway, two five-foot, motor-operated sluice gates provide a passage-way for the fish, as required by the laws of the state.

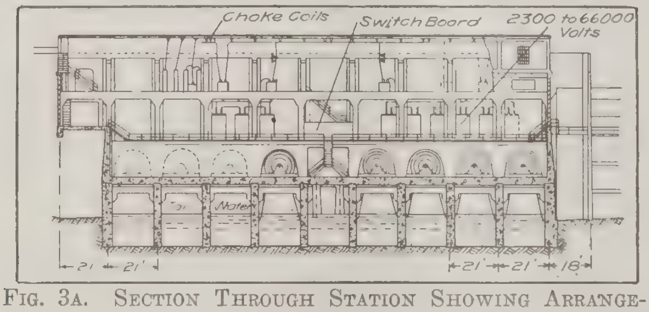


Fig. 3a. Section Through Station Showing Arrangement of Equipment.

The power house is fifty feet wide by two hundred feet in length, and extends to a height of seventy-eight feet above the tail-water level. It is seated on bed-rock at the base of the cliff, and extends to the middle of the old river channel, connecting with the east end of the dam, the head-walls of the power house forming a part of the dam. The entire structure forming the barrier across the river is constructed of concrete, reinforced with steel and substantially seated on solid rock; thirty thousand cubic yards of concrete, and one and a half million pounds of steel being used. Figs. 1 and 2 give a good idea of the structure.

STATION EQUIPMENT.

All the station equipment, including transformers, lightning arresters and high tension circuit-breakers, are located in one building, arranged so as to afford convenience and more effective operation. All rooms, balconies and compartments are spacious and conveniently arranged, and fully equipped for the handling and controlling the apparatus they contain.

The power house contains nine wheel-chambers, each being provided with steel head-gates, which may be operated by motor or hand. Each head-gate contains two small filler-gates, which equalize the pressure and overcome friction when the gates are being raised. Provisions are made for eight main units, of which only five will be installed at the present time.

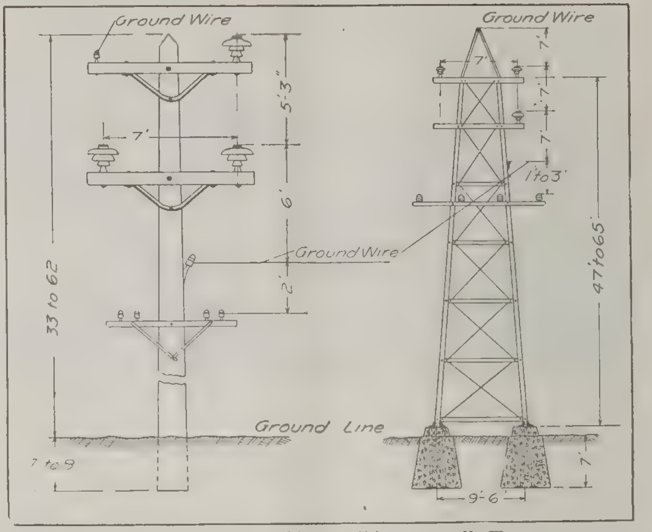


Fig. 4. Standard 66,000-Volt "A-frame" Transmission Tower. Regular 66,000-Volt Pole Top Arrangement.

Each water-wheel unit consists of a pair of S. Morgan Smith turbines having a capacity of 3600 Hp., at 214 rpm., under the mean effective head of fifty feet. However they will operate at working heads of forty to fifty-four feet, the delivered energy varying from 2600 Hp. to 4,000 Hp. Each turbine is mounted on a horizontal shaft and set in a closed concrete flume. The draft tubes are made of plate steel, eighteen feet long and fourteen feet in diameter at the bottom, and are securely imbedded in the concrete foundation walls of the power house. Each of the two exciter units installed, consists of a 200 Hp. S. Morgan Smith turbine direct connected to a 175-Kw., 125-volt D. C. generator,

Fig. 5. Standard 66,000-Volt Anchor, or Strain Tower.

operating at 600 rpm. The speed of each unit is controlled by an individual Lombard governor.

The generators are of the General Electric, three-phase, twenty-five-cycle, horizontal type, and are coupled directly to the turbine shafts. Each generator is rated at 2250 Kva., and generates current at 2300 volts. They are set with their centers twenty-one feet above the tail-water level and are protected by the reinforced concrete floor and walls from flood-waters. The operating switch-board is located on the transformer balcony, over-looking the generator pit.

The high-tension room, which is located above the transformer balcony, contains the high-tension buses and all high-tension wiring; also the lightning arresters and electrically operated oil switches that control the out-going lines. The transformer equipment of the power house consists of nine 2000-Kva. transformers arranged in three banks, stepping the generated voltage of 2300 up to 66,000, at which it is transmitted. Electrolytic lightning arresters, and the usual arrangement of choke coils, located in the high-tension room, afford protection to the station apparatus from lightning discharges, which are frequently severe and troublesome throughout this section of the country. The general lay-out of the high-tension wiring and the scheme of connections from the generators through the transformers to the transmission lines does not differ much from standard practice.

The power house equipment was thoroughly tested and started in operation on Aug. 22, 1913, since which time it has rendered continuous and very satisfactory service.

TRANSMISSION SYSTEM.

The general map shows the route of the transmission system, which comprises 150 miles of line, 23 miles of which is carried on steel towers and 127 miles on cedar poles. From the power house, the line crosses the river on two specially constructed steel towers, similar to the one shown in Fig. 5, one being placed at the power house and the other on the cellular concrete abutment, at the west end of the dam. The first twenty-one miles of the line is carried on steel towers across mountainous country, where small streams, ravines and gulches cause the span to vary from 450 to 980 feet in length. The remainder of the line is carried on white cedar poles and follows along county highways to Springfield, a distance of twenty-nine miles, and from there to Joplin, a distance of one hundred miles. Flexible steel poles, shown in Fig. 7, were used instead of wood poles in the last two miles of line, from the Newton county line to the Joplin sub-station, where the Ozark Power & Water Company's transmission line connects, through step-down transformers, with the Empire District Electric Company's 33,000-volt system.

The route of the transmission line is parallel to traveled roads wherever possible, in order to reduce the transportation, maintenance and patrol costs to a minimum. In selecting the route, care was taken to follow the line of towns and the mining district, which lies south of a direct line between Joplin and Springfield. The sub-station sites and right-of-way was acquired upon the "perpetual" plan, giving the company the right to enter upon property and construct, maintain, operate, repair and patrol the transmission line. Patrol rights were purchased only on cross-country sections, not being needed where the line follows highways.

Three types of steel towers were used for the line, namly, the flexible "A-frame," shown in Fig. 4, the rigid square strain, or anchor tower, shown in Fig. 5, and the "dead-end," or switching tower, shown in Fig. 6. In ordinary construction on level ground, the towers are spaced on an average of 450 feet apart, but in rough country where ravines, gulches and streams are crossed, the span distance

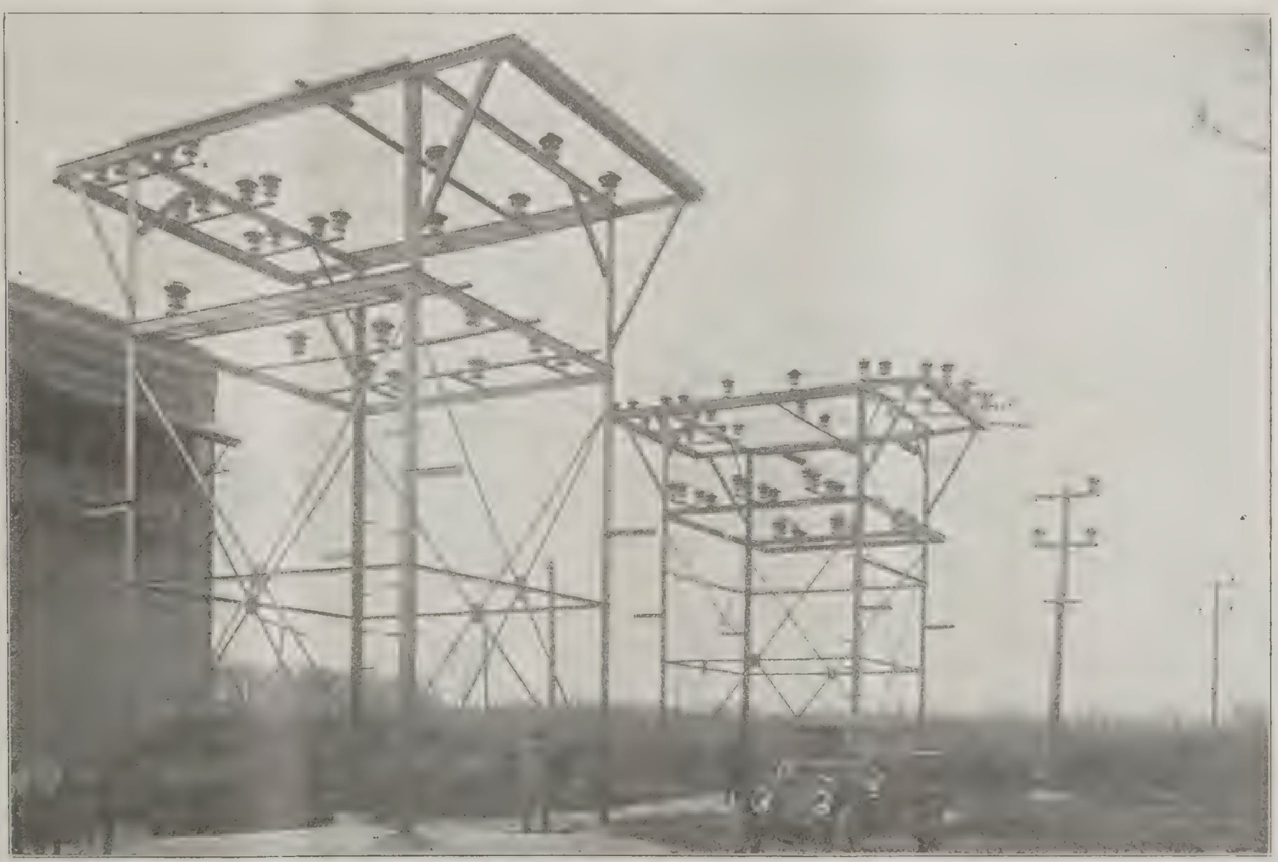


Fig. 6. 66,000-Volt Switching Towers and Substation Entrance (incomplete), also Showing Dead-Ending and Pole Line Construction.

Fig. 7. 66,000-Volt Flexible Steel Pole Line, and 33,000-Volt Wood Pole Line.

necessarily varies from 450 to 980 feet, which is the maximum span. The height of the "A-frame" towers vary from 47 feet to 65 feet, owing to the elevation of the land, and in order to obtain a "grade" of the line. The legs are secured by bed-bolts to solid concrete pillars, which are spaced 9 feet 6 inches apart, center-to-center, and set to a depth of 7 feet in the ground, except where solid rock was encountered near the surface, making it necessary to anchor the bed-bolts in the solid rock.

The concrete pillars were formed by making an excavation of the dimensions desired for the pillar, then placing the bed-bolts in position and filling the excavation with concrete, thus reinforcing the pillars with the bed-bolts. Wooden forms were used to mould the pillars to the necessary height above the ground, to provide a finished appearance and a level footing for the towers.

A square, or anchor tower, (Fig. 5), is used in each mile of the tower line to equalize the strain of the conductors and strengthen the line. The type of tower shown in Fig. 6 is used at all right-angles, dead-ends and switching points, throughout the entire length of the line. These towers are very rigid and so constructed that they are wholly self-supporting without the aid of "over-head" or "back-guys." The legs are secured to the heavy concrete pillars by means of 1-inch and 1¼-inch bed-bolts. These pillars are built up similar to those used for the "A-frame" towers, except being heavier. They are also spaced 9 feet, 6 inches, center to center, and at right angles. The average weight of the "A-frame" tower is 1200 pounds, and the square tower 2300 pounds. A specially prepared paint protects the surface of the towers from the weather.

The supports in the wood pole line are spaced 150 feet apart and vary from 40 feet to 70 feet in height, according to the elevation of the land traversed by the line. Poles having tops smaller than eight inches in diameter were not permitted to be used in the line. The roof and gains of all poles were painted, and the butts were treated with wood preserver to prevent decay.

TRANSMISSION LINE INSULATORS.

Pin type porcelain insulators of 90,000-volt design, were used on the entire system, except for dead-ends. For the purpose of making a service test of the different makes of insulators used, each make was placed in a separate section of the line. The insulators used on the tower line were of the R. Thomas & Sons Co.'s make, The Locke Insulator Mfg. Co., and Ohio Brass Co., insulators being used on separate sections of the wood pole line. All dead-ends were made on Ohio Brass suspension type insulators, six units being used for each dead-end.

The cross-arms used on the pole line are of select straight grained fir, 4¼-inches by 6-inches, and 8-feet in length, being secured to the poles by ¾-inch thru-bolts. All hardware used in the construction of the pole line, is protected by galvanizing.

LINE CONDUCTORS.

The line between the power house and Springfield carries three No. 2/0 bare, stranded, hard drawn copper conductors, which are spaced as shown in Fig. 4, giving a clearance of 7-feet between phases, on the tower line, and 7-feet horizontally by 5 feet 3 inches vertically on the pole line, as shown in Fig. 4. The conductors were pulled to a tension of 1060 pounds at 60 degrees Fahr., thus giving to a 500-foot span a sag of 7-feet, 6 inches. The conductors have a "right-over-left" rolling transportation in each two miles of the entire length of the line, and are secured to the insulators by means of soft drawn copper ties, except at river and gulch crossings, where clamps were substituted.

Two 5/16-inch Siemens-Martin galvanized stranded ground wires are carried on the tower line to protect it from lightning and other electrical disturbances. The ground wires carried on the pole line are of No. 6 galvanized iron. On the tower line, one ground wire is clamped to the apex of the tower, while on the pole line it occupies a pin on one end of the top cross-arm. The other ground wire is carried between the high-tension conductors and the telephone lines, thus serving the double purpose of protecting the telephone system from lightning and reducing the induction caused by the high-tension line.

Two telephone circuits are maintained throughout the

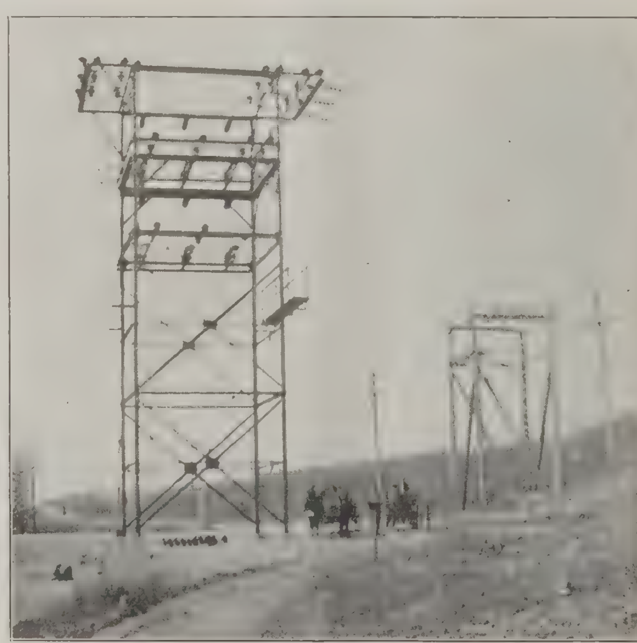


Fig. 8. Standard 66,000-Volt Switching Tower.

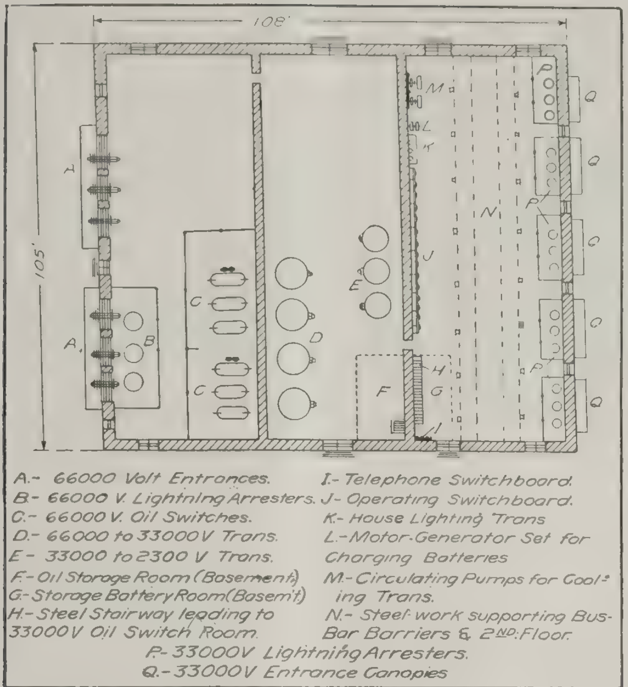


FIG. 9. FLOOR PLAN OF THE JOPLIN SUB-STATION.

extent of the transmission system, and are carried 8 feet below the lower high-tension arm. These circuits, on the tower line, are constructed of No. 8 B. & S. gage, copper clad wire, and transposed at every span, while on the pole line No. 10 hard drawn copper was used and the transposed at every second span. The familiar "figure 8 dead-end" transposition was used, as it was considered the most effective and practical. More than twenty telephones, of Kellogg make, are installed on the system and giving excellent service. In addition to the protection from lightning afforded by the ground wire carried above the telephone lines, each 'phone is provided with lightning arresters of the Vac-M giant type, which have proven very satisfactory.

The construction of the wood pole line between Springfield and Joplin is practically the same as between Ozark and Springfield, except that No. 1/0 bare solid hard drawn copper was used for the conductors, instead of No. 2/0 stranded. The last two miles of line, (between Newton county and the Joplin sub-station), is carried on 50-foot flexible steel poles as shown in Fig. 7. These poles are secured by bed-bolts to reinforced concrete pillars, which are set seven feet in the ground. The line is necessarily doubled over this section, to provide for a special switching arrangement located at the Newton county line, and also for a contemplated extension from that point. Switching towers are so installed that the line can be divided into seven mile sections, for locating and repairing breakdowns. The line patrolmen reside near switching stations, and with telephones in their homes and portable test sets, which they carry while patroling the line, they are enabled to render effective service at any moment it may be required.

SUB-STATIONS.

Sub-stations are located along the transmission line, as shown on the general map, at Ozark, Springfield, Republic, Aurora, Monett, Wentworth, Diamondville and Joplin.

The ultimate transformer capacity of the Springfield substation will be 9,000 Kw., only one-half of which is installed at the present time. The transformers are of oil-insulated, water-cooled type, and step the current down from 66,000 volts to 2300 volts. Two 1250-Kw., frequency changers deliver 60-cycle current to the local Springfield company for

FIG. 10. JOPLIN SUB-STATION, SHOWING 33,000-VOLT ENTRANCES.

commercial distribution, and a 500-Kw. rotary converter furnishes power for the electric railway system. The method of control is very much the same as that of the Joplin sub-station, which is later described in detail.

The apparatus installed in each sub-station is protected from lightning by choke-coils and electrolytic lightning arresters arranged as shown in Fig. 11.

THE JOPLIN SUB-STATION.

Located in the western part of the city of Joplin, and at the present terminal of the 66,000-volt transmission line, is one of the most complete and up-to-date switching, and substations to be found west of the Mississippi River. A view of the building and three of the company's large trouble cars, are shown in Fig. 10. This sub-station is equipped to link together the 66,000-volt line of the Ozark Power & Water Company and the 33,000-volt lines of The Empire District Electric Company, and also to send out 2,300-volt 25-cycle current for commercial distribution.

The building is 108 feet by 105 feet and 42 feet in height. Some of the material included in its construction is as follows: 78,000 selected paving, or "face" brick, 472,-

FIG. 11. 66,000-VOLT ROOM IN JOPLIN SUB-STATION.

000 selected building brick, 13 cars of sand, 1,400 barrels of Portland cement, 100 barrels of Sandusky white cement and 33 tons of building steel. The interior of the building is divided into three separate rooms, as shown in Fig. 9; the west room being sub-divided by the second floor, which carries the oil switches controlling the 33,000-volt transmission lines of The Empire District Electric Co. The dividing walls are of brick and extend to the tile roof, so that each room is independent of the rest of the building, and absolutely fire proof. The roof is supported by steel I-beam structure, the book tile being placed on the steel work and then coated with cement, pitch and gravel. The window frames and sashes are of pressed steel, with wire-glass panes. No wood is used in the structure, so that there is absolutely no fire risk on the building itself.

The incoming 66,000-volt lines, after dead-ending and passing through the air-break disconnecting switches on the switching towers, just outside the building, again dead-end on pin type insulators supported by steel framework, which is securely bolted to the outer wall of the building. The lines then enter the building through porcelain wall insulators, which are secured in position by collars formed of polished slate slabs. The outer ends of the wall insulators are protected from the weather by canopies constructed of book tile and asbestos fibre, supported by steel frame-work. After entering the building, the lines lead through choke-coils, air-break disconnecting switches, electrically operated oil switches, thence through the east partition wall to the step-down transformers. Electrolytic lightning arresters arranged as shown in Fig. 11, protect the station apparatus from lightning.

The present transformer equipment consists of four single-phase, 66,000-volt to 33,000-volt transformers; three being delta connected, and one spare, to be used in case of emergency or break-down. These are oil insulated, water cooled, Westinghouse transformers, and have a rated capacity of 2,667-Kva. each. The weight of each transformer is 26 tons, and they were placed in position by sliding them along on steel rails laid in the concrete floor. Each trans-

Fig. 12. Transformer Room in Joplin Sub-Station.

Fig. 13. Operating Room in Joplin Sub-Station, Showing 33,000-Volt Bus-bar Barriers.

former is provided with a thermometer and oil gauge; and motor-driven centrifugal pumps keep the water circulating between the transformers and the cooling tower, which is located outside, and independent of the building. The 33,000-volt leads of these transformers are carried through the west inner wall to the second floor of the west room, where they connect, through electrically operated oil switches, to the high-tension buses of the Empire District Electric Company. Indicating and recording instruments, located on the operating switchboard, connect through potential and current transformers, which tap the high-tension transformer leads just ahead of the oil switches.

All high-tension bus-bars and wiring is of ¾-inch copper tubing, and carried on pin type and post type insulators. The high-tension buses are protected by barriers of concrete and pressed brick, supported by steel frame-work, as shown in Fig. 13. "Cross-overs" and bus connections are widely separated, and flash-boards of heavy asbestos fibre, Fig. 13, are so arranged as to prevent any possible "flash-over" or brush arcing of the bus-bars.

A bank of three 33,000-volt to 2300-volt transformers delivers 25-cycle current for commercial distribution, and also supply the large frequency changers located in the central part of the city, which sends out 2300-volt, 60-cycle current for commercial service. These transformers are also oil insulated, water cooled, and are rated at 1,000-Kva. each.

SWITCHBOARD.

A thirteen panel operating switchboard is installed of special selected slate with marine finish, and is centrally located near the east wall of the west room. It

Fig. 14. 33,000-Volt Lightning Arresters in Joplin Sub-Station.

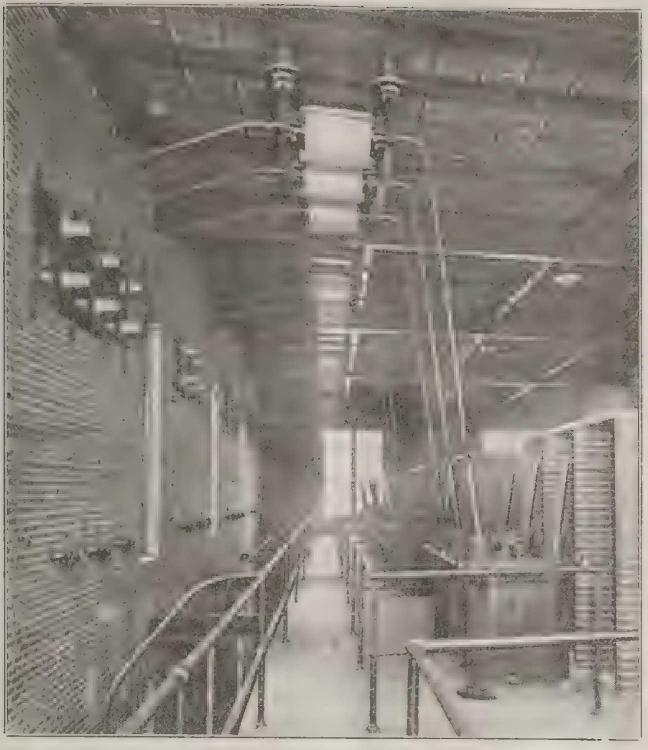


Fig. 15. 33,000-Volt Entrance and Oil Switches, Located on Second Floor of Joplin Sub-Station.

is completely equipped with Westinghouse indicating and recording instruments. All in-coming and out-going high-tension lines are controlled by oil switches, operated by small control switches on the switch board, and each control switch is provided with red and green flush-board, or "tell-tale" lamps, indicating the "open" and "closed" position of the oil switches. In addition to the oil switches, each high-tension circuit is provided with air-break knife disconnecting switches, both inside the building and on the steel anchor towers, outside.

The high-tension wiring is laid out in such a way as to afford the greatest safety for the operating force and eliminate, as much as possible, mistakes in the operation of disconnecting switches. Points of danger, within reach from the floor, are surrounded by gas-pipe railing.

The lighting system of the building is so arranged that any lighting circuit may be thrown on the 120-ampere-hour storage batteries, (which are used to operate the oil switches, so that in case of line trouble, no room of the building will be thrown into darkness. The switch-board lights are carried on the battery circuit, thus assuring light for the operator under all conditions.

CONCLUSION.

The linking together, or "tying-in" of the Ozark and Empire systems, means the "doubling-up" of teams on the heavy load. With up-to-date generating plants of more than 50,000 horsepower, total capacity; 150 miles of 66,000-volt, and 125 miles of 33,000-volt transmission lines, and a network of heavy secondary lines leading out from the many sub-stations; the Henry L. Doherty interest, after investing millions of dollars in developing Nature's resources, are now supplying current for commercial purposes throughout the extent of the country traversed by their lines.

The electric railways, the mines and mills, the factories, the business houses and the residences are laying aside their obsolete apparatus for lighting and power, and becoming consumers of electricity, because of its low cost and advantages over antiquated methods. Even the agriculturist and dairyman are taking advantage of the modern usage of electricity. Col. W. H. Phelps, of Carthage, Mo., who has a herd of 100 cows, and has his large barn and sheds lighted and equipped with electrical machinery for milking, separating the milk and preparing the feed, makes the following statement: "I filled two 100-ton silos recently, by means of steam power, at a cost of $51. The coal alone cost more than $7, which is in excess of the cost of all the lights and machinery run by electricity, that I use in one month. I filled three larger silos by means of electric power at less than one-half of the cost for the two filled by steam power."

Last but not least, by way of illustration, is the fact that previous to the organization of the Doherty interests in this district, the streets of the business section of Joplin were dimly lighted by one 550-watt A. C., multiple arc lamp overhanging each street crossing. Now the streets of the shopping district are flooded with light from the brilliantly lighted show windows, electric signs and electrically decorated building fronts.

The dam was designed and built by the Ambursen Hydraulic Construction Co., of Boston, Mass. The electrical equipment for the generating station, including switchboard and instruments was furnished by the General Electric Company. The sub-station apparatus, including switchboards and instruments, was furnished by the Westinghouse Electric & Mfg. Co. Mr. T. O. Kennedy was engineer in charge of construction, with Mr. C. E. Carter in charge of the transmission lines and Mr. Geo. Saattoff in charge of electrical equipment. Mr. George Hayler is in charge of the operating company.

Great Hydroelectrical Development in Spain.

One of the largest, if not the largest, hydroelectric enterprises in the world is now in course of construction in the district of Catalonia (Spain) by the Barcelona Traction, Light & Power Co., organized under the laws of the Dominion of Canada, with a capital of $25,000,000 and a bond issue of $35,000,000 authorized. The company's head offices are in Toronto, Canada, and its headquarters in Spain are in Barcelona. At the head of the enterprise is a New York man, who is also president of the Brazilian Traction, Light & Power Co., the Mexican Light & Power Co. (Ltd.), the Mexican Tramways Co., and other large enterprises.

The general purpose of the enterprise is the development of the electric industry in Spain. The company owns concessions for the development of various water powers on the Noguera-Pallaresa River and the Segre River, and has under construction along these rivers plants which will develop a total of about 140,000 horsepower. The first of these plants, which will develop about 4,000 horsepower, is located near the town of Pobla, in the Province of Lerida, and is nearing completion. The second is located near the town of Seros, also in the Province of Lerida and on the Segre River, and will have an installed capacity of 56,000 horsepower. It is expected that this plant will be in operation at the end of 1913. The third plant, and the most important of the three, will be located on the Noguera-Pallaresa River, above the confluence with the Segre River, and will develop about 80,000 horsepower. Of special interest to Americans is the fact that the company has already imported upwards of $3,000.000 worth of American machinery and appliances to be used in the construction of the works.

The Essential Features of the Present Fuse Situation

(Contributed Exclusively to Electrical Engineering)

BY J. J. MCINTOSH, E. E.

An Unbiased Discussion of the Arguments for and Against Refillable Fuses From the Viewpoint of Central Stations.

IN the question and answer department of the September issue of *Electrical Engineering,* a reader propounds the question, "What's wrong with refillable fuses?" I presume the reader in asking this question realized that he had opened a channel for discussion upon a subject that, to say the least, is a live one and one that has caused many heated arguments. From the view-point of the central station electrical engineer, the fuse situation presents many points of interest.

To the lay-mind the fuse is a very simple device and one not requiring any study or skill in its manufacture, or any care or attention after it is installed. To those having to do with the fire hazard, however, the fuse is a highly important device and one that needs extreme care in its manufacture and use to properly come within the meaning of the phrase, "a protective device."

To the manufacturer who complies with the code requirements—with the possible exception of that portion prohibiting the refillable type, or in other words, to those who manufacture reliable fuses—the fuse is a protective device that has required a great deal of research work and experimenting by technical and skilled men to perfect it to the extent we find it today. In the factories, great care must be given to the construction and the assembling of parts in order that the output will be uniform.

The code requirements as to the rating of fuses are: "Fuses must be so constructed that with the surrounding atmosphere at a temperature of 75 degrees Fahrenheit (24 degrees Centigrade) they will carry indefinitely a current ten per cent greater than that at which they are rated and that with a current 25 per cent greater than the rating, they will open the circuit without reaching a temperature which will injure the fuse tube or terminals of the fuse block. With a current 50 per cent greater than the rating, and at a room temperature of 75 degrees Fahrenheit (24 degrees Centigrade), the fuses starting cold, must blow within the time specified below:

0-30	Amperes	1 minute
31-60	"	2 minutes
61-100	"	4 minutes
101-200	"	6 minutes
201-400	"	12 minutes
401-600	"	15 minutes

"The temperature of the exterior of the fuse enclosure must not rise more than 125 degrees Fahrenheit (70 degrees Centigrade) above that of the surrounding air when the fuse is carrying the current for which it is rated."

It is very important in the construction of a cartridge fuse that the joint between the fuse element and the terminals be as perfect as possible. In order that a fuse be safe and reliable, the filler must have the following essential requirements: It must be non-absorptive, must be chemically inert and must not have any action on the fusible metal it surrounds. It must be in such a form as to not put any excessive pressure on the enclosing cartridge, must not pack and must allow free distribution of the metallic vapors.

In its meeting, held in New York on March 26 and 27 of this year, the electrical committee of the National Fire Protection Association considered an amendment to the code so as to allow the approval of the refillable type of fuse. Section "d" of rule 68 as now worded reads:

"(d) Construction. The fuse casing must be sufficiently dust-tight so that lint and dust cannot collect around the fusible wire and become ignited when the fuse is blown. The fusible wire must be attached to the terminals in such a way as to secure a thoroughly good connection and to make it difficult for it to be replaced when melted."

It was suggested to amend the second paragraph of the above rule so as to read: "The fusible wire must be attached to the terminals in such a way as to secure a thoroughly good connection."

At the meeting, referred to above, the proposed amendment was referred to the switch and cut-out committee for consideration with instructions to report to the next biennial meeting of the electrical committee. The plea for this action was based upon the ground that no member of the committee had had any field experience and that all the members of said committee were residents of New York where the subject was not so important on account of the local rules in force in that city. The switch and cut-out committee was enlarged by a member from each of the cities of New York, Philadelphia, St. Louis and Chicago.

The above action of the electrical committee has come in for considerable discussion and criticism. It has been argued that the refillable type of fuse has been used for a number of years and that the question at issue is one that the Underwriters have had to contend with for some years and that a delay of two years upon the plea of inexperience is unwarranted.

The arguments pro and con on the refillable versus the non-refillable type of fuse are many and varied. Those in favor of the non-refillable type only, claim:

1. It cannot be filled by anyone except the manufacturer, who has a properly equipped factory and the necessary skill for refilling, thus insuring a reliable fuse.

2. It would be difficult to prevent refillable fuses from being reloaded with improper materials, such as too large a fuse element, improper filler, and an improper fusible metal.

3. It has been standardized so as to permit any fuse of the same rating and class to be used with any cut-out of the same rating and class.

4. That the refillable type would hinder the Underwriters to a serious extent, because, while it is possible to test and approve fuses that are used in the same form in which they are manufactured and appear on the market, it would be an exceedingly hard matter to approve a device that would probably be used in an entirely different form from that in which it was manufactured.

5. It would increase the fire hazard, because it could be

refilled by anybody and everybody, and would, therefore, lose its merits as a protective device.

6. The ease with which the refillable type can be abused, the weakness of the contact between the fuse element and the terminals, and the difficulty of detecting abuse, would make it physically impossible to properly inspect the fuse while in operation.

Those who advocate the refillable type advance, among others, these claims:

1. That the unreasonable attitude towards the refillable type by certain associations and manufacturers is one founded on prejudice.

2. That the fire hazard would be decreased, because, the proper refilling materials would always be at hand, thereby making it unnecessary for users to resort to any dangerous makeshift, such as copper-wire jumpers or the substitution of improper metal for the fusible element.

3. That, due to the construction of the refillable type of fuse, it is unnecessary to employ skilled engineers to refill them, as they can be properly refilled by anyone.

4. The estimated reduction in fuse expense ranges from 80 to 300 per cent.

Laying aside the above arguments, it seems to the writer that the whole matter simmers down to the one question, Will the fuse, as a protective device, receive greater abuse under the proposed code amendment than at presnt? It has been hinted that certain manufacturers are very much opposed to any change being made in the code requirements, because as the fuse situation now stands, it means a large expenditure on the part of the consumer, and therefore a good source of income to the manufacturer. This is hardly possible to consider. Manufacturers of electrical goods are very anxious to extend the use of electricity and electrical devices as far as possible. They are without a doubt among the largest advertisers, and spend hundreds of thousands of dollars each year in educating the public on things electrical. Any short-sighted policy on their part, for a pecuniary gain, would retard the whole industry. These manufacturers have made every effort to cheapen the cost of production of their type of fuses where it could be done without in any way lowering the standard.

The first refillable fuses put on the market were very unreliable, due to poor design and construction of certain parts; but those on the market today are considered as reliable as any by a great many consumers. The manufacturers of these later types of refillable fuses had to fight against the prejudice established by their predecessors but in spite of this have built up a very creditable demand for their product. This fact must stand as a credit to their goods. It is entirely possible, and it is probable that their goods are just as safe and reliable as any other, and that the refillable fuse would not be subjected to any more abuse than is now encountered with the non-refillable type. If such is the case, the refillable deserves the approval of the Underwriters, and the manufacturers of same deserve credit for putting a reliable protective device on the market that will greatly reduce the cost of such devices to the consumer.

It is to be hoped that this question will be decided in the very near future on its merits alone and not from any interest, financial or otherwise, to those on either side of the controversy.

Important Considerations When Ordering Power Transformers

(*Contributed Exclusively to* ELECTRICAL ENGINEERING).

BY H. G. DAVIS.

Section 2. Capacities of Transformers for a Given Output.

For three-phase tranformations for a given output P, the capacities required in transformers in terms of line voltage E and current I are:

For 3-phase *Y* or delta, total rating (1.73 E $\times$ I). Rating of each (E I $\div$ 1.73).

For open delta the total rating is (2.00 E $\times$ I). Rating of each E I.

For T connection 3-phase the total rating is (1.866 E I) if not interchangeable.

For T connection 3-phase the total rating is (2.00 E I) if interchangeable.

Thus the capacities required in transformers for a given output are greater for open delta (*V*) or *T* connection when used in 3-phase connections. The delta connection is the only one capable of transforming in emergencies with one disabled transformer. The T connection gives a neutral but requires special taps while the open delta has prohibitive unbalancing. The T connection has an advantage over the open delta in many ways, and it is not necessary that the taps should be brought out at 86.6 per cent. For starting motors with a double throw switch the open delta can be used to advantage but not for continuous operation. This arrangement is shown in Fig. 6.

The *Y* connection of transformers using three single-phase transformers requires transformers of the same capacity as the delta connection. Where a neutral connection on the low tension side is required then *Y* or *T* connections must be used. This is the case when rotary converters are used for 3-wire lighting systems. The neutral wire of the direct current side of the machine is the neutral point of the alternating current end at the same time and in most cases an electrical connection is made. This connection then requires a *T* or *Y* connection on the side of the transformers feeding the machines, and if a *Y* connection is used on the secondary, a delta connected high tension circuit should be used.

As shown above the *T* connection of two transformers is used to transform a three-phase voltage V_1 to another three-phase voltage V_2. If one transformer is to be used only as a teazer, that is, the transformer forming the upright position of the T, then the capacity of this transformer is only .866 E I where E is the line voltage and I the line current of the three-phase circuit to be supplied.

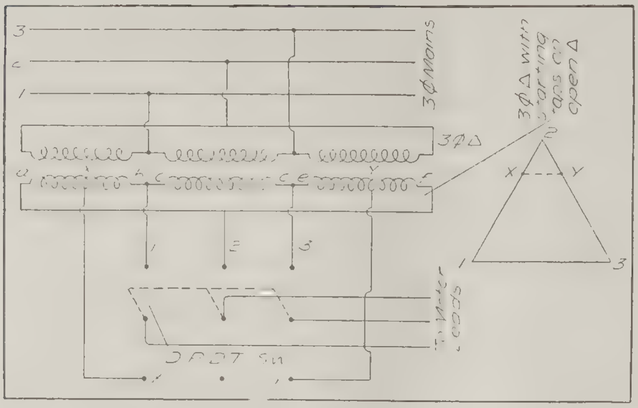


FIG. 6. OPEN DELTA STARTING CONNECTIONS. VOLTAGE TRIANGLE AT RIGHT.

By using a double throw switch as indicated, A reduced voltage can be obtained at starting. One point of the delta is used in both starting and running positions. Lead X at starting must be thrown on lead (1) and lead Y on lead 3 of the motor, otherwise the rotation of the machine would be reversed in throwing the switch from starting position (down) to running position (up).

The other transformer will have a capacity E I. If the two transformers are to be interchangeable each will have a capacity required = E I.

T CONNECTIONS FOR TRANSFORMERS FROM 2 TO 3-PHASE.

The *T* connection has a modification which is used in transforming from 2-phase to 3-phase, shown in Fig. 4 of September article. This modification as shown is that on the 2-phase side of the transformation each transformer acts as a single-phase transformer receiving power from one phase of the two phases or delivering power to one phase of the two phases depending upon whether the transformation is from a two-phase to a three-phase or from a three-phase to two-phase. On the 3-phase side, the two transformers are connected in *T* as for a regular 3-phase to 3-phase transformation—one transformer being used as a teazer and the other as a main, thus being interconnected while on the two-phase side the phases are independent. The primary of the transformer used as a teazer must have a tap for 86.6 per cent voltage and the main transformer must have a 50 per cent tap as is the case in the straight 3-phase transformation using the two transformers in *T* connection. When using the *T* connections for two-phase, three-phase transformation, the capacity required is slightly different from that required on the straight three-phase to three-phase transformation. Assume that the ratio of transformation is 1 to 1 or $E_1 = E_2$; E being used as the symbol for voltage.

Then assume I_1 = line current on the 3-phase side.
I_2 = line current on the 2-phase side.

Assume 3-phase capacity to be transformed = 1.73 E_1 I_1. Since 2-phase power delivered is (2 E_1 I_2) and is equal to the amount of power to be transformed or that delivered to the 3-phase side, then

$I_2 = (1.73 E_1 I_1) \div 2 E_1 = (1.73 I_1) \div 2 = .886 I_1$.

This means that on the 3-phase side of the two transformers the main transformer winding capacity is (E_1 I_1) and the teazer capacity is (.866 E_1 I_1) if used only as teaser or (E_1 I_1) if interchangeable. On the two-phase side then each transformer winding has a capacity of .866 E_1 I_1.

Assume a *T* connection to transform 500 KVA, 3-phase at 1000 volts to 500 KVA 2-phase at 100 volts. Main transformer 3-phase current = 500000 ÷ (1.73 × 1000) = 289. Main transformer voltage on 3-phase side = 1000. Thus the winding of the main transformer on the 3-phase side must have a rating of 289 KVA. The teaser transformer current on 3-phase side must be the current in the 3-phase line = 500,000 ÷ (1.73 × 1000) = 289 which is the same current as in the main transformer winding. The voltage required is .866 E or 866 so that the capacity of the winding is 866 × 289 = 250 KVA. However, while this is the required teaser capacity in actual use on the three-phase side, in order for this transformer to be interchangeable the winding should be for 1000 volts and 289 amperes or the capacity should be 289 KVA. Thus each transformer requires a winding for 289 KVA on the three-phase side.

On the two-phase side since each phase is separate the current = 500,000 ÷ 2 × 100 = 250 amperes. The voltage from each phase is 100 volts. Capacity of each low tension winding is then 250 KVA.

Thus the main transformer in operation has 250 KVA on the two-phase side and 289 KVA on the three-phase side. The teaser transformer has 250 KVA on each winding. Since the transformers should be interchangeable the capacity should be the same and for a given two-phase capacity on the two transformers, the capacity of the winding used on the three-phase connection must be 289/250 = 1.15 times the capacity of the winding to be used on the two-phase side. On each transformer the winding to be used on the three-phase side must be wound for the three-phase line voltage with a half voltage tap for the main and an 86.6 per cent tap for the teaser. On the two-phase side the coil voltages must be the same as the line voltages. The current capacity in the winding used on the three-phase side in the main transformer are 15 per cent greater than that required in a single transformer to deliver half the combined capacity of the two transformers at the same voltage. Thus, when used to transform from two-phase to three-phase with the T connection, the windings for the three-phase side must have the same increase in capacity as when used for a regular three-phase to three-phase T connection. The windings on the two-phase side each have the same capacity as a single-phase transformer of half the combined capacity of the two at the same voltage. This increase of capacity required for one winding should be considered and called for in ordering for if tested and designed as a single-phase transformer of a rating of one-half of the power required from the combination of the two, the result will be overheating when operated in the combination.

VOLTAGES AND CAPACITIES FOR DIFFERENT CONNECTIONS.

The following table shows the voltages and capacities required for each transformer in various connections with the required capacity of each combination in terms of power to be delivered. Table 1 shows transformation from three-phase primary to three-phase secondary using single phase units.

TABLE 1. CAPACITIES OF TRANSFORMERS FOR DIFFERENT CONNECTIONS.

Connection	Y	Delta	V	T
Line Voltage	E	E	E	E
Line Current	I	I	I	I
3-phase Power	(1.73 EI)	(1.73 EI)	(1.73 EI)	(1.73 EI)
No. of Units	3	3	2	2
Voltage of Unit	E/1.73	E	E	E or .866 E
Current of Unit	I	1/1.73	I	I
Unit Rating	EI/1.73	EI/1.73	EI	EI or .866 EI
Total Rating	(1.73 EI)	(1.73 EI)	(2 EI)	(2 EI) or (1.86 EI)
Utility	1	1	.866	.866 or .93

The above table shows the ratings required for the single-phase units making up a combination, each combination transforming the same amount of power. The utility of the combination is the ratio of the power transformed by the combination to the single-phase capacity of the combination. When the main and teaser are interchangeable in the T connection, each transformer must have the same capacity and the utility is .866. This utility is .93 when the teaser cannot be interchanged but the increase in utility of capacity is gained by a loss of flexibility of the system.

2-PHASE TO 2-PHASE TRANSFORMER CONNECTIONS.

When transforming from two-phase to two-phase by single-phase units each unit must be a single-phase unit of half the capacity of the combination. The utility of the two transformers is one and no surplus capacity is required. When transforming from two-phase to three-phase by two transformers, the winding of each transformer must have 15 per cent excess current capacity in the winding used on the three-phase side above the rating as a single-phase transformer to carry half the power of the combination. Since the capacity of the winding on the two-phase side is one, the total capacity required is 1.075 and the utility of each transformer (assuming the main and teaser to be interchangeable) is .93. If the teaser transformer of this combination can be used only as such, the utility of the two transformers as a combination is $2/2.075 = .965$. This utility increase is at the loss of flexibility.

The next section of this article will take up A. C. and D. C. voltage relations with rotary converters.

Alternating Current Engineering

(*Contributed Exclusively to Electrical Engineering*)

BY WILLIAM R. BOWKER.

Section 17. Transmission of Power.

In the transmission and distribution of electrical energy over various distances, the choice of systems to be adopted is determined from the standpoints of practicability and commercial operation. Economy in copper is attained by using polyphase systems, and especially is this the case when a three-phase system is adopted. The following table gives the comparative weights of copper on the basis of equal power transmitted, equal voltage and equal drop of voltage:

TABLE 1. WEIGHTS OF COPPER FOR TRANSMISSION OF POWER AT EQUAL VOLTAGE AND DROP.

System	Weight of Copper
Two-wire, single-phase	100
Four-wire, two-phase	100
Three-wire, single-phase (in which the middle wire is one-half the cross-section o feither ouside wire)	31.22
Three-wire, two-phase (the voltage being taken as that between the lines and neutral or common return	72.8
Three-wire, three-phase delta	75
Four-wire, three-phase (with common junction, neutral wire)	29.2

A four-wire, two-phase system requires the same weight of copper as a two-wire, single-phase system, while the three-wire, three-phase system requires only 75 per cent of copper as compared with either the four-wire, two-phase or two-wire, single-phase system. When the power transmitted, distance, line loss and voltage are constant and all wires of each system the same size, the economy in copper is as follows:

TABLE 2. WEIGHT OF COPPER FOR TRANSMITTING POWER WITH DISTANCE, VOLTAGE, LINE LOSS AND WIRE SIZE CONSTANT.

System	Copper required
Two-wire, single-phase	100
Four-wire, two-phase	100
Three-wire, single-phase	37.5
Four-wire, single-phase	22.2
Four-wire, three-phase (with neutral)	33.3
Three-wire three-phase (Delta)	75

A useful formula to determine the weight of copper is as follows:

Lbs. of copper in lines $= [(Miles)^2 \times \text{K. W.} \times k] \div [(\text{K. V.})^2 \times \textit{per cent loss}]$.

In which K. W. = kilo-watts and K. V. = kilo-volts, and k is a constant depending on the phase, system and power factor. For 100% power factor, single-phase or two-phase, $k = 363$ and for three-phase $k = 273$.

If we take the same line voltage in each case, exactly the same amount or weight of copper is necessary in both the three-phase delta and the three-phase star connection. The phase voltage of a three-phase delta connected generator is the same as the line volts, while the current in each phase is less than the line current in the proportion of 1 to $\sqrt{3}$, that is 1 to 1.73, the line current being the vectorial sum of three currents differing in phase by 120 degrees. Thus with a three-phase delta connected generator, the line voltage is equal to the generator phase volts and the line current is $\sqrt{3}$ (that is 1.73) times the generator phase amperes.

With a star connected generator, the line voltage is greater than the generator phase volts in the proportion of $\sqrt{3}$ to 1 (that is 1.73 to 1) while the outer line amperes are equal to the generator phase amperes, so that considering the line volts as being equal in both the delta and star connected systems, the amount or weight of copper required for the transmission of equal power is exactly the same.

The relative weights of copper necessary for the transmission of power at a given loss, as determined by the maximum difference of potential is as follows:

TABLE 3. RELATIVE WEIGHTS OF COPPER FOR TRANSMISSION AT A GIVEN LOSS AND MAXIMUM DIFFERENCE OF POTENTIAL.

System	No. of Wires	Per Cent Copper
Single-phase	2	100
Two-phase	4	100
Two-phase (with common return)	3	145.7
Three-phase	3	75

The relative copper efficiencies for transmission at a given loss, as determined by the minimum difference of potential is as follows:

TABLE 4. RELATIVE WEIGHTS OF COPPER FOR TRANSMISSION AT A GIVEN LOSS AND MINIMUM DIFFERENCE OF POTENTIAL.

System	No. of Wires	Per Cent Copper
Single-phase	2	100
Two-phase	4	100
Single-phase	3	37.5
Two-phase (common return)	3	72.9
Three-phase (delta)	3	75
Three-phase (neutral full section)	4	33.3
Three-phase (neutral one-half section)	4	29.17

The amount of copper necessary for transmitting a given power at a fixed percentage of loss is determined by the rule, that the weight of copper varies inversely as the square of the voltage. In the single-phase systems, if the voltage is E, the potential between the two outside wires may be represented by $2E$. In the threephase, three-wire delta connection, the line voltage being represented by E, the pressure between any wire and the junction is $E/\sqrt{3}$.

The single-phase system, having a voltage E, can be converted into two single circuits of voltage $E/2$. The weight of copper in each system is inversely as the square of the voltage, thus we have $(2/E)^2$ is to $(\sqrt{3}/E)^2$ or as 4 is to 3. That is, the relative weights of copper for the single-phase and three-phase systems are 100 per cent and 75 per cent respectively, and the same relation exists between the two-phase, four-wire, and three-phase, three-wire systems.

The following table shows the relative comparative values of the phase volts and phase amperes and line volts and amperes of generators and power transmission lines for various systems. In this table V and v are phase volts and line volts respectively, and A and a phase ampere and line amperes respectively.

The line amperes are the amperes for each transmission line and in the case of the two-phase, three-wire system, the common return carries an increased current, in the proportion of 1 to $\sqrt{2}$, that is 1 to 1.41, since it has to carry the vectorial sum of two currents differing by 90 degrees.

TABLE 5. RELATIVE COMPARATIVE VALUES FOR DIFFERENT SYSTEMS.

Systems	Phase volts	Line volts	Phase Amps.	Line Amps.
2-phase, 4-wire	V	$v=V$	A	$a=A$
2-phase, 3-wire	V	$v=V\times\sqrt{2}$	A	$a=A$ in outside wires
		$=V\times 1.41$		$a=A\times\sqrt{2}$ $=A\times 1.41$ in common return
3-phase, 3-wire star.	V	$v=V\times\sqrt{3}$ $=V\times 1.73$	A	$a=A$
3-phase, 4-wire star.	V	$v=V\times\sqrt{3}$ $=V\times 1.73$	A	$a=A$
3-phase, 3-wire delta	V	$v=V$	A	$a=A\times\sqrt{3}$ $=A\times 1.73$

For single-phase circuits, $I = W \div (E \times P.F.)$

Where I = current in line in amperes; W = energy delivered in watts; E = potential between mains in volts; $P.F.$ = power factor.

For two-phase circuits,

$I = 0.50 \times [W \div (E \times P.F.)]$

For three-phase circuits,

$I = 0.58 \times [W \div (E \times P.F.)]$

When the power factor cannot be accurately determined, it may be assumed to have the following approximate values:

Lighting load with no motor 0.95
Lighting and motors 0.85
Motors only 0.80

From the above formula, if the values of W, E and $P.F.$ are the same, it will be seen that the current in each wire of the two-phase system equals 0.5 of the current in each wire of a single-phase system. The current in each wire of the three-phase, equals 0.58 in each wire of the single-phase system. The current in each wire of the three-phase equals 1.6 times the current in each two-phase wire.

With alternating current systems of wiring, either of single-phase, two-wire or four-wire, two-phase, which carry non-inductive loads, such as incandescent lamps, the above formula may be used to calculate the amperes. Where the load is inductive, such as motors or arc lamps, an addition of 25 per cent to the number of circular mils obtained by the following wiring formula is necessary if the current required has been figured on the same basis as used for direct current. This is to compensate for the power factor.

Single-phase, three-wire circuits may be figured on the same basis as direct-current, three-wire, if non-inductive.

THREE-PHASE WIRING.

In a three-wire balanced three-phase system, the current in each wire of the primary and secondary, to the point where the three-wire system is divided into two-wire, is 1.732 times the amount it would be if three separate single-phase circuits were used, owing to each wire having to carry current for two phases.

For example, with a load of incandescent lamps taking 300 amperes, that is, 100 amperes on each phase, with the three-wire balanced three-phase secondary mains, the current in each of the three wires will be 100 × 1.732, or 173.2 amperes, which latter value should be used for calculation in the wiring formula. In other respects the three-phase, 3-wire system may be calculated the same as a two-wire system, and each of the three wires made the same size.

Three-phase motors usually have a name plate giving the amperes per phase, which represents the total current in each line wire. Under those circumstances it is not necessary to use the factor 1.732 to obtain the size of copper.

The Horse power formula is,

H. P. = [Amperes per phase × volts × 1.732 × P. F.] ÷ 746.

Amperes per phase = [H. P. × 746] ÷ [Volts × 1.732 × P. F.]

The value of power factor (P. F.) is less than unity, or one, and varies approximately from .65 for 1.0 H. P. to .90 for 50 H. P. motors.

In calculating the total load from the switchboard voltmeters and ammeters,

Watts = Amperes per phase × volts × 1.732 × P. F.

WIRING FORMULA.

Circular Mils. = [Length of run in feet × amperes × 21.5] ÷ volts lost.

In the above formula, the length of run is the length in feet on one side of the circuit, volts lost is the voltage drop, and the circular mils. give the size of wire.

EXAMPLE. What size of wire should be used on a 250-volt vircuit required to carry 200 amperes a distance of 350 feet with a 3 per cent full load loss.

3 per cent of 250 volts = 7.5 volts loss.

[350 × 200 × 21.5] ÷ 7.5 = 200,667 c. mils. or approximately No. 0000 B. and S. gauge wire.

As previously stated, on alternating current circuits which carry an inductive load, an addition of 25 per cent to the circular mils. or size of wire gauge is recommended. The current in amperes is calculated in the manner already explained.

The constant 21.5 is obtained as follows: The resistance of one linear foot of copper wire, with a cross-sectional area of one circular mil. (c. m.) is 10.75. Therefore the resistance of any copper wire = (Length in feet × 10.75) ÷ Circular Mils.

By Ohms law,

E = [C × length in feet × 10.75] ÷ Circular Mils. Where E and C are volts and amperes.

Also C. M. = [C × length in feet × 10.75] ÷ E.

In the wiring formula given however, the length in feet is considered the run, that is, one side of the circuit, and the 10.75 × 2 = 21.5 the constant.

To determine the size of fuse wire to be used on an alternating current circuit, say for instance in the fusing of an induction motor, the rating of the fuse and resulting size should be such that it will carry 25 per cent more than the current or amperes per line. In the case of a three-phase induction motor the following formula can be used to obtain the amperage.

Amps = [H. P. × 746] ÷ Eff. × V. × P. F. × $\sqrt{3}$ or Amperes = [Horse power × 746] ÷ Efficiency of motor × volts × power factor × 1.73.

In the case of a 25 horse power 220 volt, 3-phase induction motor, with a 90 per cent efficiency and .89 power factor, the amperes per terminal are,

A = [25 × 746] ÷ [.90 × 220 × .85 × 1.73] = 64 amperes.

Adding 25 per cent, a fuse of such a rating or size as to carry 64 + 16 = 80 amperes is required.

Where starting compensators or devices are not utilized with induction motors a fuse of such size as to carry a starting current several times the amperes per terminal is necessary.

The next section of this series will take up the application of vector lumination in alternating current circuits and problems.

The Design of Steam Power Plants

(Contributed Exclusively to Electrical Engineering)

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Section 6. Details of Layout of Plant Discussed in September Issue.

IN what follows the arrangement of equipment for the railway and lighting plant will be taken up, assuming that all apparatus has been selected according to specifications already named. Beginning in the turbine or engine room, we find that an arrangement similar to the preceding layout will be best suited for an installation of this character. That is, to place the steam end both machines toward the boiler room, leaving sufficient room around each machine so that operators can get around conveniently. The engine could be placed on a lower floor level than the turbine, and for some reasons this would be an advantage. It would allow the engine foundation to be built low to absorb the vibrations. On the other hand, a large mass will be required for this foundation so that it may well be made above ground rather than to go deep into the ground. This arrangement admits of a most satisfactory layout for the engine room floor and really has no serious disadvantages.

The steam driven exciter set should be placed near the boiler room wall in order to make the steam lines as short as possible. The motor driven exciter, as well as the two rotary converters, may be placed at any convenient point as near the switch board as possible to shorten the leads as much as possible. These machines are not shown on the plans.

The basement may be used for the auxiliary machinery as in the previous design. The boiler room arrangement will differ in some respects from the previous layout in that we will arrange the design with the idea of little growing in the immediate future. With this in view we may place the heater and boiler feed pumps in the center of the boiler room with one-half of the boiler battery on one side and one-half on the other. This makes a very uniform arrangement as well as a convenient one. The heater is placed on a platform near the partition wall at which point we can reach it with short runs of exhaust pipes from the auxiliary machinery, such as the condenser turbines, exciter engine, boiler feed pumps and any other non-condensing machinery. It is not necessary to run the atmospheric exhaust lines from the turbine or large engine to the heater, as these machines should not be run non-condensing any more than possible. There should be sufficient exhaust steam from the auxiliaries to heat the water to a maximum temperature, which is 210°F, with exhaust steam at atmospheric pressure, in an open heater.

In this design, we have selected the open type feed water heater instead of the closed. This selection should always be made where there is more than 3 or 4 per cent of solids in the water. This amount of material if precipitated on heating the water would be detrimental in a closed type heater. At this point we may say one of the great indirect advantages of a heater in connection with a boiler plant is the fact that most of the detrimental mineral matter held in solution in the water will be precipitated at or below 210° temperature consequently it relieves the boiler from this deposit.

The location of the heater as in the previous design should be elevated above the pump suction at least 3 feet and more if convenient.

The location and arrangement of the boiler feed pumps should be such as to make them easily reached. Frequently it is advisable to place them with the heater as this arrangement makes pipe connections easy and flexible. While each of the pumps should be designed suitable for boiler feed purposes, the piping arrangement should be such as to allow either of the pumps to be used as a service pump to the heater.

In some instances the boiler feed pumps might be placed in the turbine room or basement with other auxiliary machinery, away from the dust and dirt of the boiler room, but where this is done, it necessarily requires additional help to operate the plant, and for this reason the writer believes that this apparatus should be located as shown in Figs. 1 and 2.

The unit smoke stack has been selected for this design, not because the writer approves of such construction for a plant of this size, but on account of the advantages, and disadvantages which we might discuss. This type of stack is much cheaper in first cost than the central stack and it lends itself to expansion since each boiler has its own stack. Also the breeching cost is held to a minimum. Even with these advantages the construction has never been very popular and really carries with it the effect of bad design. A stack of this kind can be made quite light which reduces the cost.

We next turn attention to the condensing machinery, and will discuss the engine condenser first. This type of condenser as shown on the drawing is what is known as the elevated jet type. The condenser cone is placed not less than 34 feet vertically above the water level in the tail pipe discharge or hot well. This does not mean that the head must be this high above the engine, for when the contour of the ground is such that a vertical distance below the condenser cone of 34 feet may be obtained, it may be placed with reference to the hot well and without consideration of the engine location.

The size of the pipe line from engine to condenser cone may be made the size of the engine opening provided the engine has been designed for condensing. At any rate this line would be checked up in the following manner:

With a 300 Kw. engine operating at 26 lbs. per Kw. (16 lbs. per I. H. P.), 26-in. vacuum and 200 ft. per second velocity for steam to condenser, we have the following,

$300 \times 26 \times 175$ cu. ft. $= 1365000/3600 = 380$ cu. ft. per sec.

Then $380/200 = A \times 12$ where A equals cross section area of the pipe and is equal to $\pi D^2/4$ from which we have $380 \div 200 = (12 \pi D^2) \div 4$ and $D^2 = (4 \times 380) \div (200 \times 12 \times \pi) = 19$ or a 20-in. pipe.

Since the pipe rises about 34 feet above the engine, it will be impossible to get the water of condensation out of this line if we do not make special preparations for same. This can be done however, by making an entrainer at the foot of the 20-in. riser pipe. This is nothing more than a special foot ell with a curved pocket to it which allows the water to flow to the low point and be drawn off through a vacuum trap.

The velocity of the steam will sweep the water before it with a moderate elevation of vertical pipe. A good rule to determine how much rise we may have without putting in an entrainer and a drain is as follows: If the rise is not greater than 12 diameters of the pipe, the velocity will sweep the water over with it. In this case we would have 12 × 20-in. = 240/12 = 20 ft., but we have a rise of 34 ft. therefore we must put in the entrainer and drain. This is not shown on the drawing. The drain from the entrainer will have to be trapped off in such a manner as to allow the condensate to pass off without breaking the vacuum. This can be done by using a vacuum trap on this line. This style of trap is usually of the tilting type, and the arrangement is such that when the trap tilts, the connection with the vacuum is cut off and a steam jet blows the water of condensation out. A weighted check

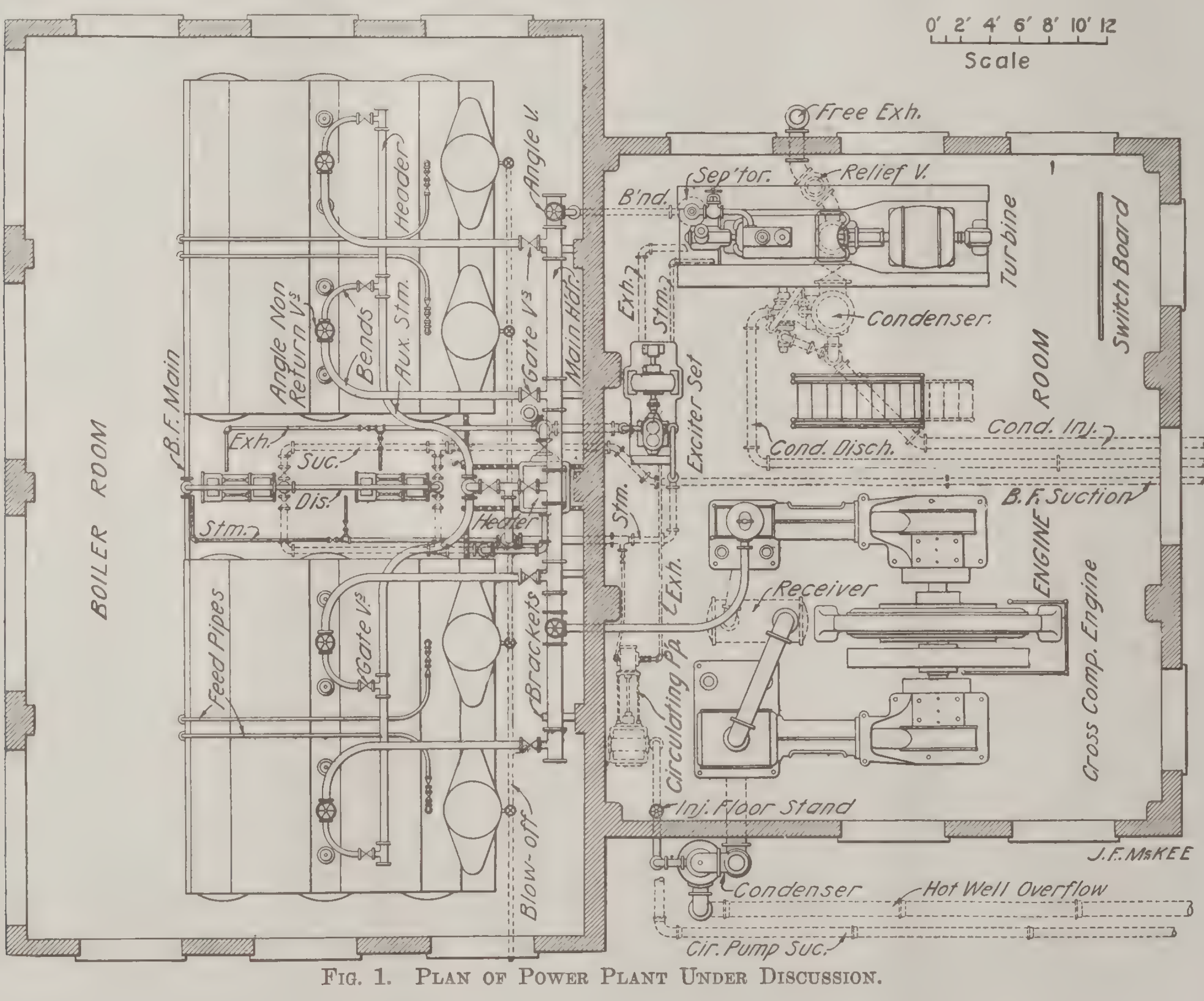


Fig. 1. Plan of Power Plant Under Discussion.

valve must be used on the line to discharge, to prevent the breaking of vacuum, but allowing the discharge to pass off.

The cone or condenser proper of this type of machine is not different from the head on what is known as the low lift condenser. It gets its name of "barometric condenser" from the elevation above the engine. As stated at the beginning it is necessary to have the hot well in which the tail pipe is placed at least 34 feet below the throat of the condenser in order to prevent the water from sucking back and over into the engine. In order to keep a tight seal on the tail pipe, it is necessary to extend this pipe at least three feet below the surface of the water in the hot well. After the water passes from condenser to hot well it can overflow either to waste or to a cooling pond or tower as the case may be. We will discuss a cooling tower later.

Normally the circulating water for this type of condenser has to be pumped from the cold well to the 34 ft. height in order to perform its function. But after the vacuum has been established necessarily the pump gets advantage of the condition. Where a reciprocating pump is used for this service, it simply means a throttling down of the pump after the vaccum has been formed. Where an electric driven centrifugal pump is used, it is desirable to select a pump that will operate under the regular condition when the vacuum has been established and since this type of pump is a constant speed pump, it would not have power enough to raise the water the required height in starting up the plant unless some special arrangement is made to take care of this extra head. This may be accomplished by cutting in a bypass valve between the riser or injection pipe (discharge from pump) and the return or tail pipe from condenser. This valve should be located at about half way between condenser and hot well. When the plant is started up this valve is opened and the pump discharges through it into the hot well since a partial vacuum is found, the by-pass valve is gradually closed and with the vacuum in the system, the pump is able to raise the water to the proper height in order to put the water over the throat of the condenser head.

The location of this type of condenser may be at any convenient point with reference to the engine. Usually the head or condenser is placed on the outside of the building wall at a convenient point where the hot well and waste waters may be disposed of most conveniently. In order to get good results from an installation like this, it is imperative to locate the condenser head at such a point that the hot well may be placed directly beneath same. This is true because the vacuum is produced by the rapid fall of the water through the throat (congested part of tail pipe) and tail pipe, and if the hot well is located off to the side and bends are required, this velocity is retarded and possibly killed.

The condenser for the turbine is the same as in our preceeding design and needs very little comment. It is readily seen that the design best suited is the low lift jet type of condenser, which as shown before is adapted to the class of work where the water of condensation is not to be saved, which condition would apply where the natural source of water is good for boiler feed purposes, and where the condensate is not required for other purposes, such as ice making. These conditions will be discussed later in a design for this particular service.

The condenser machinery as in our preceding design is located in the basement which makes the engine or turbine room free of this type of machinery and noise.

The pipe arrangement and specification will be discussed in the next article, as well as the building and any other details that have not already been touched upon.

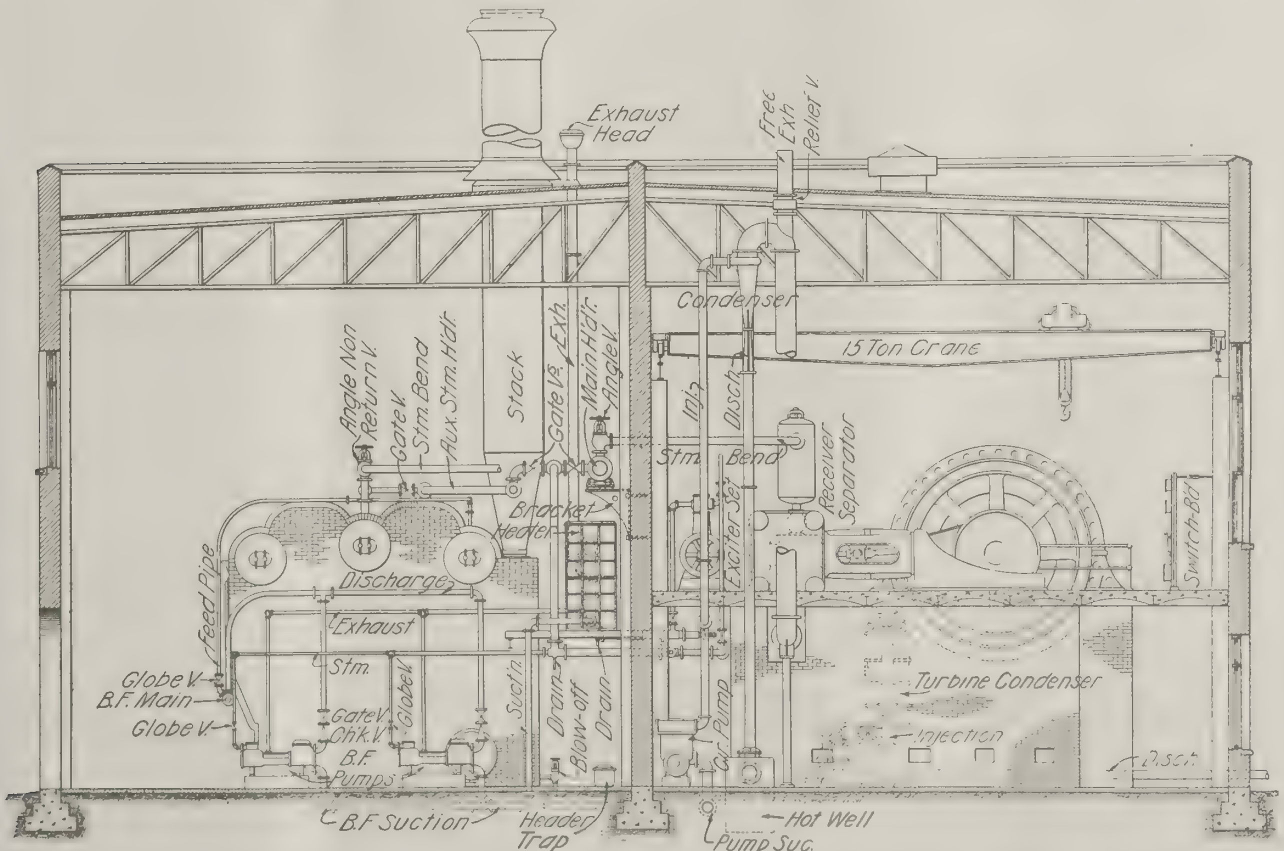


FIG. 2. ELEVATION OF POWER PLANT UNDER DISCUSSION.

The Protection of Transformers and Transmission Lines

A Survey of Conditions of Protection.

BY E. E. F. CREIGHTON, CONSULTING ENGINEER, GENERAL ELECTRIC COMPANY.

A Discussion of Lightning Arresters and Ground Wires.

It is now generally conceded that long transmission lines are not at the present time adequately protected against lightning. The demands for dependable continuous service have become more and more exacting and the difficulties of protection at the same time have brought up new factors for consideration. A number of problems yet remain to be solved, yet the situation is being handled with much more intelligence as regards practical considerations than at only a very few years back, for the destruction caused by lightning is now being given considerable study. As a protection against lightning at the present time, the aluminum electrolytic arrester is considered most efficient and is most used where the apparatus to be protected or the severity of conditions justify the expense of installation. In other cases the multi-gap arrester seems to fit in, especially in distribution work at around 2300 volts. In what follows a review of some of the conditions of protection is given, the information being abstracted from a paper presented by Mr. Creighton at the recent Chicago convention of the National Electric Light Association.

The improvement in protection of lighting transformers has come from recognition of the necessity of placing a lightning arrester at each transformer in order to get a high degree of protection. A perfect arrester situated a few poles distant from a transformer will give comparatively little protection to the transformer because the potentials from lightning are usually very concentrated and localized. With the requirements of a lightning arrester at each transformer, there naturally arises the necessity of an installation of arresters at less cost than is given by the standard multi-gap arrester in a wooden box. At the same time it is desirable to make the arrester equally efficient in protection, and stable against self-destruction. Naturally, all these factors cannot be obtained in their fullest. This endeavor to lessen the cost has led to the development of a self-housed, self-contained arrester known in the trade as a compression chamber lightning arrester. In this arrester the high resistance shunt has been discarded and more gaps have been put in series than were formerly used with the standard multi-gap arresters. This greater number of gaps gives better arc extinguishing qualities to the arrester. If it were not for the addition of an antennæ around the greater number of gaps, the spark potential would be increased. The employment of the antennæ, however, permits the use of double the number of gaps without any increase in the spark potential. This statement applies to a frequency of 60 cycles. The arrester is actually more sensitive to discharges at high frequency than at 60 cycles.

ALUMINUM LIGHTNING ARRESTERS.

All the technical conditions of design of aluminum arresters have warranted the use of charging resistances and spring clips for the horn gaps on all arresters, just as they have been used on arresters designed for cable circuits. Keeping down costs has lead to a compromise which eliminated the use of charging resistances in most of the installations of aluminum lightning arresters during the past few years. A careful study of the conditions has revealed the fact that the charging resistance is a good investment. Aluminum arresters which have had their films dissolved due to one of several conditions, have failed, not during lightning storms, but during the re-formation of the films. The qualities which make the aluminum arrester a good discharger for lightning, make it also take a heavy current if the films are not in good condition. Although the number of troubles with aluminum lightning arresters is proportionately small, practically all these troubles have taken place during the charging. Since the aluminum cell is a condenser, it is possible to place in series with it a resistance of considerable value, and still not prevent the arrester from taking its full charging potential. This solves the problem of limiting the charging current to a reasonably small value, even although the films are badly dissolved; and of safeguarding the arrester against the destructive effects of heavy dynamic current. Even for an expert there is no outward appearance of the arrester by which he can tell the condition of the films before the circuit is closed. If charging resistances are used the operator can feel perfect security in closing the circuit, in that the resistances will carry the whole current of the arrester circuit for a brief time without damage to themselves. Furthermore, in terms of a popular expression, the arrester is thus made more nearly "fool-proof."

Where the films are out of condition, and the arrester takes initially a heavy current rush, the arc at the horns becomes undesirable. Any kind of an arc in a current tends to set up oscillations. For this reason, spring clips are used at the horn gaps, which cut out the arc during charging of the aluminum arresters. With metallic contract across the horns, the wave shape of the current in the arrester circuit is similar to the wave shape of current in any short length of idle transmission circuit. By the use of these clips, and a suitable charging resistance, disturbances in parallel telephone wires can be reduced to a very small fraction of the disturbances that are set up without their use.

Due to the natural operation of the lightning arrester there is no appreciable wear of the aluminum plates or electrolyte even after several years of operation. Up to January, 1912, an electrolyte was used in which a fungus grew. As a result of this fungus growth, vinegar was formed in the electrolyte which decreased its value in that it hastened the dissolution of the film on the aluminum plate. Since January, 1912, electrolyte has been in use which is fungus proof. This electrolyte has been under observation for three years, and from all indications is serviceable for a great many years more. With this means of preventing the only appreciable deterioration in the aluminum arrester, it seems desirable not to dismantle arresters at intervals, as has formerly been recommended. In dismantling an arrester there is the possibility of wetting the supporting sticks, and thus introducing a spot of weak insulation in the stack of cones. A sufficiently satisfactory and more economical means of investigating the condition of an arrester is found in the use of an ammeter to measure the charging current. So long as this charging current does not exceed one-half ampere at 60 cycles, and one-quarter ampere at 25 cycles, one may rest assured that the aluminum films are in good condition. A convenient method of applying this ammeter to the arrester tanks has been devised. This consists of using an ammeter mounted on a wooden stick, the end of which carries two clips that slide into a jack.

EARTH CONNECTIONS.

All experience continues to confirm the use of earth pipes consisting of ordinary pipes driven into the ground as far as convenient, and the earth around the pipe thoroughly salted down. In driving a pipe eight feet deep, it is usually more convenient to drive a short piece of a larger size down four feet and withdraw it, and then place the longer piece in the hole, which brings its top within the striking height of a sledge. The question often arises, why put salt around the pipes? The fact of the matter is that practically the whole of the resistance of the earth connection lies in the immediate neighborhood of the earth pipe. The resistance decreases with the amount of moisture around the pipe, and with the conductivity of that moisture. The endurance to withstand continuous current through the earth connection also depends upon the amount of moisture around the pipe. Furthermore, in cases where the pipes have been dried out, it is desirable to have some material in the neighborhood of the pipe which will naturally attract moisture from the surrounding region. This feature of absorbing and holding moisture, technically known as "deliquesent," is a property of many of the salts. Ordinary table salt, sodium chloride, has this property to a considerable degree, and is a good conductor of electricity. Calcium chloride is one of the most used materials for absorbing moisture, especially from gases. It has a much higher attraction for moisture than ordinary table salt, although its cost is somewhat higher. There are no fancy, expensive kinds of earth connections which are any better than an ordinary iron pipe combined with imprisoned moisture held by natural salts. Where an earth connection is intended to carry heavy dynamic current, as for example, at the neutral of a grounded generator, the nature of the problem is not changed. It is simply necessary to add sufficient area to carry the maximum dynamic current without reaching the density of current which will dry out the earth around the pipe. In such a case it is usually desirable to feed in salt water from time to time in order to keep such earth pipes thoroughly soaked. The use of several earth pipes at a distance of six feet or more apart, to reduce the earth resistance, is now a well-known practice. The chemical action of the salts in wearing out iron pipes is sometimes mentioned as an argument against the use of salt. In a number of test samples it was found that the corroding action of the salt on the pipe was of negligible value even after a number of years of use. Even under the worst condition of corrosion, it is better to permit it and have a good earth connection than to preserve the metal against corrosion by keeping it dry and having, continuously, a very poor earth connection.

OVERHEAD GROUND WIRES AS AN UNSOLVED PROBLEM.

Little by little the last few problems in the protection of apparatus are being solved. This work is being done by the manufacturers of electrical apparatus. The prospects are bright for reaching, in the near future, the condition of insulation and protection in transformers and generators such that nothing but negligence will cause damage to the apparatus. All conditions of protection are at present so much better in stations than they are on the lines that interruptions are almost invariably due to damage to some point on the transmission line. It has been patent for a number years that the protection of lines is not being sufficiently studied to produce a suitable engineering advancement. No single company has been willing to expend the money to obtain the apparatus and the rarely developed talent for the investigation of lightning phenomena on transmission lines. As a matter of fact there have been no devices made as yet which will give accurate information regarding the localization and distribution of lighting potentials along a line. There is required for this primarily a recorder which would simultaneously and quickly record the discharge of electricity at or near many insulators. One part of the outfit necessary to study the efficiency of overhead ground wires is now to be found in the device called the "multi-recorder." There are still lacking the necessary interest and co-operation among transmission systems to organize a scientific attack on this problem.

The recently developed possibility of making accurate studies of the value of overhead ground wires is earnestly brought to the attention of the members of the Association. Many thousands of dollars are being invested every year in overhead ground wires. There is little doubt that where they have been installed they have been of sufficient value to warrant their cost. There are, however, many places where the conditions of installation do not warrant the use of the overhead ground wire. For example, in the case of 2300-volt lines on wooden cross-arms situated inside the limits of a city. At the other extreme, there are probably many places where the use of several overhead ground wires would be fully justified. Expenditures for constructions are made somewhere blindly, and no attempt is being made at the present time to get a technically correct solution of this problem.

The methods used in testing various shells and insulators should include the following: Method A. This is the usual method of test for either one piece or multipart insulators. The plan consists in immersing the head of the insulator in water up to the depth of the threading. Connections are then made. Method B. This is a regular test for multipart insulators and consists in separately testing each piece, exactly the same as the whole is tested in Method A. Method C. This is a dry test, and is a test of the whole insulator, whether one piece or multipart.

Strain insulators are usually tested (Method C) by using a metal tube passed through the insulator as one terminal and a chain or wire around the wire groove, as the other terminal.

Wall insulators are usually tested (Method C) by passing a metal rod through the insulator and applying a metal strap around the outside of the point provided for the panel.

Methods of Locating Opens and Grounds on Series Arc Circuits

(*Contributed Exclusively to* Electrical Engineering).

BY JAMES M. PURCELL.

THE essential linue troubles that are encountered in the operation of series arc circuits are pen circuits and grounds. The effect of an open is obvious. When an open is discovered at the station, the first thing to do is to cut the faulty circuit out of commission. The line may be down in the street, which is often the case with this trouble and when such is the case, it is a serious menace to life and property. The voltage of the line, which on a fully loaded fifty light circuit is generally about four thousand volts, on an open circuit reaches a value sometimes fifty per cent in excess of this, or around 6,000 volts.

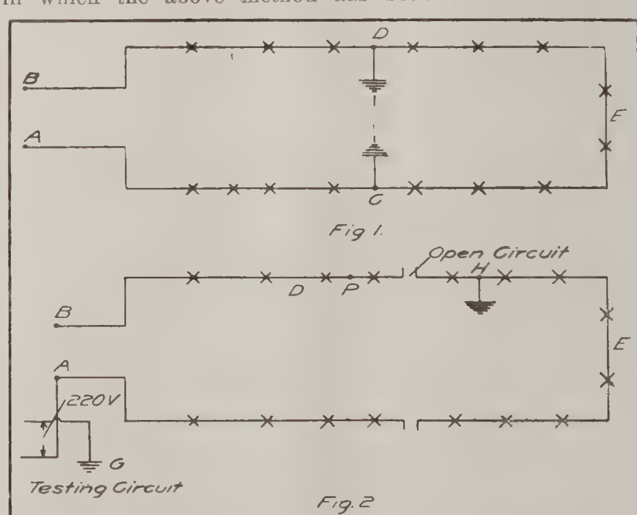
Grounds, while not of so serious a nature at first, are of enough importance to warrant the immediate attention of the trouble man. Fig. 1 represents an arc circuit with a ground at *C*. This single ground by itself is not dangerous, neither does it interfere with the proper operation of the system. But should the arc wire come in contact with some low tension wire in its long route through the streets, a disastrous fire or a bad accident might happen. Again, referring to Fig. 1, another ground might come on at *D*. If both of these grounds were heavy ones, then all of the lamps between D and C would be out. Another danger which might arise from two heavy grounds is the damage that could be done to these series incandescent lights that might be connected in the loop. *A B C D*. In this case the grounds might short circuit a considerable portion of the circuit and the instantaneous current values might be such as to burn up the lamp. This may in some cases be as high as 10 amperes. An accident parallel to the above condition happened within the writer's experience, in which seven or eight 100 watt, 7.5 amp. lamps were destroyed. Partial grounds at *D* and *C*, by acting as an resistance in multiple with loop *D C* seriously hamper the proper operation of the lamps and effect their light.

To the writer's knowledge there is no method using the ordinary commercial instruments for locating (from the plant) a break in an arc circuit. This must be done on the outside, by the trouble man. This may be done in three ways. (1) By the use of a testing magneto; (2) by the use of a suitable testing circuit and interrupter in series and a testing coil and telephone receiver in the hands of a trouble man; (3) by means of a suitable testing circuit connected to a damaged circuit and a lamp bank, with the trouble man. The first two methods will not be considered, the first being unreliable, and the second involving the use of two or three pieces of apparatus. The third method has been successfully used by the writer, and is as follows: A low voltage, say, 220 volts, is connected at the station to the line at *B* and to the ground as in Fig. 1. The trouble man goes to the middle point of the circuit as at *E*, and attaches his test lamps (2-110 volt lamps) between the line and the ground. Knowing the terminal to which the testing circuit at the station is connected (which is the right hand wire leaving the station) the lighting of the test lamps indicates, as can be readily seen, that the break is between *E* and *B*. He then goes to the middle point of this section, as at *F* and getting no light, knows that the open is between *F* and *E*. By repeating this halving of the defective section each time, he will quickly locate the trouble.

In the location of grounds, the magneto and testing circuit as used in the tests for opens may be used. Referring to Fig. 2, a ground may develop at *H*. The test is connected as in the previous case, one end to the circuit, the other to the ground and the trouble man starts at the middle point as before. At any point between *H* and *A* the test lamp will light, but as soon as the ground *H* is between the tester and *A*, the lamps will remain dark. The circuit will have been completed from the ground at *H* to the ground at *G*.

There are other methods used in locating grounds, using the high tension voltage of the arc system, but most of them involve some danger. One method uses a number of incandescent lamps connected in series and to the ground. Full voltage is impressed on the grounded circuit and a flexible cord which is attached to one side of the line and the other end moved along the bank of lamps until the lamps are burning at full brilliancy. The voltage across the lamp in the outside circuit being known by counting the number of incandescents, the location of the ground may be determined. This is illustrated in Fig. 3. Another high tension method is to ground one end of the circuit and then impress normal potential on the line. A number of lights, between the line ground and the station will not light and the ground can thus be located. This is not to be recommended however.

The high tension method as mentioned and used by the writer, enables the ground to be located while the circuit is in normal operation, and requires only the instruments that are found on a modern arc switch board. The plant in which the above method has been used has ten 100



Figs. 1 and 2. Diagrams for Location of Grounds.

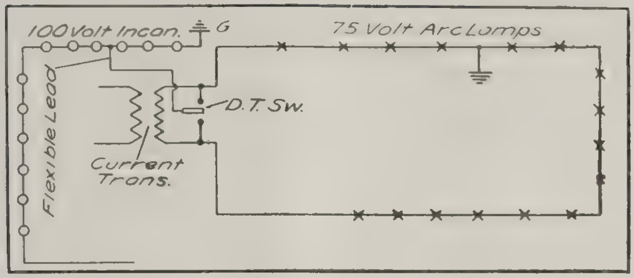


Fig. 3. Location of Grounds by Use of Lamp Bank.

light, 2 circuit arc panels mounted on pipe frame-work side by side. In addition to the plug switches each panel has testing plugs, which are connected with voltmeter and ground detector by means of a test bus running in the rear, the length of the ten panels. In Fig. 4 is shown a wiring diagram of a panel.

The back plug contacts at A and B are connected to the testing or voltmeter bus, while the front contacts are connected to the line. A special plug as illustrated in Fig. 4 is constructed of a fibre tube, through which a wire is run. This wire terminates in a copper cap on the end of the fibre tube, on the other end to the ground through a flexible wire. Line voltage is first taken by inserting the regular testing plugs at A and B, and the reading noted. The special testing plug is inserted at A and the regular plug at B. This will give the voltage between B terminal cross the lamps to ground at C. This reading we will call (b). Another reading may be taken now, reversing the plugs which we will call (a). If the sum of the readings (a) and (b) equals the line voltage then an indication is given that the test will be correct. The line resistance being small the drop will be composed of the drop across the lamps. Knowing the drop across each lamp, the distance from the station will be proportional to these two readings.

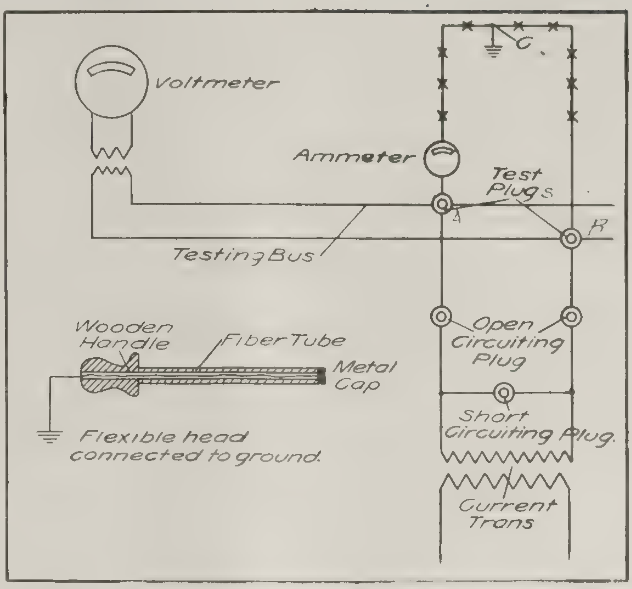


Fig. 4. Voltmeter Method of Locating Grounds.

Example. A fifty light 7.5 a. c. arc circuit shows a line voltage reading of 4000 volts. The reading (a) is 1600 volts and (b) equals 2250. The sum of these two readings is 3850 volts, which is near enough to be a check on our test. Now each lamp takes approximately 75 volts. Then the ground C will be 1600/75 equals 21 lamps distant, counting from A or 2250/75 counting from B.

Some Problems Met by an Electrical Troubleman

(Contributed Exclusively to Electrical Engineering)

BY J. A. HORTON.

Section 1. A Discussion of Causes and Solutions of Various Troubles in Electrical Equipment.

OCCASIONS sometimes arise for changing the ratings of direct current generators and motors, that is, a change of the windings to suit new voltage conditions that will call for a different current to correspond to a given horsepower rating. In changing from 500 volts to 250 volts or from 250 volts to 125 volts, or vice versa, or in making any change wherein the voltage before or after the change is an exact number of times that after or before the change, respectively, the winding modifications required may be comparatively simple. In going from 250 volts to 125 volts or from 500 volts to 250 volts, ordinarily only the armature need be rewound, because where the machine has more than one field coil, the desired field coil modification can be secured by changing the shunt field coil connections from plain series to parallel or to series-parallel as the case may require. Thus two coils in parallel across 125 volts, would give the same magnetization as two coils in series across 250 volts.

The point to be made here is, that in passing from a given current rating to a higher current rating, the current carrying capacity of parts other than the winding, should not be overlooked. In passing from a lower to a higher voltage rating, the matter of insulation of the increased voltage is important. In passing to a lower voltage rating, however, the current is increased correspondingly and the connecting cables and brushes may be unable to carry the increased current corresponding to full power rating of the machine in question. The matter of increasing the current carrying capacity of the cables is a simple one, but to increase the capacity of the brushes, larger brush-holders may be required and there may not be sufficient room on the commutator to accommodate them. Where 125 is the voltage after the change or where the load to which the machine is to be subjected, is a constant one, the brush capacity problem may be solved by the substitution of copper brushes for carbon ones, assuming the latter to have been used, as is generally the case on machines operating at voltage exceeding 125 volts. Of course if the machine is to be used as a motor to operate in both directions, copper brushes may not be considered, unless special measures are taken to provide for tipping the brushes for the rotation direction desired.

Another point sometimes overlooking, which has caused trouble, is the series field capacity of compound machines. This proposition may be looked after either by connecting the series coils in parallel or in series-parallel, to give the required current capacity increase, or by discarding the series windings and operating the machine as a shunt machine. Finally, in the cases of shunt or compound generators, if the shunt coils were connected in series before the change and are connected in parallel or in series-parallel, after the change, it will be necessary to increase the current carrying capacity of the field rheostat, because the total exciting current has been increased. Failure to consider these points has caused expense and, in some cases, disappointment.

Another Common Oversight.

Where direct current generators bought at different times and, perhaps, from different makers, are to be run in parallel, it is natural to expect that they will not share the total load as proportionally as will generators bought at the same time and from the same maker, because in the first case, their characteristics are different. However, assuming similar characteristics and an equalizer of ample cross section, equalization will not even then be satisfactory, unless heed is paid to the requirement that the series field resistance of each machine be inversely proportional to its capacity. It must be remembered that series field resistance includes not only the resistance of the series field winding itself, but of the cable that connects that winding through the switch to the bus bar. Wiring contractors and customers who install their own machines, often overlook this point and then wonder what the trouble may be when one machine takes more than its share of the load. Two machines exactly similar in all respects will take equal loads if their connecting cables are of the same length. If one machine is further from the switchboard than the other its connecting cables must be made correspondingly larger, in order to keep their effective series field resistance equal. If the machines are of different sizes and are at different distances from the switch board and the resistances of the series field windings are unknown and cannot be conveniently determined, it may be necessary after installation, when a load can be applied, to get equalization experimentally.

Helping Radiation in Motors and Generators.

Generators and motors may be of open or of enclosed construction. The former construction is adapted to service in which the unit is not subjected to conducting dusts and vapors or to drippings and rain. The latter may be used anywhere, but they cost more, because for a given rating, they must be heavier than the corresponding open unit. Purchasers often buy the open type because it is cheaper, box it in or build a house around it, if conditions demand this procedure, and then wonder why the machine heats. In many cases housing produces no bad results because the unit does not happen to run anywhere near its full load. In cases of full load or of overload, however, trouble brews because the heat generated can not get away and the temperature runs up to the danger point. An instance was noted where a 300 Kw. generator operating in a paper mill, was enclosed in a house but little larger than the generator and switchboard and with the door of which kept closed, the insulation was almost boiling. Cutting of windows in one side of the coop near the bottom and in the other side near the top, decreased the temperature 20 degrees C. In another case, a motor in the top of a tinned roof elevator was boxed in for fire protection. A few more days would have brought the fire. A 10-inch hole in the top of the box and another in the bottom, relieved the situation. Finally, an enclosed motor known to be overloaded, was heating so badly that it was almost impossible to keep oil in the bearings. The work was important, so water was piped from a dam and sprayed upon the motor to save it until it could be replaced with a larger one.

A Peculiar Symptom.

One of my inspection clients claimed that a 3-horsepower direct current motor, operating a washing machine in his bottling works, was gradually losing its speed, thereby slowing down the whole train of operations and decreasing the output of the plant. A test of the motor seemed to show that the voltage, current, commutation, temperature, sound and speed were all normal. Tests were then made on the motors of the devices immediately preceding and following the washer in the work train, to make sure that speed increase there had not made the washer motor appear slow by comparison. As the client was not satisfied that his own imagination was entirely responsible, he asked the inspector to call on Sunday, when everything was shut down, so that the motor could be taken apart without interrupting the service. It proved unnecessary to disassemble the machine, because on taking speed again, with everything quiet, the inspector noticed that the act of pressing the speed counter against the end of the armature shaft, raised the pitch of the commutator noise a full tone, corresponding to an armature speed change of about 300 rpm. While the commutator was perfectly smooth to the hand and to the eye, and did not give a sign of a spark (it carried about half load), the mica actually was slightly high, thereby introducing resistance into the armature circuit. The effect of shoving the armature over with the speed counter, was to bring new commutator surface under the brushes. This cut out the mica-air film under the brushes and raised the speed.

Trade Tricks.

Direct current generators and motors of the commutating pole type, are generally shipped by the makers, with the brush holder rocker-arm doweled in the position in which it is to be operated. On non-commutating pole machines, corresponding marks on the rocker-arm and on the bearing housing end, indicate the rocker-arm position corresponding to no load neutral. Under other load conditions, some machines will operate satisfactorily, with the brushes on the no load neutral and other machines may require that the brushes be shifted forward or backward according as the machine is used as a motor or as a generator. In any case, the finding of the best brush position is a matter of rocking the brushes to the non-sparking point. An inspector was invited to look at a large motor that had never been right "since the strike." The brushes sparked badly and reasonable shifting did no good. Resistance, polarity and insulation of fields and the brush count were checked and found correct. From an operator's remark that the machine was much "slower than it used to be," the inspector concluded to further investigate brush conditions. The theoretical neutral was determined by following a conductor from the slot to the commutator bar and on shifting the brushes accordingly, commutation was perfect. It seems that all brush holders had been turned around because the armature rotation had been reversed. The original operator knew of this and had shifted the brushes back to the old marks before he left. Anyone familiar with the particular make of motor would have noticed this at once, as it was, a half day was spent testing.

Trouble With Solenoid Brake Coils.

The current taken by a direct current magnet depends upon the resistance of the winding and upon the voltage applied to it. In the case of an alternating current magnet, the current depends also upon the self-induction of the coil and the self-induction in turn depends upon the reluctance of the magnetic circuit of which the movable magnet armature is a part. Ordinarily when a hoist is operating, the brake coil is energized, the brake shoes are held clear of the brake wheel, the armature mates closely with the magnet and the reluctance of the magnetic circuit formed by the magnet and the armature is very low. Under this condition, the self-induction is high and the current through the coil is small. The instant the current is interrupted in the hoist motor, however, it is also interrupted in the brake coil and either gravity or a spring applies the brake.

This is an economical arrangement, because the brake coil then takes current only during the duty cycle and then the current is a minimum. When current is applied to the hoist motor, current applied to the brake coil the instant before, energizes the coil and releases the brake. At this time the armature is removed from the magnet a distance depending upon how well the brake adjustments are maintained. With this air gap in the magnetic circuit, the reluctance is high, the self-induction is low and the first impulse of current is several times the value that the current will have with the armature closed upon the magnet. For example, a coil that ordinarily takes a current of 6 amperes may admit a momentary current of 30 amperes under normal conditions, and may admit a current of 50 or 60 amperes if the air gap in release position is not kept adjusted at standard value. Within certain limits of shoe wear and pin wear an alternating current solenoid brake outfit will not indicate a need of adjustment by any evident action or want of action. The fact that excessive wear may greatly increase the distance through which the magnet must attract the armature, does not materially affect the promptness with which the armature is drawn to the magnet, because, owing to the large air gap, hence great reluctance and small counter emf. of the coil, the current increases in a measure sufficient to keep the attracting force almost constant. Therefore, within certain limits, the only way to check the condition of a lot of solenoid brakes is by inspection. The penalty of lax inspection is a lot of roasted solenoid brake coils.

About the first symptom of brake coils weakened by roasted insulation, is their failure to release the brakes promptly. If the voltage then falls below normal the brakes won't release at all, and this means that not only is the hoist motor required to operate with the brake applied, but that at all the voltages a certain amount below normal, the brake coils are taking current corresponding to a large air gap, so that the abuse becomes accumulative. The safety of the brake coils depends upon the gap closing as soon as the controller is advanced to an operating position. If the voltage is insufficient to provide current enough to lift the armature, ultimate burn-out of coils is assured, although they may be of liberal design.

Valuation of Public Service Properties

A Discusison From Standpoints of Public Service Commissions and Investors

BY L. R. NASH.

WITH the increase in number and the extension of the field of public service commissions, the various hearings on rates and other public service investigations, more and more attention has been paid to the determination of the value of properties employed by public service corporations. The value of these properties have figured most in the assessment of taxes, determination of rates, fixing prices for sale or purchase and the limitation of security issues. In all appraisals one of two viewpoints have been taken—namely, a determination of the original cost of the property or the cost of reproducing it at the present time. In most cases the former cost is most equitable, as it represents more nearly the assets of the company from a physical standpoint when a suitable amount is allowed for depreciation.

In discussing the various factors entering into the valuation of any property, Mr. L. R. Nash, of the Stone & Webster organization, in a recent issue of the *New York Commercial,* has the following to say: Having determined the cost of the existing physical property, the question of its depreciation must be considered in determining present value. While some authorities believe that, for purposes of rate making at least, there should be no reduction in value on account of depreciation so long as the property can be operated and its customers served at one hundred per cent efficiency, it is more commonly held that deductions should be made for visible deterioration.

The argument in favor of depreciated values may be summarized as follows: A property is supposed to earn a reasonable return upon its fair value in addition to its operating expenses, taxes and a suitable allowance for depreciation. If the property depreciates,as is bound to happen to some extent under the best of management, its depreciated or present value together with the accumulated depreciation fund would equal the value when new. After replacements of worn-out elements have been made from the depreciation fund, the increased present value, together with the balance of the depreciation fund, would still equal the value when new, this latter condition continuing indefinitely. If, with adequate earnings, no provision is made for depreciation, and all profit is distributed to the owners of the property in the form of dividends at unusually high rates, the excess in dividends should be considered as a portion of the investment returned in advance, leaving a balance reduced to the extent of the accumulated depreciation, which in turn is measured by the difference between present value and value new.

The values so far discussed are bare physical costs representing what may be called inventory value or structural cost, the latter term being used herein. This by no means represents the total value of the physical property. No work of importance should be undertaken without carefully prepared plans, specifications and engineering advice. Skilled and general supervison of the construction work is also usually advisable. Insurance against fire and accidents during construction is a wise precaution. Interest must be paid on construction funds during the construction period, and brokers are entitled to a fee for furnishing these funds from the sale of the company's securities. Taxes must also be paid on real estate and other property from the date of purchase. Most well-developed public service properties are the result of gradual development under which construction costs are greater than if the complete property were assembled at one time. In the latter case a general contractor usually assumes responsibility for the entire work, charging a percentage on all sub-contracts. It is therefore the custom of many appraisers to figure the structural cost with wholesale unit prices, and to add a percentage for either "piece meal" construction or contractor's profits. Finally, it is always found that inventories of property are more or less incomplete and difficulties encountered in construction are hidden, leading to low values which must be corrected by an added percentage of contingencies. All these elements, usually expressed as percentages of the structural cost, are definite and essential factors in the assembling of the physical property without which it would be incomplete.

One further element only remains to be considered to determine the fair value of the property. It is variously styled good will, going value, earning value, development cost, etc. Up to this point we have considered the physical property with its necesary "overhead" charges and the organization of a corporation to own and operate it. So far it has only potential business value. It is merely a collection of inert physical elements with a suitable legal status and capacity to perform certain functions. It must not only offer its wares, but demonstrate that they are reliable, suited to the needs of prospective customers and worth the price asked for them before it can claim stability as a business enterprise or security as an investment. It is generally recognized that this transformation from potential to kinetic usefulness involves costs to which, from the above description, the terms going value and good will might logically be applied.

The first step to be taken with a duly incorporated and constructed public utility is the assembling of a suitable operating organization, each part skilled in its particular duties and properly co-ordinating with all other parts. In spite of most active commercial work, a profitable business is very rarely secured at once. Its development may not only be slow but in some communities it may depend upon a growth of the community which the utility itself must foster.

It is, however, in many cases unquestionably a public benefit that transportation and other public service be extended into territory which for some time may be unprofitable. When and how shall the deficit be paid? The old, conventional way was to allow the public service rates to remain undisturbed with growing business until profits had exceeded normal returns on the growing investment sufficient to wipe out the early deficits. But before this happy time has arrived some aggressive citizen or public service commission sees apparent exorbitant profits from a public monopoly, and the balance of the unredeemed deficit may be lost.

Even if the company is allowed to make up its deficit in full, the aggresive citizen, although he may not appreciate it, still has a real grievance. He is helping to pay in a comparatively few years the entire cost of the necessary development of the community. Such injustice, as it may fairly be called, is avoided by allowing the public utility to capitalize its losses during the development period, the community then paying at any one time only a fair return upon the total losses.

It thus appears that while development cost is lagrely incurred in putting a business originally upon its feet, it may continue for a much longer period. It is broadly contended that, where any public utility is established with the approval of the comunity, and economically constructed and operated without obvious lack of business judgment in the ability of the community in the long run to support it at reasonable rates, the community is bound to see that in the long run the utility gets a fair return upon its investment, whether this investment be in property or in losses in its business.

The matter of inventories and unit costs has been briefly but sufficiently considered. The allowances which are necessary for "overhead" charges need further definition. The first element to be considered is contingencies, because it represents additional physical property, and might properly be classed with such property rather than as an overhead charge. Depending upon the thoroughness in preparation of inventories and examination of the property for abnormal construction conditions, it is customary to allow from 5 per cent to 10 per cent. In estimates of cost of reproduction an allowance of 10 per cent is commonly made for general contractor's profit. If the actual original cost of the property is to be estimated, contractor's profit would ordinarily be appropriated on only a part, but the balance, constructed "piecemeal," should be figured with unit prices at least 10 per cent higher. For engineering and supervision it is most common to allow 5 per cent, although a higher percentage is sometimes considered necessary. Some authorities exclude engineering charges, in part at least, from certain equipment such as rolling stock. Liability and fire insurance and taxes during construction are of minor importance, and commonly grouped in authoritative cases with other items. They may amount to approximately 1 per cent. The requirements for interest during construction depend upon the time required to complete the work under estimate. An average allowance is 5 per cent. It is customary to employ brokers in connection with the issue and sale of securities covering the project. Their fees for such services may be from 2 per cent to 10 per cent, or more, depending upon the attractiveness of the issues and the risks and responsibilities assumed. The percentages above discussed should be successively added to the structural cost.

There is less consistency in the provision made in appraisals for the intangible elements, including the preliminary organization and promotion costs. They are very largely ignored by some authorities, and given very considerable value by others. From 2 per cent to 5 per cent is not uncommon, and more has occasionally been allowed. There is still less agreement with reference to development costs. Apparently the lack of full understanding as to what is properly included under this heading is responsible in some measure for this situation. It also appears from a review of authoritive cases that some distinction is made with respect to the purposes of the valuation. The courts have held in a number of cases of sale or purchase that the value of "good will" was from 10 per cent to 25 per cent of the cost of reproduction. A careful study by competent engineers of the actual losses incurred in developing the business of a number of public utility companies has shown that they agree very closely with an average of 30 per cent of the cost of reproduction.

It will be of interest to consider the aggregate of all the above overhead charges as compared with the structural cost. The successive addition of the percentages applying to the physical property gives a cost of reproduction from 129 per cent to 158 per cent of the structural cost. The further addition of percentages connected with the organization of the company gives totals of 131 per cent to 163 per cent of the structural cost. The final addition of percentages to cover development costs gives an undepreciated fair value from 141 per cent to 188 per cent of the structural costs. It thus appears that it is by no means inconceivable that such fair value in certain cases may be double the structural cost if development costs are fully considered.

As has already been suggested, for purposes of property taxation or bond issue, the physical elements and their overhead percentages only are ordinarily considered. In rare cases, all elements which enter into the fair value should be included. For purposes of purchase or sale the fair value will be considered in connection with original cost, capitalization, present earning power, future prospects and other factors familiar to the investor.

There remains to be considered in some detail the procedure in rate cases, which are becoming more and more common with the establishment of public service commissions. The principle established by these regulating bodies is that rates should be no higher than are necessary to yield a fair return to the owners of the properties, any increase in profits being followed by corresponding rate reductions. The more conservative method of regulation may be more specifically described as follows: A company may charge only such rates as will provide for necessary operating expenses, including full maintenance of the property, taxes, a proper allowance for depreciation, and a reasonable return upon the fair value of the property. The important questions involved are as follows: 1. What is a proper depreciation allowance? 2. What is a reasonable return? 3. What is the fair value of a property?

The subject of depreciation presents unusual complications. We are confronted with a complex factor in depreciation which has been aptly styled "functional depreciation" as distinct from the better understood "physical depreciation."

It is recognized, for rate making purposes, that earnings should be sufficient to provide fully for the replacement of physical elements at the end of their useful life and for extraordinary repairs during that life. What, with our present light, shall be set aside for this purpose? It is the custom of many companies to retain not less than 10 per cent of their gross earnings before dividends are declared, or to retain from 20 per cent to 25 per cent for depreciation and maintenance together. Another and more accurate method is to set aside a certain percentage of the cost of the physical property, either as a whole or by applying suitable varying percentages to different groups of elements.

The rate of return to be allowed on the value of the property varies with the location and character of the business. The basis from which it is determined is logically the rate charged by banks in the local field for secured loans. The return on public service investments should be enough higher than this rate to compensate for lesser security of both principal and return on account of possible unwise municipal or other restrictions, competition, and other adverse influences. It is generally believed that an exclusive or indeterminate franchise which insures freedom from competition, justifies a lower rate of return than otherwise, and therefore permits lower rates to the public. Also that even under these conditions a rate of 2 per cent higher than prevailing bank rates is justifiable and essential to secure the capital necessary to satisfactorily conduct and expand the business. Commissions have approved rates of return of 7 per cent and 8 per cent under non-competitive conditions, and opposing experts have agreed that 10 per cent was not excessive in cases where competitive sentiment prevailed in a community although competition might not actually exist.

The question of the fair value of the property, to which rates of return as above discussed shall be applied, has been already considered. It may be assumed that present or depreciated value is that approved by a majority of authorities, but that such value should not be used unless depreciation has been earned or unless unearned depreciation and other losses have been included in development costs. The depreciated value of well-maintained utilities is normally between 75 per cent and 85 per cent of the cost of reproduction.

After assuming in any specific rate case a suitable rate of return upon the fair value of the property, determining depreciation requirements and adding operating expenses and taxes, the total amount which may be earned is obtained. If this is less than actual earnings, suitable reductions in rates are justifiable. If, on the other hand, the total is greater than the actual earnings, an increase in rates would be equally appropriate.

No reference has been made above to the inclusion of franchise values in appraisals, other than to provide for the bare costs of acquiring them among the organization expenses. While in some appraisals large values have been allowed for franchises, it has been very generally held that all such rights, freely granted by the public, are not properly capitalized. If, on the other hand, franchises are actually sold by municipalities, the price paid by the company is a proper part of the fair value of the property. Franchises freely granted are often the subject of taxation. The determination of a franchise value for such purposes is sometimes required. In a few states the procedure is defined by law, in others it is largely a matter of guess work. In most cases there is some recognition of the so-called net earning rule, which, as defined by the New York courts, may be briefly stated as follows: Deduct from gross earnings, operating expenses including maintenance and depreciation, and a reasonable return on the value of tangible property devoted to public uses, the balance capitalized at a fair rate giving the franchise value. It will at once be seen that under strict commission rate regulation the franchise value would be substantially equal to the overhead charges not directly applicable to the physical property.

Atlantic City Convention of American Electric Railway Association

At Atlantic City, N. J., the convention city of the north and east, the American Electric Railway Association during the week of Oct. 13 to 17, held its 32d convention, which, let it be known, was one that truly dug into the problems of the industry and laid bare as never before their internes for careful and thoughtful consideration. The address of President George E. Harries, of Louisville, Ky., will go down in the association's records as a masterpiece on current work and problems in the electric railway field. It set the pace for the discussion of facts regarding development work in the future and the precarious conditions that now exist on account of new difficulties. Fired by his remarks and words of encouragement, other problems were attacked in a like manner, with the result that the convention record is a mass of useful suggestions and details by men of large interests and responsibility as well as numbers of managers and engineers who through experience in railway work are in a position to contribute much of value to the average electric railway official and engineer.

The American Electric Railway Association, made up of 401 member companies and 2,997 individual members, is now a wonderfully well organized body, as the nature of its work slightly hinted at above, clearly proves. It is the parent of five other affiliated and allied associations, the Engineering Association, Accountant's Association, Claim Agents' Association, Transportation and Traffic Association and Manufacturers' Association, each taking up matters pertaining generally to electric railway management and operation. Each association has its own organization and its own convention program, so that the individual interests of the members of so large and influencial a body are best conserved and matters vital to the different branches of the industry best presented and discussed. As an indication of the interest taken in the convention, it is only necessary to state that the present convention was attended by over 3,100 members and guests.

In what follows a report of the Engineering Association only will be given in full. It is believed that our readers who are interested in the proceedings of the other associations will do well to secure all other papers from the secretary of the parent body, or perhaps a more practical thing would be to secure the copies of the daily edition of our worthy contemporary in the electric railway field, the *Electric Railway Journal,* of dates Oct. 14 to 17 inclusive. The work this publication contributes to the convention delegates and other readers as well, by covering in a complete manner every item of convention interest, is one most liberal and again indicative of the spirit that exists in promoting the interests of the association.

PRESIDENT GEORGE H. HARRIES' ADDRESS.

The annual address of the president of the American Association opened with remarks of encouragement in regard to the future trend of the electric railway business. These remarks were tempered, however, with statements referring to some of the difficulties which have been encountered in the electric railway field thus far, as well as some of the problems yet to be solved. Considerable emphasis was laid upon the fare situation and it made plain that some method must be devised of increasing the revenue from same. President Harries said: "Never was public transportation so cheap or of such excellence as it is now. Never has desire to render the maximum of service for the minimum of cost been more sincere or effective. Never has there been so much of expensive comfort for the patron or so much costly discomfort for the company." He urged that the members look the financial situation squarely in the face in order that the supreme question of an unyielding fare be dealt with properly.

In reference to the serious question of fare, he quoted James D. Mortimer, president of the Milwaukee Electric Railway & Light Co., on the nickel zone system. It seemed to be the opinion of this authority that the solution of the difficulties presented is in the fixing of single fare limits at the present limits and arranging some system of fares outside this area that will permit the collection of additional fares proportioned to the distance traveled in the other zones. He believes that the nickel is too large a sum to charge for the short distance outside the inner zone that many passengers ride. The smallest practicable zone best suited to the conditions that exist today seems to be one mile, and expediency seems to justify a charge not in excess of two cents for a ride across such a zone with an additional two cents for each mile ride across other mile zones surrounding the city zone. These remarks quoted from Mr. Mortimer were followed by an explanation of the Bureau of Fare Research which is to secure valuable data over a period of three years.

President Harries commented especially on publicity work, advising that it take the form of local work done in educating civic bodies, chambers of commerce, regulating commissions and the public generally. He emphasized further the importance of official representation at the National capitol to keep in touch with legislative, executive and judicial projects and acts that concern common carriers. He mentioned this on account of the fact that the Interstate Commerce Commission is engaged in the preliminary planning of federal valuation of interstate properties and the methods adopted by the commission will be of as much importance to interstate companies as those whose operation crosses state boundaries, for the final rulings of the national commission will ultimately govern the practice of all state regulatory bodies.

The latter part of Mr. Harries' address was devoted to the convention program and the work of the different associations.

OFFICERS OF THE AMERICAN ASSOCIATION.

The officers of the American Association elected at Atlantic City: President, Charles M. Black, vice-president of the United Railways of San Francisco; 1st vice-president, C. Loomis Allen, Syracuse, N. Y.; 2nd vice-president, Charles L. Henry, Indianapolis, Ind.; 3rd vice-president, John A. Beeler, Denver, Colo.; 4th vice-president, L. S. Storrs, New Haven, Conn.

Papers of Engineering Association.

The address of President Martin Schreiber of the Engineering Association was the important feature of the opening session of this branch of the convention. In this address Mr. Schreiber pointed out that the executive committee has instigated no radical departures from ordinary routine followed in the past. Standing and special committees now have subjects assigned to them at the first of the year and specific duties assigned to vice-presidents. He mentioned the fact that the engineering association was the first to take up the study of electrolysis, the investigation now being a joint one at the request of the American Association. Progress has been made by the co-operation of the committees with other technical bodies and at least two specifications recommended for adoption by the association have been standardized by others.

The report of the committee on standards covering matters relative to changes in procedure for the adoption of standards and the preparation of the Engineering Manual was presented by Paul Winsor, chairman, of Boston, Mass. In addition to the regular work of the committee, the matter of procedure and of the compilation of existing engineering practices of the association were taken up. The matter of standard forms for specifications and the publication of standards and recommended practices were turned over to a sub-committee, the work of this committee to be presented in book form and revised annually. These recommendations and suggestions were the result of the mid-year conference. The sub-committee recommended the new publication and suggested that it be named "Aera Engineering Manual," to be printed and furnished each member company and individual members.

The report of the committee on power distribution was presented by G. W. Farmer, Jr., chairman, of Boston, Mass. This report presented specifications for rubber insulated wire and cables, the committee confining itself to specifications for wiring cable of not more than 2,500 volts working pressure and two grades of compound have been designated. Specifications for trolley wire was considered, in connection with certain changes in the American Society of Testing Materials hard drawn wire copper specifications, as regards tensile strength, elongation and torsion covering sizes of 00, 000, and 0000 round trolley wire. Specifications for steel tubular and wooden trolley poles were also submitted.

Overhead crossings and transmission lines for electric light and power systems came in for discussion, it being advised that the specifications presented at the 1912 conventions should be rewritten in a number of sections to include suggested changes which met with the approval of the joint committees. The appendices of the report contain detail specifications of rubber insulated wire and cable, as well as for tubular steel poles, much data being in the form of tables.

The report of the committee on electrolysis as presented by Albert S. Richey, chairman of the committee, of Worcester, Mass., took up a general discussion of the corrosion of underground conductors by stray earth currents. The subject of tests, including a potential survey, was thoroughly taken up, a discussion of current flow in pipes, and determination of amount and distribution of current leaving underground metallic conductors. The method of reducing earth potentials and currents, thus mitigating electrolytic corrosion was also briefly touched upon. The report is an important one and the work of the committee will be decidedly useful.

The report of the committee on block signals for electric railways was presented by Chairman J. M. Waldron, of the Interurban Rapid Transit Co., New York City. This committee repeated its recommendations of last year, that for high speed interurban service, automatic signals be controlled by the use of continuous track circuits, and that expenditures be concentrated on continuous track circuit control with a cheaper form of indication in preference to a more expensive form of signal and less reliable control. Signalling systems on single and double track suburban lines for short headways and high speed were outlined. The appendices to the report cover a summary of installations of signals by different manufacturers during the past year, including descriptions of the apparatus.

The report of the committee on train operation for city service, by Chairman H. H. Adams, of Chicago Railway Co., Chicago, Ill., dealt largely with the question of transportation matters as applying to the operation of two-car trains in city service and to the effect of train operation upon schedule speeds with various types of trains in service, comparing this with single-car operation, also effect of length of stop on train operation. The committee referred especially to tests of train operation made by the Public Service Railway Co., of New Jersey, since these tests are both complete and exhaustive. A report of these tests accompanied the committee's report. The experience of the Pittsburg Railways Co., through its general manager, P. N. Jones, was also presented. The committee especially recommended in regard to city service problems, that the operating officials of city properties give the subject of two-car train operation serious study and attention, as it is the belief of the committee that a distinct saving is to be made by train operation during periods of the day over portions of a system.

The report of the committee on train operation for interurban service, by Chairman Edwin C. Faber, of the Aurora, Elgin & Chicago Railways Co., Wheaton, Ill., presented information based on data received from over sixty companies, twenty-six of which are using train operations to a greater or less extent in regular passenger service. Most of their roads which are operating trains in regular service have cars equipped with multiple-unit control. The data secured seems to show a general tendency of electric interurban service is to follow steam road practice, particularly as the density of traffic and length of haul increases. In regard to the saving effected in power consumption by the operation of trains, about 25 per cent of the roads consider there is a saving estimated at from 2 to 25 per cent over what it would be with single cars. The majority, however, have never investigated nor considered this phase of the situation. The report is accompanied by considerable data to determine the energy consumption of one, two and three-car trains in regular service.

The report of the committee on buildings and structures, by Chairman R. H. Pinkley, of the Milwaukee Electric Railway & Light Co., Milwaukee, Wis., discussed the subject from three standpoints. First, modern car house construction; second, fire protection rules; third, general specifications and form of contracts for railway structures.

The report of the committee on heavy electric traction, by Chairman E. R. Hill, of the Pennsylvania Railroad Co., New York City, reported its co-operation with the committees of the American Railway Association and American Railway Engineering Association, in reference to clearances for automatic stops, but stated that no decision has been reached and recommended that the investigation be further considered.

The report of the committee on power generation, by Chairman C. S. Wood, of the power department of the Pennylvania Railroad, Altoona, Pa., stated that from information collected, the committee believes that with gas engine plants costing $90.00 per Kw., as compared with steam turbine plants at $50.00 per Kw., the saving in the higher economy of the gas engine is not sufficient to offset the additional fixed charges, except in cases where the cost of coal is from $6 to $8 per ton. The report was accompanied by three appendices covering the subjects of peak loads, boiler settings and furnace designs, automatic relays and distant control of valves. It was stated that the total cost of plant output can be decreased with the higher rates of working of the boiler plant, that this cost can be reduced to about one-half in the ordinary plant if the boilers are installed to operate at double rating during the peak load period. Where generators are Y connected on large underground systems, a further protection from shutdowns due to surges was recommended through grounding the neutral. Also to isolate the effected portion of the system and protect the station from shut-down, reverse current or reverse energy relays operated from transformers in the generator leads for the automatic operation of generator oil switches should be installed. At the power house end of feeders, relays of the overload type with adjustment for the time limit, should be used.

The report of the committee on engineering accounting, by Chairman J. H. Hannah, chief engineer of the Capitol Traction Company, Washington, D. C., and S. B. Lasher, of the Republic Railroad & Light Co., New York City, presented replies to letters sent out that show inter-departmental and overhead charges varying in amount from 10 per cent to 110 per cent. The committee stated that inasmuch as this matter is governed by local conditions, it does not justify recommendation. The committee is of the opinion, however, that some definite means for arriving at charges covering overhead expenses on construction work done by companies should be determined. The report took up the essential elements of a system of accounting on electric railway properties and concluded with reference to its reports of 1912, regarding subdivision of the maintenance and equipment account.

The report of the committee on life of railway physical property, by Martin Schreiber, of the Public Service Railway Co., Newark, N. J., and R. N. Wallis, of the Fitchburg and Leominster Street Railway Co., Fitchburg, Mass., showed the following conclusions of the committee: 1. That the basic elements that determine the life of physical property are, use, climatic and soil conditions, maintenance, inadequacy, obsolescence, the human element, public demand and earnings. 2. That it is not practical or even theoretically possible to assemble these several elements into any one form of a logical table that will apply equally throughout the country and on different routes or lines of the same system. 3. That the ultimate solution of depreciation of railway property is insured earnings.

The report of the committee on way matters, by Chairman J. M. Larned, of the Pittsburg Railways Co., Pittsburg, Pa., took up the subject of modern rail fastenings used on tracks where the heaviest types of electric locomotives are operated, and where the traffic is fast and frequent. Data for the New York Central and Hudson River Railroad Company's electric zone and that of the New York, New Haven & Hartford Railroad Co.'s electric zone, were presented. The report was accompanied by three appendices for splice bars, for girders and high T-rails, revised specifications for open-hearth steel girder and high T-rails and a brief discussion on the use of T-rails in paved streets.

The report of the committee on equipment, by J. R. Phillips, of the Pittsburg Railway Co., Pittsburg, Pa., took up wires and cables for car equipment, specifications for steel wheels, storage battery car operating data, air brake hose specifications, and revision of brake shoe standards. The report was accompanied by five appendices covering these points and giving an immense amount of data and information. The report contains 72 pages.

At the final session, the following officers were elected for the coming year to have charge and direct the work of the Engineering Association: President, J. H. Hanna, Capitol Traction Co., Washington, D. C.; 1st vice-president, L. P. Crecelius, Cleveland, Ohio; 2nd vice-president, John Lindall, Boston, Mass.; 3rd vice-president, B. F. Wood, Altoona, Pa.; secretary and treasurer, E. B. Burritt, of American Association.

Pittsburgh Convention of the Illuminating Engineering Society.

The seventh annual convention of the Illuminating Engineering Society, attended by some 500 members and guests, was held at Pittsburg, Pa., September 22 to 25. A decided interest was taken in all the papers presented and an enthusiastic discussion given all the topics. In what follows brief abstracts of the papers and the important points of the discussions are given as an indication of their nature. The proceedings of the convention are voluminous and contain much valuable data. Those readers who are especially interested in illumination will profit by a review of the original material as presented, which arrangement can be made with the association's secretary.

As was expected, the address of President Preston S. Millar, giving the present status of the art of lighting, was replete with valuable information. When this address is available for distribution, doubtless it will be in great demand. The information presented was drawn from answers to questions received from central stations, gas companies, engineers, railway companies, manufacturers and others interested in illuminating engineering throughout the United States. The subjects of intensity, direction, diffusion, color, contrast, hygiene, safety and cost, were touched upon. President Millar showed that the cost of lighting is a small percentage of the total operating cost of any building.

The report of the committee on progress surveyed particular development in all fields of lighting and took up not only electric but other units. The progress of the different fields of lighting were touched upon, as well as the nature of units and reflectors now available. Legislation as regards lighting was also a topic treated.

A paper on "Incandescent Lamp Improvements," by Ward Harrison and E. J. Edwards of the National Electric Lamp Association, Cleveland, Ohio, revealed the fact that the tungsten filament since 1908 has increased in strength more than 300 per cent and that the wire drawn filament has increased 40 per cent since 1911. This paper also took up the use of chemicals in the bulbs of recent types of lamps to reduce the blackening, and also discussed the use of the coiled filament making possible new forms of lamps, as well as helical filament lamps for use in small bulbs. The tubular and the focus types of lamps for show-case lighting were also discussed.

The discussion brought out the fact that the useful life of present tungsten lamps is reached when the initial candlepower has dropped to from 65 to 72 per cent and that this smashing point is independent of the cost of lamps and renewals, provided the lamp is operated at proper efficiency.

"Cooling Effect of Leading-In Wires," was the subject of a paper by T. H. Amrine, Harrison, N. J. The author presented a study of the cooling effects of leads upon the filaments of street series lamps as a part of a general investigation into the effects that dimensions and material of lead wires and supports have on incandescent lamp design. For lamps having lead and filament dimensions usually found in street series lamps, the cooling effects decrease with the increase of lead length, with decrease in lead diameter, and with increase i nthe thermal resistance of the material of leads.

Mr. S. G. Hibben, of Pittsburgh, Pa., presented a paper entitled, "Modern Practice in Street Railway Illumination," in which he pointed out that up to the present time, street car lighting has been done inefficiently with bare carbon filament lamps. Four standard tungsten lamps are now on the market with suitably designed downward reflecting shades, enabling the energy cost for lighting to be cut in half and allowing an increase in useful light of more than 80 per cent. The economical and scientific lighting of street cars is now being rapidly developed. Tungsten lamps in 94 and 56 watts rating, seems to be the most economical sizes for street car use. The discussion brought out the fact that it is preferable to use two 56 watt lamps on two circuits, rather than 94 watt lamps on one, as shadows are less objectionable where there are more lamps.

"The Psychological Values of Light, Shade, Form and Color," by D. F. P. Lewis, of Buffalo, N. Y., was the subject of a paper taking up a physical study of lighting and the effect upon the eye. Following Dr. Lewis' paper, one by C. E. Ferree, of Bryn Mawr, Pa., on "The Efficiency of the Eye Under Different Systems of Illumination, and the Effect of Variations of Distribution and Intensity," was read, which contained information on experiments described at the Brussel Congress on School Hygiene held during the latter part of August.

"Some Theoretical Considerations of Light Production," by W. A. Darrah, of Pittsburgh, Pa., was the subject of a paper discussing some of the inherent limitations of various electric illuminants and discussing briefly the effects of these limitations upon progress in the art of illumination.

"Current Developments in the Manufacture of Incandescent Lamps," was next taken up by John W. Howell, of Harrison, N. J. The author pointed out that the difficulty in the manufacture of incandescent lamps with a thin filament is their breakage and with a thick filament, the blackening of the bulb. The fragility feature has been overcome by using ductile tungsten filaments and the blackening by means of so-called "vacuum getters." He stated that the life depends upon the specific consumption at which the lamp operates. The "half-watt" lamp recently introduced was commented upon and a three ampere, 0.6 watt per candle lamp giving about 500 candlepower, and a 20 ampere, 110-volt, 2,200-watt lamp giving 5,000 candlepower exhibited. The latter is the largest candlepower incandescent unit ever produced. In the discussion of this paper, the developments in arc lamps were taken up and considerable improvements shown in the various lamps, as well as other improvements which are possible.

The Neon-Tube lamp was the subject of a paper by George Claude, of Boulogne, France, the inventor of the lamp. The author showed how the red light of the Neon lamp is corrected by the use of mercury tubes placed near the Neon tubes, producing an agreeable illumination at a total consumption of from 0.8 to 0.9 watts per candle. The difficulties in producing the Neon lamp were outlined in some detail.

Following the above paper, one was presented by W. A. D. Evans, of Hoboken, N. J., on "The Mercury-Vapor Quartz Lamp." The author explained the difference between the standard mercury-vapor tube lamp and the quartz mercury-vapor lamp, giving figures and facts on the characteristics of the quartz type and the construction of the burners. The color of light from the quartz lamp is similar to that of the tube lamp with a certain amount of red added, giving a closer approximation to daylight. Experiments are now under way to determine the availability of this lamp where sunlight is essential, such as for bleaching of cotton and vegetable fabrics, testing of permanency of colors, and photographic work.

The subject of church lighting was presented by two papers, one by R. B. Ely on "Church Lighting Proper," and one by Edwin F. Kingsbury on "Experiments in the Illumination of a Sunday School Room With Gas." The author of the first paper recommended 0.3 to 2.5 watts per square foot as good illumination for churches and that the ratio of illumination between the chancel and the main portions of the church should be about two to one, There is a tendency in favor of indirect lighting or concealed direct lighting for churches, the direct system, however, has been generally adopted, on account of lower installation and operating cost. Mr. Kingsbury's paper described the lighting by gas of a typical Sunday school room composed of a large central floor with a high glass paneled ceiling and alcoves at the ends. The discussion brought out the fact that an intensity on the horizontal plane of .75 to 1.5 foot-candles is satisfactory for churches and Sunday school rooms when the eye is protected from glare.

A paper on "Distinctive Store Lighting," by Clarence L. Law and A. L. Powell, of Harrison, N. J., was next presented, taking up designs of lighting in shoe stores, millinery stores, toy and candy stores, etc. Considerable data on dimensions, walls, ceiling and floor covering, arrangement of fittings, types of glassware, numbers and sizes of lamps, and general description of the appearance of each store were given.

"Factory Lighting," by M. H. Flexner and A. O. Decker, of Chicago, was presented through a paper. This paper brought out important features entering into the design and redesign of a lighting system for factories. The author stated that foreign countries have taken better illumination a little more seriously than America, since committees have been employed by the government whose duties are to study the effect of good and bad light from the general health standpoint and report methods for bettering conditions. The latter part of the paper gave charges for service according to a proposition advanced by the Commonwealth Edison Co., to introduce proper lighting in factories in the Chicago territory. The rental charge of 25 cents per fixture per month is made, allowing the customer to use either 100, 150 or 200 watts in each fixture. At the end of a two-year period, this equipment becomes the property of the customer and this charge is discontinued. The maintainance charge is paid by the consumer at 25 cents per fixture per month, except during the months of June, July and August. At the end of the two-year period, the consumer may discontinue paying this charge and take care of this equipment himself. The energy charge for service is at a scheduled rate of 10 cents net per kilowatt-hour for the first 30 hours of use of the maximum demand per month, and 5 cents net per kilowatt hour for all energy used in excess of this amount. The Commonwealth Edison Co., expects to install 10,000 of these fixtures within the next year. The consumer is asked to sign a contract for a period of 24 consecutive months, and after the expiration of this period, the wiring and fixtures become the property of the consumer. It is thus seen that the Commonwealth Edison Co. offers to install equipment at its own expense and allow the factory owners to pay for the equipment in installments.

"Store Lighting," by J. E. Philbrick, was the subject of a paper taking up the features of gas lighting installations in eight small stores. Considerable information was presented in the form of test data and layouts.

"Hospital Lighting," by William S. Kilmer, of New York, was the title of a paper taking up the shortcomings in hospital lighting. The paper treated only the lighting of the operating room and wards, and described practical fixtures for the solution of various problems. The author advised not less than 25 foot-candles and preferably 40 for operating table illumination. In the discussion following the paper, it was pointed out that the indirect system with an intensity of 10 foot-candles on the working plane for the operating room, has given satisfactory service since objectionable shadows are eliminated.

H. B. Wheeler, of Chicago, presented a paper entitled, "The Lighting of Show Windows." This paper presented the essential features in lighting typical show windows, discussing intensity required along the line of trim and selection of reflectors, their spacing and methods of installation. Considerable data on well lighted windows was given.

"The Pentane Lamp as a Working Standard," was the subject of a paper by E. C. Crittenden and A. H. Taylor, of Washington, D. C. This paper recommended the use of tested Pentane lamps as secondary standards of candle power when electric standards are not available and gives a detailed statement of the methods of testing followed by the Bureau of Standards.

A paper on the illuminating engineering laboratory of the General Electric Company was next presented by S. L. E. Rose. The author described the work of the company, beginning in 1895 when the study of illuminating problems was started at the Lynn works. The present laboratory, now located at Schenectady, having been moved from Lynn in 1909, is equipped to make tests of all kinds of illuminants.

"The Photo-Electric Cell in Photomotry," was next presented by F. K. Richtmyer, of Cornell University. The author took up the possibilities of a photo-electric cell for photometric use, dealing principally with conditions in the research laboratory. Diagrams of connections and suggestions of methods for using the electrometer were also given.

"Some Studies in Accuracy of Photometry," was the subject of a paper by E. J. Edwards, and Ward Harrison, of Cleveland, Ohio. A number of investigations were reported in this paper, including determination of errors in illumination measurements and methods of obtaining and recording distribution data.

"The Characteristics of Enclosing Glassware," by V. R. Lansingh, Cleveland, Ohio, was the title of a paper which took up in a thorough manner the use of different glassware. The glassware now available was divided into two groups, one purely transmitting and diffusing, such as ground, opal and leaded glass, the other prismatic glass which employs the principle of specular reflection. Photometric curves and data were given as well as other data showing the comparison of the different types.

At the close of the final business session, the retiring president, Preston S. Millar, introduced President-Elect Charles O. Bond, who made an appropriate response.

Chicago Convention of Electrical Vehicle Association.

With delegates from the Pacific coast, the South, New England, and the Middle West, the fourth annual convention of the Electric Vehicle Association of America, now in session as this issue goes to press, promises to be not only the largest but the most interesting and important in the brief history of the organization. The convention is held at the Hotel La Salle, Chicago, and in addition to the business sessions, there has been arranged an interesting exhibit of the latest models of electric vehicles and the newest in automobile accessories.

It is interesting to note that this association, which is hardly three years old, has grown to a membership of 450, representing the leading manufacturers of electric vehicles, the electric power companies of the largest cities, the manufacturers of electric vehicle supplies, members of the faculty of technical schools, and even the users of this type of vehicle. Further, during the brief history of the association the number of electric vehicles in operation has increased 50 per cent, an increase that is largely traceable to the influence of the association, through its fifty thousand dollar advertising campaign that is carried on each year.

Some idea of the work that will be accomplished may be had from the program of the two days' session. Arthur Williams, of New York, in his presidential address, will tell in detail the work that has been accomplished and what the association aims to do in the future. A member of the Baker Vehicle Company will speak on, "Electric Vehicle Salesmanship;" a representative of Gimbel Brothers' New York store will tell "Why We Adopted the Electric Vehicle." F. E. Whitney, of Philadelphia, will report on "Electric Vehicle Tires," and "The Charging of Storage Batteries in Unattended Garages," will be the subject of a paper by M. R. Berry. "The Merchant, the Central Station and the Electric Truck," will be the subject of a paper by F. Nelson Carle, advertising manager of the General Vehicle Company. E. S. Callahan, of the National Electric Light Association, will talk on "Co-operation Between Electric Manufacturers and Central Stations." The effect of the electric vehicle on insurance rates will be explained by a member of the Philadelphia Board of Fire Underwriters. Other speakers will be Hayden Eames and Ralph Temple.

There will be dinners for the delegates, special entertainment at the hotel and trips about the city for the purpose of studying electric vehicle operating conditions, the traffic regulations and the garage system of Chicago. It is expected that two hundred of the delegates will come from New York and Boston alone, for whom special trains have been chartered.

New York Electrical Show.

The New York Electrical Exposition and Motor Show opened October 15, to remain open until October 25, some day or so after this issue goes to press. The exposition was held at the Grand Central Palace, and this year over 100 exhibits are shown. Special lighting arrangements are provided, both inside and outside the Palace, and twin flaming arc lamps installed in the vicinity of the Palace, a distance of five blocks between 42nd and 47th streets.

The exhibits of the Agricultural, Commerce and Labor, Navy, Army and Treasury departments of the government and those of the New York, Brooklyn and Yonkers central station companies are of particular interest. The New York Edison Company's exhibit includes an electric farm displaying electrically operated incubators and numerous motor-driven devices. Other displays include an electrically equipped laundry, and a method of showing patrons the relative light-giving qualities of electric lamps.

The exhibit of the Brooklyn Edison Electric Illuminating Co., shows a $49 house wiring plan; a demonstration arranged to show what 10 cents worth of electricity will do when used with any of the modern lighting, heating, or cooking devices, and another portion shows small motors for household use.

The United Electric Light & Power Co., has a model electric grill room, where food is served to guests, prepared in an electric kitchen where model electric household devices are displayed in operation. A cheap house wiring plan is also displayed.

The New York and Queens Electric Light & Power Co.'s display is intended to interest manufacturers through showing views of successful plants and factory sites in their territory.

The Yonkers Electric Light & Power Co. exhibits numerous pictures of attractive homes, using electric service in every possible form. Since this is a suburban town, the display interests all types of customers.

The displays are spread over three floors of the Grand Central Palace and are both extensive and small, as seemed to be desirable.

New York Convention of Association of Iron and Steel Electrical Engineers.

During the last week of September the Association of Iron and Steel Electrical Engineers held its seventh annual convention, at New York City. This organization now has a membership of 253, and is working out important problems in connection with the electrical end of the iron and steel industry. Papers on the following topics were presented and discussed.

"The Selection and Operation of Carbon Brushes," by W. P. Poynton, of W. T. Teaudron Co., dealt with carbon brush manufacture and operation from 1895 to date. Much information was given on conditions met in practice. Alternating current and direct current magnet control was presented in a paper by M. A. Whiting, of the General Electric Company, control problems of machines operating under different conditions, and illustrations of characteristic curves of motors and generators in rolling-mill service being shown. "Direct-Current Turbo-Generators," by H. A. Rapelye, of the Westinghouse Electric & Mfg. Co., was the subject of a paper which discussed design of turbo-generator units, the speed conditions under which they best operate and the use of the helical reduction gear with the floating frame construction.

The committee on standardization, E. D. Egan, chairman, brought up for discussion the specifications for electrical mill equipment. Securing high-speed production seemed to be the trend of improvement desired and recommendations were approved which would aid in reducing troubles in operation and perfecting designs of mill apparatus. To work out physical details of such apparatus is not the work of the committee, but rather securing of favorable results therefrom. "Developments in Switching Devices for Power Circuits," a paper by T. H. Mahoney, of the Westinghouse Electric & Mfg. Co., took up progress in design of circuit-breakers, and air-break switches. "The Design and Use of Lifting Magnets," was discussed in a paper by B. E. Fernow, Jr. A comparison of circular and bipolar types of lifting magnets was given, showing the circular magnet to have the advantage of efficiency when handling pig-iron and scrap. Little trouble is now experienced with this apparatus, such being confined to wear of current-carrying leads and mechanical details.

"The Mercury-Vapor Quartz Lamp," was the title of a paper by W. A. D. Evans, which took up the design and operation of this lamp. The data given showed that the 220-volt type operates at from $4.00 to $5.50 per 1,000 hours. Lamps placed about 38 feet high on 80-foot centers give good illumination. "Present Status of Electrical Drive for Main Rolls," a paper by Brent Wiley, presented data as to character and capacity of electrically operated mills in Europe and America. He showed that motor operation compares favorably and has advantages over steam-engine drive as regards cost of operation and efficiency. It was stated that roll breaking had been reduced 90 per cent in several mills through installation of motor drive on main rolls, graphic instruments connected thereto showing undue friction and wrong sections in rolling.

The progress report on illumination presented by Ward Harrison and H. H. Maydrick, showed striking progress in the use of the tungsten lamp for mill illumination and the falling off in carbon arcs, other arcs and carbon incandescent lamps. The authors stated that the use of obsolete units yet in operation is costing the plants of the association's membership over $1,000,000 annually. It is estimated that 24,000 kilowatts of carbon arc and incandescent lamps are in operation in 76 plants. The new one-half watt tungsten lamp was recommended for future lighting installations.

"Variable Speed Drives," was the subject of a paper by K. A. Pauly, of Schenectady. Adjustable speed control of induction motors as well as advantage of variable-speed motor drive for main rolls of mills were topics taken up. "The Present Status of the Electric Furnace," by Wilfred Sykes, was a paper reviewing arc and induction types of furnaces. Data was given for electric furnace operation in Germany and United States from 1908 to 1912. "Herringbone Gears for Steel Mills," was the subject of a paper by P. C. Day. Operating characteristics were discussed and the use of overhung pinions and gears discouraged. High ratios were advised where necessary, a speed of 1,500 linear feet per minute being desirable, although for open gears 3,000 feet per minute is practicable.

The following officers were elected: E. W. Friedlænder, president; O. R. Jones, first vice-president; R. Tscheutscher, second vice-president; W. T. Snyder, secretary; James Barrett, treasurer.

CORRECTIONS. In the article by Alan Bright in the October issue, the following errors should be noted: In next to the last line of the first column on page 422, the word "magnetic" should be "magnetite." In Table 1, the typical width of the street at Dayton, Ohio, should read 50 feet 3 inches instead of 50 to 3 feet. In the eighth line of the first column of page 425, the word "throughout" should be inserted after the word "structure."—Ed.

New Business Methods and Results

Representing Interests of Central Station, Electrical Jobbers, Dealers and Contractors.

Current Topics and Events in Central Station Fields.

The Wisconsin Railroad Commission, the public service commission of the state, has now been in operation for five years. In a recent address Chairman John H. Roemer points out some of the ways in which service has been improved, rates adjusted, and the standing of the various utilities put upon a better basis. No small share of these results has been made possible through the enforcement of better accounting methods. The municipal plants, which, under the provisions of the Wisconsin law are under the jurisdiction of the commission, were the greatest offenders along this line, many of the accounts being hopelessly jumbled. Some of them rather resented the apparent interference, but there can be no doubt but that the changes have been beneficial.

One large corporation, which was operating with a very badly mixed and discriminatory rate schedule, was compelled by the commission to adopt scientific rates. They estimated a reduction of revenue amounting to $30,000 per annum. To their surprise after the rates were readjusted the business grew so rapidly that within two years they applied to the commission for permission to make a further reduction! This bears out the statement already made in these columns, that discriminatory rates attract unprofitable and drive away profitable business.

The Wiscosin commission has proven to the City of Milwaukee that they can save $50,000 per annum by buying their current instead of spending a million and a half in erecting a plant in which to manufacture it. The commission points out not only the saving in investment charges but also the fact that the central station can operate at higher efficiency.

Electricity is no longer a luxury. This is settled. It is rapidly becoming a necessity to rich and poor alike. In a western mining camp, out of 23 shacks or cabins, 19 were found to be wired and using current. In Altoona, Pa., hundreds of the cheapest houses, occupied largely by foreigners, laborers, railroad employees, and artisans, are wired for electric light. The work was done in a substantial way, with arrangements for time payments, and the current supplied through excess indicators.

The new store of the Filene Company in Boston, requires about 500 Kw. for its illumination. Indirect lighting prevails. Aggressive lighting companies are now renting lamps and fixtures. In Houston, Texas, a merchant can rent a 250 watt tungsten lamp complete with fixtures and globe or shade for 40 cents per month.

An electric road vehicle has made another record by making a cross country run of 258 miles in 13.5 hours. The average speed was 19 miles per hour. Several short "boosts" only were given the battery.

At the recent A. I. E. E. convention, Mr. P. M. Lincoln brought out some interesting facts pro and con on the subject of the central station vs. the isolated plant. The advantages of lower investment cost in proportion to the capacity, lower operating costs in proportion to the output, and greater diversity factor, were balanced against the greater distribution expense of the central station, as well as the use of the exhaust steam by the isolated plant owners.

The newest thing in decorative lighting is to be seen in front of the Continental and Commonwealth Bank, in Chicago. Four handsome lanterns, each containing a quartz lamp with its characteristic tinted light, are installed. The lighting is excellent and the effect very striking.

In Baltimore there are 50,000 Hp. in motors on the company's lines, but—there are 400 isolated plants with 76,000 Hp. yet in operation.

Special Central Station Loads.

In previous issues we have considered some of the principal factors which affect the general efficiency of central station service and have also considered the conditions under which various loads may be profitable or unprofitable. In the present number we discuss the commercial methods in use for securing certain classes of business which may be considered more or less special, or at least of unusual interest.

The ordinary load of the central station may be rather definitely divided into residence lighting, commercial lighting, and power business. The residence lighting load was first developed and for a number of years many central stations depended almost wholly upon it for their revenue. The load factor of this business in the beginning was quite poor, but has been slowly but surely increasing through the use of light over longer hours, as well as by the introduction of irons, and other current-consuming devices, until a (diversified) load factor of 20 to 25 per cent is considered well within possibility.

Commercial lighting business considered alone, is not as desirable as residence lighting. The diversity factor is higher, and the peak overlaps the winter residence lighting peak. The hours of use are short, except in certain departments of large stores. The load factor of this business is also gradually improved by the use of signs, window display, and also by the addition of late hour business, such as moving picture shows, and the like.

The characteristics of mixed power business are now pretty well defined. Such business consists of the ordinary run of factory service, elevators, small pumps, ventilating fans, and motors for hundreds of different uses. While this business is often regarded as being off peak, this is not wholly the case, especially during the winter season, and power business in general has a lower factor than might be supposed, running from 25 to 40 per cent, while under the most favorable conditions rarely exceeding 50 per cent, except in those cases where power is required during both day and night.

There are, however, certain loads procurable by the central station which utilize the capacity of the machinery at times when it would otherwise be idle, and thus make for more efficient production of current. Other loads, while not off-peak, yet prove to be valuable additions to the general power and lighting load, because of involving long hours of use, the effect being to raise the station load factor. Some loads are off-peak because of the season, others because of their strictly daylight application, others because the hours of use can be controlled. In the first class may be considered the lighting of amusement parks, the supplying of service to the owners of isolated plants who prefer to shut them down during the summer when steam is not needed, and to a certain extent refrigeration service. Some suggestions in regard to this business were given in the April, 1913, number, in the consideration of "Profitable Summer Loads," and will therefore not be given extended comment here.

The application of electric power to laundries has so far not been very encouraging. Laundries require large quantities of steam and hot water, and unless the central station can undertake to supply these as well as the power required, it cannot as a rule make them a favorable proposition. Where the laundry adjoins or is quite close to the central station, the taking over of the entire lighting, heating and power requirements of the laundry is entirely feasible. However, the development of the electric ironing load in the summer is entirely profitable for both parties. Current can be sold for this purpose as low as 2½ or 3 cents in most cases without any investment for additional equipment, and the greater comfort and speed in doing the work is of distinct advantage to the laundry proprietor.

Refrigeration, while largely dependent on the season as to amount, is yet somewhat in use at all periods of the year. However, it is possible to remove it entirely from the peak, due to the fact that enough "cold" can be stored up, if it be permitted to use such an unscientific expression, to last for two or three hours. The advantages of purchasing refrigeration instead of ice are quite evident. The customer secures a lower as well as a more uniform temperature, there is no bother connected with loading up the boxes with ice, and it is cleaner and more sanitary in every way. Most companies supply such business at their ordinary power rates, and yet find it is profitable at even lower figures, since the fixed charges are almost eliminated. One customer who had been paying an ice bill of $500 per year now obtains refrigeration for from $3.00 to $30.00 per month, or a total of $162.00 per year. The rate in this case is 4 cents.

Besides the supply of current to private plants, there is always the opportunity of taking over the entire load of ice plants where one exists in the town. The advantages to both are apparent. The ice company necessarily has machinery which is used to its full capacity only during three or four of the summer months, at just which time the central station is running the lightest. In fact, the advantage of combining the two kinds of business is so apparent that many Southern companies, essentially central station companies, have the word "Ice" as part of their corporate name. The advantage of corporate union may not be so eminent, but there is no question but that the power required for an ice plant should come from the central station.

There are a number of industries which afford profitable loads for the lighting company by reason of being carried almost exclusively by daylight, and therefore are off-peak. Such loads are those of stone yards, brick yards, gravel pits, quarries, etc. These can be connected on about the same basis as the refrigeration load, although some allowance should be made for their usually scattered location. Another wide and rapidly increasing field is the charging of electric vehicles. However, since it is planned to devote one or two entire numbers in the early future to this subject, we will refer to it only at this time.

As additions to the general power load, perhaps none is of greater importance than the supplying of current to a municipality for pumping water. It is an entirely dependable load, rather heavier in summer, and can be made strictly off-peak, since all the pumping necessary can be done in from 12 to 18 hours, except in case of emergency, such as fire, in which case arrangements for an extra charge should be made. A small town cannot do its pumping by steam as cheaply as by electricity. Small steam pumps are inefficient, and require a good deal of attention. Electrically driven pumps require very little attendance, and the expense of boilers and firemen are eliminated. In a small plant the pumps may even be started and stopped by remote control by an employe at the power house, doing away with practically all attention at the pumping station.

The rates for this service are sometimes given on a basis of Kw.-hr., and sometimes on the basis of water pumped. We know of one case in which a rate of 3 cents per Kw.-hr. with a 30 Hp., 3-phase motor saved the municipality from 50 to 60 per cent of the former expense when using a gasoline engine. In Duluth, Minn., payment is made on a sliding scale, and varies from $5.50 to $6.50 per million gallons. In this case the records show an actual return of about 4½ cents per Kw.-hr. The pumpage is about 10 million gallons per day, and the yearly revenue from this business is over $18,000 per year. In comparison we may consider a small town in Nebraska, in which the cost of doing the pumping electrically is 5 cents per 1,000 gallons.

Similar to this business is the furnishing of power for irrigation. Until recently one naturally connected irrigation with conditions in desert places, but now even in what we are accustomed to think of as fertile sections, market gardeners are beginning to appreciate the great increase in productiveness by judicious irrigation. Many, in fact most of these trucking sections, are located in close proximity to large cities where they could be easily reached by the distribution network of a central station. While this business is as yet almost entirely undeveloped, it will pay investigation.

Another central station opportunity is the taking over of the electric railway load. This is now being done in many cases. The Third Avenue Railway Co., New York, purchases its entire current from the New York Edison Company. In Pittsburg, the Allegheny County Light Co., and the Pittsburg Railways Co., have a joint power house on Brunot's Island. In Detroit and in Cleveland, the railways are large purchasers of central station power. This arrangement is beginning to be particularly of value when the street railway begins to outgrow its direct current equipment and needs high tension current to feed its interurban lines. In such cases the central station can step in and supply the need and save the railway company the expense of additional equipment. In most cases the load factor of the station is improved by the addition of this load. The peak as a rule does not coincide, coming earlier than the station peak in the summer, and later in the winter.

Industrial heating offers a number of special opportunities. In fact, such load is practically all special. Welding equipment is coming into limited use, with a demand that is large and a current consumption rather small. Later on, if welders begin to be used in large numbers, they will be quite a profitable load, because the diversity factor will be high. Soldering irons and glue pots are being used a good deal. However, such devices as these are of most value in a general educational way, than for any amount of current that they use. We cannot say that industrial electric heating has reached a point where it has any especially attractive features to offer.

A possible exception to the above might be in the field of the electric blast furnace. There are a few of these in use throughout the country, but most of them are supplied from electric current generated at the mills. However, one central station in California is supplying a 15-ton furnace. The voltage required is from 60 to 80, and there are three 750 Kw. transformers used. This furnace produces 18 tons of best grade iron every 24 hours. The chief advantage of the electric furnace lies in the high grade of metal which it is possible to produce, and in the absolute control which the operator can have over the temperature. To make this business attractive, it is necessary to offer current at a rate of below 2 cents per Kw.-hr.

In general, electro-metallurgical, electro-chemical processes can only be carried on within reach of hydro-electric plants, where current can be generated very cheaply. Carborundum, aluminum, and calcium carbide are produced in the electric furnace, and in foreign countries and to some extent in this country, atmospheric nitrogen is being rendered available by the electric discharge. In future, no doubt, other such applications will be developed.

There are other loads more or less special, or rather, novel, for which the live central station man should be on the lookout. One of these is the electrical supply for fire alarm systems. In one city the Gamewell system had been supplied with current from 80 gravity cells. The cost of chemicals, for the battery, amounted to $125 per year, and the estimated share of attendance chargeable is $200 more. A change was made to 110-volt D. C. supply with a small battery across the mains protected by a reverse current relay. With ½ ampere flowing, the consumption amounted to 500 Kw.-hrs. per year. In another case, with a previous cost of $190 per year for 29 Gamewell boxes, the energy supplied by a central station at 12 cents per Kw.-hr. amounted to only $21 per year. In this case a 1-6 horsepower motor generator set was used. Probably a flat rate for this service to include inspection and upkeep of battery would make it profitable.

Another possible load is the supplying of current for wireless sets. A commercial DeForest outfit for long distance work consumes about 5 Kw. The current is measured by meter and special precautions have to be taken to keep high tension surges from burning out the meter coils. Two condensers connected across the line, with middle point grounded have been found to remedy this trouble.

One of the latest industries of interest to the central station is the utilization of a by-product, exhaust steam. Even if condensed, it is not possible to return to the system more than a fraction of the heat in exhaust steam. One pound of live steam at 125 pounds pressure contains 1189 heat units. The same pound of steam after passing through the engine still contains at atmospheric pressure 1146 heat units. After being condensed, it contains only 181 heat units, which can be returned to the boiler, having lost 966 heat units to the condensing water, or 80 per cent of the original energy in the steam. The sale of this exhaust steam for heating is now being practiced by a great many central station, and under favorable circumstances, is profitable business, with one exception. When a corporation takes out a franchise under which it has the privilege of supplying service to the public, it also takes the responsibility of rendering not only continuous service to its customers, but also the obligation of supplying all who apply, and in order to do this the exhaust steam may not always be sufficient. In such a case there is no alternative but to turn live steam into the pipes to supply the deficiency. However, ordinarily, the needs of a community are met by the use of exhaust steam only. There are two ways of measuring this service, by a flat rate based upon the number of square feet of radiation, or by a meter which measures the condensation. The last method is now recognized as being the best for both parties.

A. G. Rakestraw.

Regulations to Prevent Accidents to Employees and Public.

The management of the Rochester Railway and Light Company, Rochester, N. Y., is now taking active steps to prevent accidents. A book of rules and regulations is furnished each employe which includes safety suggestions to themselves and to others, the public included. A general safety committee has charge of these matters and new rules are issued as they suggest themselves and published in the company's house organ, *Gas and Electric News.* The following rules have recently been issued:

New Regulations for Linemen.

1. wear gloves. Do not handle wires carrying a potential of over 250 volts without a rubber glove on each hand, and do not handle any wires in proximity to wires carrying a potential of over 600 volts without a rubber glove on each hand. Gloves will be furnished by the company and will be promptly replaced if at any time they are found to be defective.

2. section cut-outs and switches. Foremen and emergency men must inform themselves as to the location of sectionalizing plug cut-outs and live oil switches and fuses, as well as the wires fed therefrom, and whenever necessary to open feeder circuits shall do so at such a point as to interfere with the service as little as possible.

3. protective devices. This company will provide approved protective devices for the use of men working on live wires or in dangerous proximity thereto, and it shall be the duty of all employees to make the conditions as safe as possible before attempting any work upon "live wires."

Rule for All Employees

The following rule is not a new one, but if carefully remembered and observed will certainly act as a great preventive of accidents:

report defects. All employees in going to and from work at any point on the company's circuit will note defective or unsafe conditions which may be apparent on poles, arms, braces, pins, insulators, or wires of the company, and report them to foreman or to superintendent at the nearest telephone.

The following statements to employees in regard to this movement to prevent accidents, indicates the attitude of the company. "We know that our safety work has saved a good many employees from injury and perhaps death in the past few months. Have you ever thought of this? Perhaps you are one of those who have been saved from injury. That is why safety work pays you and your family. Moral: Co-operate."

"Investigate every accident and try to prevent an accident occurring in like manner. Foremen can reduce the number of minor accidents, if they see to it that their men have sufficient help while lifting heavy beams, pipes, steel, etc. To prevent accidents we must thoroughly understand their causes. Every danger point in every machine and in every process must be located and definitely grappled with."

"No employee is expected to take a chance, or run the risk of injuring himself or another, for the sake of saving time, or for any other reason."

This is an excellent policy and many, in fact all public utilities who are not issuing safety precautions, will do well to give the Rochester example serious thought.

Stewart C. Irby, Manager New Business Department, Hattiesburg Traction Company, Hattiesburg, Miss., Describes New Office Building and Recent Progress.

On the night of September 30, the new building containing offices and sales room of the Hattiesburg Traction Company, was formally opened to the public. The front of the building is constructed of white enamel brick and provision made to illuminate it as shown in the illustration. For this purpose fifty 60-watt frosted tungsten lamps

New Home of the Hattiesburg Traction Company, Hattiesburg, Miss.

are used, placed under the cornice at the top of the front and one side. A large sign also adds to the attractiveness of the front. The first floor of the building is to serve as a display room, with a cashier's booth and offices for the new business force in the rear. The second floor is occupied by the executive heads of the company. On this floor an assembly room has also been provided with a kitchen adjoining, which will be used for demonstrations of electric cooking. The general offices and sales room are illuminated with attractive Holophane Urno-lite fixtures containing 400-watt tungsten lamps, arranged so as to give best possible illumination.

The Hattiesburg Traction Company was taken over by the Doherty Operating Company, in September, 1911, and since then the entire system has been practically rebuilt. Instead of four second-hand cars, which the company had prior to that time, it now has nine strictly first-class passenger cars, with additional equipment, which will be delivered before the first of the year. The car barn now occupies more than three times its original floor space to accommodate the added equipment. The power plant has been more than doubled by the addition of a new 1,500 Kw. Westinghouse turbine, and corresponding improvements have been made throughout the entire electrical system.

Remarkable progress has also been made in securing a motor load for now nearly every industry in Hattiesburg is using electric drive. Two years ago there were not more than three electric signs in the city, while now numbers of considerable size are installed. One of the most novel slogan signs of the South is installed here, the gift of the Hattiesburg Traction Company to the city. This display was described in the November, 1912, issue of *Electrical Engineering*.

Mr. William F. Wallace, of Rochester Railway and Light Company, Rochester, N. Y., Shows How the Electric Sign is Used in Cooperative Boosting.

The Chamber of Commerce of Rochester conceived the idea of securing from its members sufficient funds to purchase and erect at the eastern and western entrances of the city, strikingly beautiful and effective electric signs. One of these is shown in the illustration presented here. The New York State Railways and the state engineer donated the use of the land on which to erect the signs and the Rochester Railway and Light Company furnishes the current and maintains the signs for a period of five years without charge.

Both signs are 50 feet high and 32 feet wide. The letters are the 30-inch grooved type, with a grooved border around the entire sign. The signs represent the Chamber of Commerce slogan and contain 585, 10-watt lamps and 9, 100-watt lamps in each. The cost of these two signs was a little over $3,000 raised by subscriptions among the business men at $10 each.

This arrangement is believed to be one that emphasizes the possibilities of cooperative effort and thereby stimulates activity of the latent forces within our citizenship which when once fully aroused will constitute an irresistable force for social, civic and commercial betterment of the city of Rochester and any other city that takes a similar step.

An Electric Sign Boosting Rochester, N. Y.

W. G. Morgan, Manager New Business Department San Antonio Gas and Electric Company, San Antonio, Texas, Has Placed in Service an Immense Electric Sign.

In the center of the city of San Antonio, and commanding its busiest thoroughfares, there has recently been completed and placed in service what is in all probability the largest electric sign, in point of dimensions, in the South. It stands on three immense steel towers, over 125 feet in height, and built from the ground up, is a framework over 60 feet in width, which carries a beautiful spectacular electrical display. The reading matter on the sign recites the fact that "Leading all others, with an output of over 200,000 bottles daily, Pearl Beer cannot be beaten."

Fig. 1. Large Electric Sign Erected at San Antonio, Texas.

The display consists of a pair of gigantic sky-rockets, which shoot up on either side, arching gracefully to the center of the sign, cross and burst, with varicolored showers dropping a distance of thirty-eight feet, and gradually dying out in lustre until they disappear completely. The large seal which is a replica of the Pearl Beer trademark, meanwhile scintillates, appearing in the form of a large broach studded with pearls.

The approximate candlepower of the sign is 12,368, there being 3,092 Pass and Seymour 61988 receptacles required to thoroughly illuminate all of the letters and parts, tungsten lamps of four candlepower being used. To haul the lamps to the sign took two trips of a large two-horse truck and to screw them in place took two men the best part of two days, exclusive of placing the 1,775 Betts & Betts color caps, which required nearly two more days time for an apprentice. The receptacles alone amounted to a large truck load, and, if placed six inches apart in a straight line, would make nearly a third of a mile.

The sign contains over two miles of wires of various sizes, the necessary connections requiring over 8,200 separate soldered, taped and sealed joints. A total of 12 Western Electric low-voltage sign transformers are used, there being 5, 2000-watt, 2, 1500-watt, 1, 1000-watt and 4, 500-watt sizes. These are mounted on the rear of the frame in such relation to the flashing mechanism as to decrease the amount of voltage drop and amount of copper necessary as much as possible. The quadruple-deck flasher, furnished by Betts & Betts, of New York City, stands over six feet long and four feet high, its cams operating at four different speeds. Besides this is a specially constructed dimming apparatus for the star showers which ingeniously decrease their candlepower until cut out entirely. The flasher weighs over 1,000 pounds, and every one of the 118 connections is properly fused at entering the flasher.

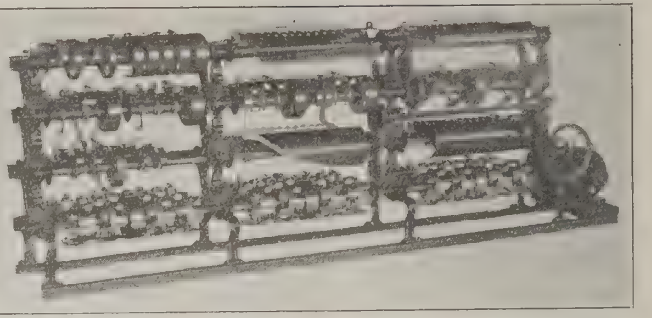


Fig. 2. Flasher Used With Sign Shown in Fig. 1.

This sign was made by the Greenwood Advertising Company of Knoxville, Tenn., constructed and shipped complete, on the twenty-second working day after placing the order in the factory, and an entirely strange set of mechanics erected and connected same without difficulty from the complete information and detailed drawings furnished by the makers.

An Electric Makes Long, Hard Run.

At the time of the Burlington, (Vt.), convention of the New England section of the N. E. L. A., September 17 to 19, Mr. E. W. M. Bailey, general manager of the S. R. Bailey and Company, of Boston, Mass., made an interesting endurance run of 528 miles from Boston to Burlington, Vt., with a Bailey electric roadster, equipped with Edison battery, covering the distance in 13 hours and 35 minutes. In view of the difficult parts of the run as regards possible speed and power required, the fact that the run was made with no adjustments or repairs, is a convincing argument in favor of the electric in even severe service. The hardest part of the route was from Springfield, Vt., to Rutland, fairly mountainous, with repeated descents to valleys and through several places of road repairs.

No attempt was made to run the car an extreme distance on one charge, such not being good touring practice and not necessary. The car was given a full, normal charge before leaving Boston. No full charge was given the battery enroute, but partial charges were taken at five different places —Fitchburg, Keene, Springfield, Rutland and Middlebury, at rates varying from 30 to 150 amperes. The normal charging rate of the battery is 37.5 amperes. The car was a model E Bailey roadster, equipped with 60 cells Edison battery of the new A-5 size. It is not a special car, simply taken from service after having been run 10,700 miles during the last 11 months.

The performance accomplished could be considerably improved by repetition. The operator had never before been over any part of the road beyond Concord, Mass., and had never visited any of the cities or towns except Fitchburg and Burlington. On account of these features, the run was a very fair and practical test of the electric and one which indicates most satisfactory operation of an electric vehicle.

Questions and Answers from Readers

Readers are invited to make liberal use of this department for discussing questions, obtaining information, opinions or experiences from other readers. Discussions and criticisms on answers to questions are solicited. However, editors are not responsible for correctness of statements of opinion or fact in discussions. All published answers and discussions are paid for.

ACTION OF REACTANCE IN A CIRCUIT.

Editor Electrical Engineering:

(409) Please explain through your columns the action of a reactance in an alternating current circuit. What effect, if any, does it produce in a direct current circuit? How are power reactances designed and on what kind of a core are they mounted? Where are they located in a central station system? R. F. Meiderhiser.

ELECTRIC RAILWAY BLOCK SIGNAL SYSTEM.

Editor Electrical Engineering:

(410) Please supply a diagram showing the nature and connections of a manually operated block signal system for a single track suburban electric line. J. H. Bingham.

TRANSFORMER DESIGN TO SUPPRESS WAVE DISTORTIONS.

Editor Electrical Engineering:

(411) The writer has seen the statement that a transformer designed to operate at low densities and low magnetizing current has a tendency to suppress harmonics and wave distortions. Is this the only advantage of such design and the determining factor on size of core, etc? Will some reader explain how wave distortions are suppressed by such design? W. E. F.

SPACING AND ARRANGEMENT OF CONDUCTORS FOR TRANSMISSION LINE.

Editor Electrical Engineering:

(412) Please advise how to calculate the inductance of a 3-phase transmission circuit of 6,600 volts, 60 cycles, five miles long when the three conductors are spaced on one cross-arm in a horizontal plane and when they are spaced two on one cross-arm and one on a cross-arm below or with a triangular arrangement. Spacing of conductors 18 inches in horizontal plane. 750 Kw. transmitted. Size of wire 4-0 copper. In which case is the inductance greatest and at what voltages are each recommended? W. E. C.

SYNCHRONIZING WITH LAMPS.

Editor Electrical Engineering:

(413) In synchronizing two 220 single-phase alternators, it is necessary to have either four 110-volt lamps in series or the lamps will burn out. This is on account of the fact that the emf's of the machines in some way combine to give as much as 440 volts at times. I would like to see an explanation of this showing the voltage waves and how the added voltage occurs. Also I have heard it said that in the case of two, 220-volt, three-phase machines, the voltage on the synchronizing lamps will never be greater than 220, and that only one 220 or two 110-volt lamps need be used. Please show voltage waves for synchronizing two, three-phase machines, and how 220 volts only is possible. E. C. T.

COST OF GENERATING ELECTRICAL POWER.

Editor Electrical Engineering:

(414) In the June, 1912, issue of *Electrical Engineering* cost data was given on generating electric power in small steam plants where the exhaust steam is used a part of the year only for heating purposes. I have a plant of 1300 Hp and we use exhaust steam for feed water heating and for drying purposes during the summer months and for heating the building in winter. Oru plant is located at Baltimore, Md., which will give you an idea of the nature of the winter season.

The temperature of our feed water entering the heater is 60 degrees F., at present and after leaving the heater is 224 degrees F. The steam pressure is 125 lbs. gage. Please give in your columns, the cost chargeable to power when all the exhaust steam is used the entire year for drying purposes and heating the building. Our plant consists of one 200 Kw., one 165 Kw and one 75 Kw generators. I would like to see this information appear in your next issue. G. T. Burch.

Use of Shunt Resistance Multi-Gap Lightning Arresters. Ans. Ques. No. 334.

Editor Electrical Engineering:

There is a difference in the design and connections of shunt resistance multi-gap lightning arresters when used on a grounded Y system and on a delta and undergrounded Y system. The difference consists in the use of a fourth arrester leg between the multiplex connection and ground on the ungrounded systems. The reason for this is that the arrester is designed to have two legs between line and line. If one line is accidentally grounded, the full line potential is thrown across one leg without the fourth or ground leg. On a Y system with a grounded meutral, the accidental grounded phase causes a short circuit of the phase and the arrester is relieved of the strain by the circuit breaker tripping. In short, the fourth or ground leg of the arrester is used when, for any reason, the system could be operated

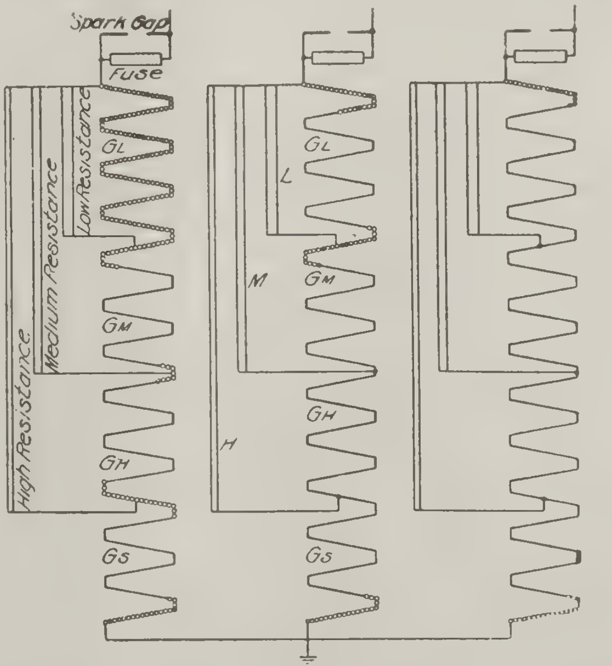


FIG. 1. CONNECTIONS FOR Y SYSTEM WITH GROUNDED NEUTRAL.

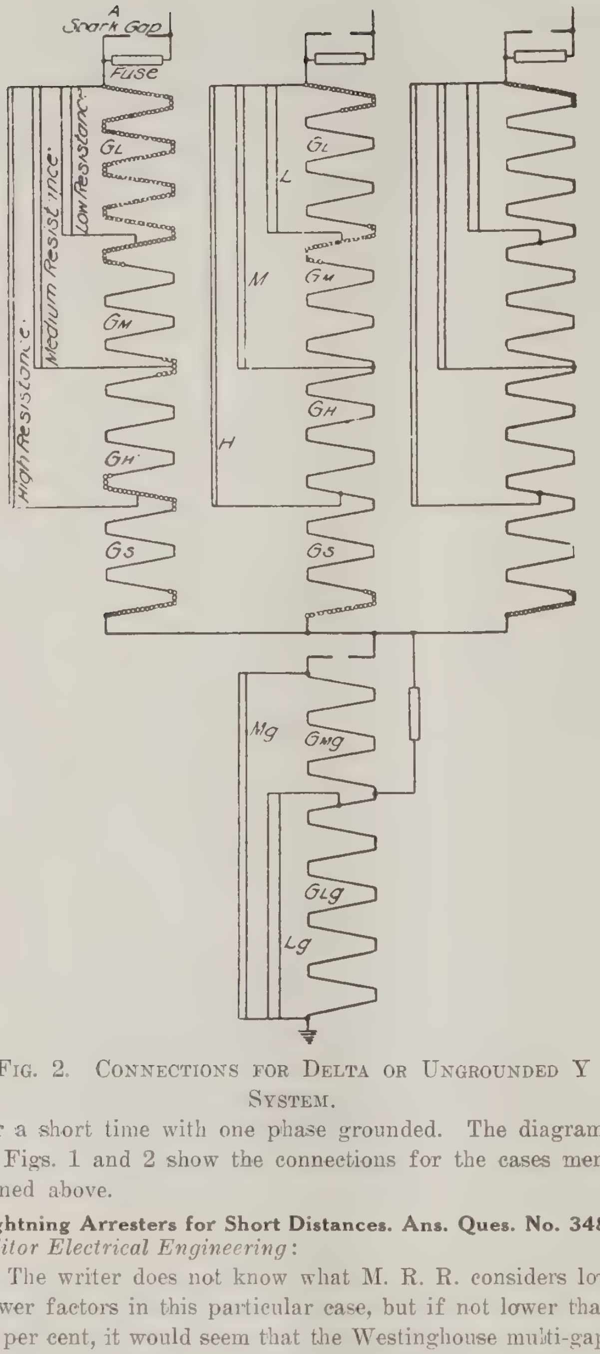


Fig. 2. Connections for Delta or Ungrounded Y System.

for a short time with one phase grounded. The diagrams in Figs. 1 and 2 show the connections for the cases mentioned above.

Lightning Arresters for Short Distances. Ans. Ques. No. 348.
Editor Electrical Engineering:

The writer does not know what M. R. R. considers low power factors in this particular case, but if not lower than 75 per cent, it would seem that the Westinghouse multi-gap, nonarcing arrester would suit his conditions. While this arrester canot be recommended on circuits of very low power factors, nor on 25-cycle systems on account of the fact that arcing cannot be easily suppressed, the arresters will work satisfactory within a radius of 5 miles from the generating station and on systems up to 500 Kw.

W. E. White (New York).

Transformers for Induction Motors. Ans. Ques. No. 347.

Editor Electrical Engineering:

The writer gives the following tables to supplement the information given by Mr. Boyle in the July issue. Table 1 gives the voltages, both primary and secondary, of transformers usually installed on transmission systems:

TABLE 1.—SINGLE-PHASE TRANSFORMER VOLTAGES.

Voltage of Circuit	110-Volt Motor.		220-Volt Motor.	
	Prim.	Sec.	Prim.	Sec.
1100	1100	122	1100	244
2200	2200	122	2200	244

Tables 2 and 3 give the current values of different sizes of induction motors and the transformer sizes best suited for use with these sizes.

TABLE 2.—CURRENT TAKEN BY THREE-PHASE INDUCTION MOTORS AT 220 VOLTS.

H.P. of Motor	Approx. Full Load Current	H.P. of Motor	Approx. Full Load Current
1	3.2	20	50
2	6.0	30	75
3	9.0	50	125
5	14.0	75	185
10	27.0	100	250
15	40.0	150	370

TABLE 3.—CAPACITIES OF TRANSFORMERS FOR INDUCTION MOTORS.

Size of Motor H. P.	Kilowatts per Transformer. 2 Single-Phase Trans.	3 Single-Phase Trans.	1 Three-Phase Trans.
1	0.6	0.6	
2	1.5	1.0	2.0
3	2.0	1.5	3.0
5	3.0	2.0	5.0
7½	4.0	3.0	7.5
10	5.0	4.0	10.0
15	7.5	5.0	15.0
20	10.0	7.5	20.0
30	15.0	10.0	30.0
50	25.0	15.0	50.0
75	40.0	25.0	75.0
100	50.0	30.0	100.0

Induction motors up to 5 Hp. may be started by an ordinary line switch without a starter, but it must be remembered that in these cases sometimes as much as 4 to 5 times full load current is taken at starting and that the torque is about 1.25 times the full-load torque.

H. B. Davis (Mo.)

Largest Size of Motor.

Editor Electrical Engineering:

In the April, 1913, issue, W. C. G. asker for information on what is now considered the largest practical size of a.c. motor that will operate satisfactorily. The writer will now state that he knows of a 3-phase, 25-cycle, 6,600-volt induction motor of 6,500 Hp. in operation at the plant of the Illinois Steel Company, at Gary, Indiana. This motor can operate at two speeds, namely, 57 rpm. low and 107 rpm. high, and is giving satisfaction. The motor is of General Electric design. B. F. Pittman (Ind.)

Corrosion of Mine Cables. Ans. Ques. No. 372.

Editor Electrical Engineering:

In Mr. R. E. Neale's answer to question No. 372 in the September issue, he deals with direct current. In view of the fact that alternating current is used in this country in a great many mines for underground power, lighting and signalling, I wish to state that I am thoroughly convinced that electrolysis takes place on alternating current circuits to some extent, and more so on low frequencies than high.

In a mine shaft 1,200 feet deep using alternating current at 30 cycles, corrosion and electrolysis is very noticeable, which caused destruction of rails, pipe and especially electric wiring. The mine is wet at certain times of the year, caused by seepage of surface water. This is known to contain small quantities of sulphuric acid which forms a good electrolyte for this action. The rails and pipes are affected at turns and ends near the shaft and in wet places.

The electric wiring running down the shaft is affected at connections which are not thoroughly taped with rubber and friction tape and painted with P. & B. paint, and at places where the insulation is damaged. The screws are eaten away between insulators and wood, caused by the insulators being continually wet and clamped on the wires, which injures the insulation. Corrosion, pitting and the eventful breaking of the wires are the cause of considerable trouble. Further, a man standing on a rail or wet place and touching certain wet timbers will receive a slight shock, which is unquestionably alternating current.

Chas. A. Bliley, (Cripple Creek, Colo.)

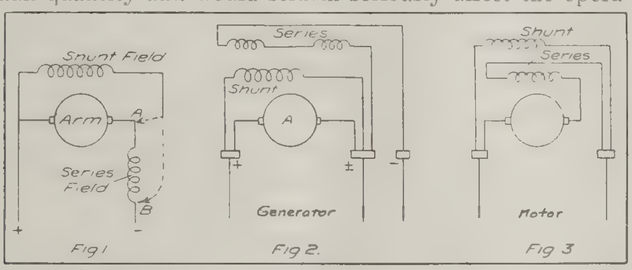
Use of Time Limit Relays. Ans. Ques. No. 388.

Editor Electrical Engineering:

The purpose of the time limit relay is to prevent needless interruptions of service in case of a short circuit on a transmission line that is quickly cleared. The inductance of the windings and transformer coils, etc., of an A.C. system is high enough so that a short circuit will do no immediate injury. If, therefore, a short circuit occurs, it is quite possible that the resultant arc will burn off the cause of the short circuit and clear the line without interruption of service, and without opening the circuit breakers. As far as I know there are no disadvantages connected with their use in places where they would be specified by competent engineers.

Long vs. Short Shunt Field Connections. Ans. Ques. No. 376.

Referring to Fig. 1, if the shunt field is connected at *A*, it is called a short shunt, and if at *B* a long shunt. The only practical difference is that in one case the voltage across the shunt field is affected by the drop in the series field, and in the other case it is not. This drop is quite a small quantity and would seldom seriously affect the operation of the machine. However, the connections are usually made so that the shunt field voltage will be independent of the current flowing as far as possible, and hence generators are usually connected with a short shunt as shown in Fig. 2, and motors with a long shunt as shown in Fig. 3.



Grounding Transformer Neutral. Ans. Ques. No. 378.

A detailed study of the voltage and current conditions, assuming faults at various points in the system, would occupy considerable space, and it is doubtful if it would be of any real value. A ground or fault may be of high or low resistance, and the relative amounts of current passing through the fault, and the circuit proper, as well as the voltage relations, would depend upon the resistance to ground at the fault, the resistance of the earth circuit, and the cable resistance, all of which are entirely independent variables.

About the only thing of which we could be sure is that in the case of a partial or total ground at any point, such as at C of the figure there would be a greater or less rush of current through the ground, and this would show up at points located at 4, and at G. The voltage to ground at the fault, and between that point and the transformer would diminish and in the case of a dead ground be practically zero. In the case of partial ground the voltages and current at other points might not be seriously affected, but if the ground were heavy, there would be a general distortion of the current and voltage values all over the system. In general, the effect would be to lower both current and voltage at points other than on the transformer side of the grounded line.

A. G. Rakestraw (Pa.)

Proper Size of Motor for Pump. Ans. Ques. No. 394.

Editor Electrical Engineering:

The most satisfactory solution of the problem in question No. 394 in the August issue, would be obtained from pump manufacturers giving, in addition to the data there presented, the frequency of the alternating current available. The frequency will limit the choice of speeds for the motor, and thus affect the size of the motor, and consequently its cost. ("Size" referred to here means the dimensions and weight of the motor as distinguished from the term "size" in the subject of the article, which relates more particularly to the rating of the motor). The speed of the motor must also be known in determining the proper pump for the service. However, the following calculations will serve as a guide in determining what to install for the conditions given:

The smallest pump handles 350 gallons per minute, operating against a head of 250 feet, which we will assume includes the suction lift and friction head. The water horsepower or effective work done will be $(350 \times 8\frac{1}{3} \times 250) \div 33{,}000 = 22.1$ horsepower. The efficiency of such a pump would probably be about 60 per cent, hence the brake horsepower required, or the output of the motor, would be $22.1 \div .60 = 36.8$ horsepower, so that it would be advisable to install a 40-horsepower motor.

Similar calculations for the second pump, handling 450 gallons per minute against 250 feet head, give, for the water horsepower, $(450 \times 8\frac{1}{3} \times 250) \div 33{,}000 = 28.4$ horsepower. Using the same efficiency as above, the brake horsepower required will be $28.4 \div .60 = 47.4$ horsepower, requiring a 50-horsepower motor.

Since the fire pump is to handle 750 gallons per minute, delivered through an 8-inch pipe, the velocity of water in the pipe will be $(750 \times 231) \div (50. \times 12 \times 60) = 4.8$ feet per second. The loss of head due to friction may be calculated from the formula:

$h = f\ [(4\ l \times v^2) \div (d \times 2\ g)]$ (Kent 8th edition, page 714).

In this formula h = friction head in feet; l = length of pipe in feet; d = diameter of pipe in feet; v = velocity of water in feet per second; f = coefficient of friction, usually taken as .005 (1 + 1/12 d) for clean iron pipes.

Substituting in this formula, and solving, we find the friction head is 65 feet. Since the pump takes water from a well, we may assume that the suction life is about 15 feet, so that the total head pumped against will be $220 + 65 + 15 = 300$ feet. Hence the water horsepower will be $(750 \times 8\frac{1}{3} \times 300) \div 33{,}000 = 56.9$ horsepower, or assuming 60 per cent pump efficiency, as before, the brake horsepower will be $56.9 \div .60 = 94.8$ horsepower, requiring a 100-horsepower motor.

Suppose a 10-inch line were installed instead of the 8-inch line proposed. The velocity of water in the pipe would then be $(750 \times 231) \div 78.8 \times 12 \times 60 \doteq 3.05$ feet per second, from which the friction head is found to be 20 feet, using the same formula as above. The total head will now be $220 + 20 + 15 = 255$ feet, and the water horsepower 48.3, requiring 80.5 brake horsepower. For this service a 75-horsepower motor would probably be installed, since it is unusual to find an A.C. motor rated between 75-horsepower and 100-horsepower. In comparing the two alternatives thus given, it must be borne in mind that in the first case the motor will have some reserve capacity, while in the second case the motor will be overloaded under normal conditions, and have less reserve capacity.

Since this pump must handle 250,000 gallons per day, it must be in operation about 5½ hours per day, or 166.66 hours per month, with 30 days' operation. If the 8-inch pipe is installed, the brake horsepower, as we have shown, is 94.8, or assuming 90 per cent motor efficiency, the power input to the motor must be 78.6 Kw., requiring a total of 13,100 Kw. hours per month. Similarly, if the 10-inch pipe is installed, the power input to the motor must be 66.8 Kw., requiring 11,135 Kw. hours per month. If power can be purchased for one cent per Kw.-hr., the difference in favor of the 10-inch pipe will be $19.65 per month, or $235.80 per year, in cost of power only.

Now let us figure the additional cost of the 10-inch line, as compared with the 8-inch line. We will assume that cast iron, bell and spigot pipe will be used. The service will require medium weight pipe, weighing 55 pounds per foot for the 8-inch pipe, and 73 pounds per foot for the 10-inch pipe. Thus there will be required 145 tons of 8-inch pipe, or 193 tons of 10-inch pipe for the one mile line of pipe. For illustration, we will take the cost of pipe as $30.00 per ton, in place, although this figure may be considerably reduced, depending upon local conditions. The 8-inch line, one mile long, will then cost $4,350, and the 10-inch line $5,790, or $1,440 more than the 8-inch line. The saving in power cost, as figured above, will thus be seen to return a handsome income on the additional investment, in addition to a possible saving of $250 in the first cost of the motor. It is indeed possible that a 12-inch line would show a return on the additional investment required, if the cost of power is high, or the installation inexpensive.

C. S. Stouffer (Ill.)

Series vs. Parallel Armature Windings. Ans. Ques. No. 399.

Editor Electrical Engineering:

Parallel or lap windings are usually used on low voltage and high current machines, while series or wave windings are used for low current and high voltage motors or generators. A wave winding is a two circuit winding, while in the lap winding the number of parallel paths is equal to the number of poles. The prime requisite of a correct armature winding is that, after making a circuit of the armature, the circuit should terminate in a bar adjacent to the one we started from, either ahead or behind it. When it ends ahead of the starting bar, it is called a progressive winding, when back of it a retrogressive winding. No practical difference exists between them. An armature that has been wound progressively may be wound retrogressively, the only difference being that in the case of a motor, the direction of rotation would be reversed, and in a generator, it would have to be turned in the opposite direction to generate. The retrogressive winding would possibly require less copper.

The position of a coil should be such that when one side of it is under a north pole, the other side should have the same relative position under the south pole. In other words, when one side of a coil is in the strongest field of one polarity, the other side of the coil is under the same position under a field of opposite polarity. It is only when a coil is so situated that it is generating a maximum emf. in a generator, or exerting its greatest torque in the case of a motor. From this it can be seen that theoretically a coil need not have its other side lying under an adjacent pole, but may be several poles removed, although for reasons of symmetry and economy in the use of copper, they are always made adjacent. The advantages of a series or two circuit winding are the absence of excessive strains due to unequal air gaps, and the fact that only two brushes are required, while with a lap or parallel winding as many sets of brushes are required as there are poles. This makes wave winding preferable for street railway motors. These motors are all practically four pole motors. If they were lap wound, four brushes would be needed. As only one side of the motor is accessible, trouble would be experienced in keeping the brushes in good condition.

Position of Brushes on Generators. Ans. Ques. No. 401.

The position at which the lead from a coil connects to a commutator bar, depends entirely on the location of the brushes with respect to the poles. The brushes must be placed in such a position that the bar they rest on is connected to the end of a coil whose sides lie in a neutral space between the pole pieces. Now if the lead from the side of the coil lying in the neutral space is brought straight out to the commutator bar, the brushes would be located in line with it. In some motors the type of construction or need for making the brushes more accessible, as in the case of railway motors, makes it necessary to give the leads a certain amount of throw to either right or left, to bring the brushes in a position permitting of easy adjustment and inspection. Wherever circumstances permit it, or make it necessary, locating the brushes opposite the centers of the pole pieces, results in a saving of copper.

P. Justus (Ohio)

Position of Brushes on D. C. Generators. Ans. Ques. No. 401.

Editor Electrical Engineering:

In regard to question No. 401, by V. K. S., in the September issue of *Electrical Engineering,* will say that the brushes are always set at the neutral region on the commutator. This neutral region can be brought to any desired location by bringing the armature leads backward or forward as much as it is desired to bring the brush holders and brushes backward or forward. Thus it is seen that the brushes do not have to be set at what looks like the neutral point, but at what actually is the neutral point on the commutator.

T. W. Bisland (Miss.)

Meaning of Term Phasing-In. Ans. Ques. No. 397.

Editor Electrical Engineering:

The term "phasing-in" with respect to alternating current apparatus, and particularly to synchronous motors, means the fulfilling of two conditions, namely, synchronism and the adjustment of the proper phase difference. By synchronism is meant the getting in step of the motor and generator. To do this, a motor must reach its synchronous speed, which we know from the relation,

R.P.M. = (60 $\times$ frequency) $\div$ (number pairs poles).

Owing to the insufficient torque exerted by a synchronous motor when starting under load, some outside means must be used to bring the motor up to this speed. There are now two means used in general practice to attain this result. The first utilizes an auxiliary induction motor which is geared to the shaft of the synchronous motor and will run at a speed faster than the speed to be attained by the synchronous motor. This auxiliary motor is started and when the proper speed is reached, it is disconnected, and the synchronous motor is said to be in step. The other method is largely used in the starting of rotary converters without load and consists of cutting out the field circuit and impressing either the full line voltage or two or three different steps of it on the armature circuit until the machine attains its rated speed when the field circuit is cut in. This is accomplished by taking voltage from different taps at the transformers.

By the term phase difference is meant the condition that the emf. of the line and the emf. of the motor must oppose each other or, in other words, the phase difference or the phase angle must be about 180 degrees.

Some means must be had to learn the point at which these two conditions are fulfilled. One way is to employ a synchronoscope which automatically indicates the difference in the motor and generator frequencies by means of the speed and direction of rotation of its pointer while the other method employs incandescent lamps properly arranged. These lamps will glow the brightest when the angle of phase difference is zero degrees and when the phase difference is 180 degrees the lamps will be dark. To illustrate this, suppose that the motor is started and as the difference in speed is great, the lamps will alternately become bright and dark with more or less rapidity of change, but as the speeds approach each other the alternations will become slower and will finally become slow enough so that the switch may be closed during the period that the lamps are dark. Then the synchronous motor is said to be "phased-in." H. A. Cozzens, Jr. (N. J).

Position of Brushes on D. C. Generators. Ans. Ques. No. 401.

Editor Electrical Engineering:

The position of brushes depends upon the lead given to the ends of the coils connected to the commutator bars. The brush must be in contact with the coil that occupies the slot between two pole pieces. If the end comes out straight to a bar opposite this slot, then the brushes will be between pole pieces, while if the end bends over to the left or right of this slot, then the brushes will be just that much to the left or right of the line between the two pole pieces. A. J. Kalinonski, (Colo.)

New Apparatus and Appliances

A Combined Take-up and Pay-out Wire Reel.

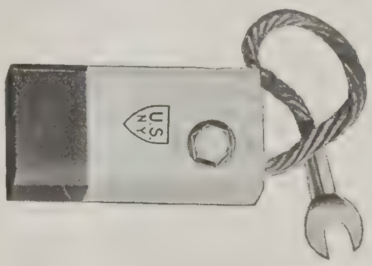
The accompanying illustration shows the Eichholff combined take-up and pay-out wire reel made by Mathias Klein and Sons, 562 W. Van Buren St., Chicago, Ill. These combination reels are designed to save time and labor in the handling of wire by telephone, telegraph and electric light companies where ordinarily a pay-out and a take-up reel is required, the one reel taking the place of two.

The reel disc proper instead of being made of wood is of No. 10. galvanized sheet steel; is 34 inches in diameter and has a 1 inch flange turned around the edge. As the disc is smooth there are no spokes or rim to cut through the copper coating or the insulation on wire, and for this reason is also excellent for coiling up barbed wire. The reel has an adjustable wire guide and one man can coil up wire without assistance. It has a brake around the hub which can be set to operate at any tension. It also has a stop-pin which will absolutely hold the reel disc stationary. The reel arms are adjustable and a coil of wire can be removed from the reel without the least trouble.

The Eichhoff Combination Wire Reel.

Generator and Motor Brushes.

In the design of motors and generators and in their operation, the most successful and efficient brush is an important consideration. The United States Carbon Company of 212 East 37th St., New York City, has established through tests and under operating conditions, what is known as a high-efficiency, self-lubricating carbon brush. These brushes are said to be dustless, noisless, non-arching and lubricating throughout their life, and designed for the most exact specifications. In their manufacture, the component materials are combined to give greater ampere capacity per



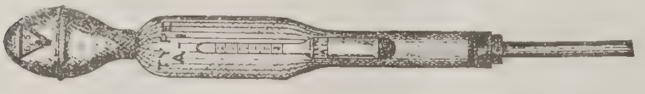
A U. S. Carbon Brush With Pigtail Connection.

square inch of cross section than so far demanded by engineering practice. Particular attention has been paid to the contact drop, specific resistance, abrasiveness and degree of hardness and a wide range obtained in classes and grades permitting the proper selection of brushes for every specified case. Their high conductivity prevents the bad heating effects and losses so occurent in brushes. They diminish wear on the commutator to a minimum and their long life quality reduces renewals in such a way as to give machinery the highest operating standing.

Brushes are made in carbon, carbon and graphite, and pure graphite grades moulded and cooled under high pressure, making them free from stratification and shrinkage cracks so continually met with in "forced" or "extruded" materials. Their length of life is claimed at not less than 50 per cent above the average maximum.

Hydrometer Syringe for Use With Storage Batteries.

The General Scientific Equipment Company, 2000 Market street, Philadelphia, Pa., has devised a hydrometer syringe for determining the state of charge of a storage battery. Its operation is based on the fact that the sulphuric acid solution of a battery varies in density between full charge and complete discharge, it being lightest when the battery is completely discharged. By inserting the tube



Storage Battery Hydrometer Syringe.

of the syringe in the storage cell opening and withdrawing a part of the solution by means of a bulb, the specific gravity is indicated by a hydrometer mounted in the syringe cylinder. This hydrometer is graduated in a convenient scale so that by knowing the reading for complete charge and for complete discharge, any intermediate charger can be ascertained. It also furnishes a means for maintaining the proper specific gravity of the solution at all times by observing the reading after the battery has been charged.

Packard Transformers.

The transformer industry received its greatest impetus when silicon alloy steel replaced soft iron cores. The use of this material made it possible to greatly reduce the core-losses and also the copper-losses by reason of the smaller cores and higher magnetic densities which became usable. It is safe to say that the advent of silicon alloy steel has reduced the losses by 50 per cent so that an efficiency of 99 per cent is sometimes excelled in large transformers and 98 per cent is common in the ordinary sizes. To improve an article already so nearly perfect will be admitted to be a

Fig. 1. Construction Details of Packard Transformers.

difficult matter and calls for the utmost attention to even the smallest details of design.

A transformer has recently been placed on the market by the Packard Electric Company, of Warren, Ohio, which is claimed to possess several important improvements. Four extra oil-ducts have been provided for ventilating the interior of the transformer, the openings for these ducts being shown in the yokes in the illustration below.

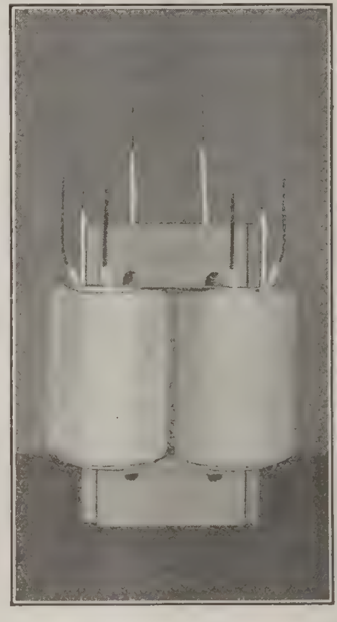


Fig. 2. Core and Windings of Packard Transformers.

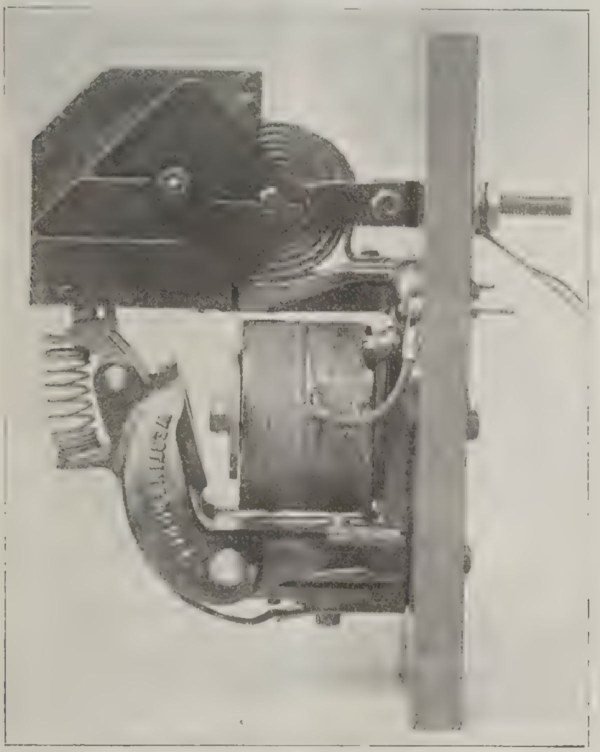
The cruciform core which manufacturers of core type transformers use usually have four oil ducts on each core, but two of these are ordinarily closed up by the yokes at the top and bottom. In the design of the transformer discussed this difficulty has been avoided by giving the yokes a form which makes the four inside ducts available for ventilation purposes and insures a supply of cool oil in the interior of the transformer where it is most needed. This feature alone makes it possible to operate them under severe conditions and high overloads. Besides the above feature, a special form of core is used, which eliminates cross-magnetization. All secondary leads are brought out through a single strong porcelain bushing which has the effect of reducing stray magnetism in the iron cases and thus improves the copper losses and regulations.

New Westinghouse Magnet Switches.

A new design of direct current and alternating current magnet switches for automatic controllers, have been put on the market by the Westinghouse Electric & Manufacturing Company. These switches have been designed to obtain continuity of operation for the controller on which they are used to secure long life to the wearing parts, and to insure rapid repairs in case of accident. The switches are of the clapper type, arranged so that they are opened by gravity assisted by a spring.

The direct current switches are single pole, and the alternating switches two-pole, and can be supplied with three poles when desired. Direct current switches are made in both shunt and series forms. The wearing parts, such as contacts, arc shields, etc., are in general the same in both alternating current and direct current types of the same capacity, thus reducing the number of repair parts to be carried in stock by firms using both kinds.

Special care has been taken to reduce the destructive action of the arc, which when formed is blown sidewise against the arc shield but is guided upwards by an arcing horn and is then extinguished by the blow-out coil. This arrangement preserves both contacts and arc shields. The contacts, in closing, have first a wiping action, then roll against each other, and are finally firmly pressed together.



NEW WESTINGHOUSE MAGNET SWITCH.

In switches of 250 ampere capacity and larger the circuit is made and broken between copper and carbon, but in all cases the final contact is between copper pieces.

The flexible copper shunts which carry the current to the movable contacts are welded to the terminals, there being no solder to melt and run down the shunt and stiffen it on solidifying.

Electrical Construction News

This department is maintained for the contractor, dealer, manufacturer and consulting engineer.

FLORIDA.

ATLANTIC BEACH. The Atlantic Beach Corp., is installing about three miles of white way street lighting and will continue the system as the streets are opened.

MAYO. On October 17, $15,000 in bonds was voted for an electric light plant.

GAINESVILLE. An ornamental street lighting system in the business district is now planned, providing for 88 standards carrying five-light clusters of one 100 watts and four 60-watt tungsten lamps. An underground feeder system will be installed, using steel taped cable. G. H. Cairns is engineer.

GEORGIA.

AUGUSTA. The Carolina and Georgia Railroad Co., has awarded a contract to build an electric railway between Augusta, Ga., and Columbia, S. C. The proposed road will be 110 miles in length and connect with the traction system built by J. B. Duke in the Piedmont district.

LOUISIANA.

NEW ORLEANS. Leon C. Weiss, of New Orleans, is preparing plans for a power house to be constructed by the Kener, New Orleans, Interurban Railway

NORTH CAROLINA.

CHARLOTTE. The Southern Power Co., is contemplating the construction of a large generating station at Fishing Creek on the Broad River, about 15 miles from Rock Hill. This plant will supplement the capacity of numerous other plants which are at the present time well loaded.

HIGH SPRINGS. The installation of a hydro-electric plant on the French Broad River is planned by J. E. Rector, of Asheville, N. C., and others.

WASHINGTON. The city plans to install three 150-horsepower water tube boilers, one 360 Kva., 60-cycle, three-phase, 2,300-volt turbo-generator, one 40 Kw. motor generator exciter, one 40 Kw. turbo-generator exciter, a surface condenser with air pump, and a six-panel switchboad with the necessary wiring. H. D. Charles is superintendent.

WILTON. Bids will be received until November 4, by the Board of Public Works on equipment for an electric light plant. G. C. White is engineer at Charlotte, N. C.

OKLAHOMA.

GRAND FIELD. The Southern Oklahoma Light & Power Co., is to install oil engines and generators costing about $4,000. L. E. Edwards is engineer and J. A. Bragham is general manager.

SOUTH CAROLINA.

CHARLESTON. The Isle of Palms Development Co., is to install a cable under Cooper River from the foot of Charlotte street to the car barn at Mt. Pleasant, and furnish electricity to Mt. Pleasant, Sullivan Island and Isle of Palms. About 6,000 feet of cable will be used which will cost about $66,000.

WALHALLA. The Linler Power Co., incorporated with capital stock of $40,000, proposes to construct a dam and power house at Old Mauldin Mill Shoals, near Walhalla. J. J. Linler and M. C. Thornton, of Hickory, N. C., are interested.

TEXAS.

GALVESTON. On October 6, the Galveston-Houston Electric Co., held a meeting to authorize $1,000,000 in common and preferred stock. Improvements and extensions are contemplated for the coming year, including the purchase of new equipment, an increase in power facilities, and the erection of a car barn. Stone & Webster Engineering Corp., of 147 Milk street, Boston, has charge of the work.

MOODY. The Home Light & Power Co., is to erect a transmission line from Eddy, Texas, and secure energy from the Texas Power & Light Co. The construction will be done during the next year and wire, poles, transformers, lamps, etc., are to be purchased. A change of the system will be made from direct current to alternating and the wiring changed accordingly. C. Canuteson is owner of the plant.

TEMPLE. The Southwestern Traction Co., will amend its charter, increasing its capital stock to $3,500,000, the proceeds to be used for extending the railway system from Temple to Waco, a distance of about 30 miles, and from Temple south to Austin, about 80 miles. A. F. Bentley is president.

WACO. The American Power & Light Co, of 71 Broadway, New York City, plans to begin the construction of the steam plant of the Texas Power & Light Co., at Waco. The plant will consist of six 600-horsepower boilers with stokers, two 6,000 Kw. turbo-generators operated at 4,160 volts. Power will be transmitted at 60,000 volts. The plant is designed by Sergent & Lundy, of Chicago.

VIRGINIA.

REUSENS. The Lynchburg Traction & Light Co., is to install another generating unit and water wheel at the Reusens power house, which will develop 1,350 horsepower, making the plant capacity 3,500 horsepower.

WEST VIRGINIA.

CABIN CREEK JUNCTION. It is planned to start work on a plant and transmission line to cost approximately $1,000,000. The plant will be located on Kanawaha River and be within transmission distance of some 200 coal mines. It is planned to construct hydro-electric plants at Old Shoals on the New River to develop 100,000 Kw. Three of the sites are also controlled on the New River, one at Blue Stone of 125 Kw., one at Richmond Falls of 15,000 Kw., and one at Gauley Junction of 30,000 Kw. The transmission system will ultimately reach Cincinnati, Huntington, W. Va., Portsmouth, Ohio, and Louisville, Ky. The Virginia Power Co., controls the West Virginia Power Co., of West Virginia. Wilbur Tusch is secretary, and Charles O. Lentz, chief engineer, at 149 Broadway, New York City.

BLUEFIELD. It is now planned to electrify the coal fields of Eastern Kentucky and Tennessee on the Louisville & Nashville, and the coal mines of Southwest Virginia on the Norfolk & Western, the work now being in charge of Stewart & James, engineers. Three steam-operated central plants will be located at the mines and a steel tower transmission line constructed from Dante, Va., to Jellico, Tenn., passing through Harlan, Middlesboro, Pineville and Jellico districts, about 100 miles. One of these plants is under way. The power will be transmitted at 110,000 volts.

Personals.

MR. J. ALLEN SMITH, president of the U. S. Light & Heating Co., manufacturers of the U-S-L electric starter and lighter, storage batteries and electric car lighting equipments, sailed October 11 for England and the Continent, his second trans-Atlantic trip of the year. Mr. Smith will not only attend to unfinished and new business but will endeavor to visit the various automobile shows, which are held earlier in England and Europe than in this country. As a result of the first trip, the officials of the more prominent automobile and railroad companies abroad are now familiar with U-S-L products and the U-S-L trade mark is already associated with English and European manufactories. Mr. Smith has announced no definite date for his return to America.

MR. C. C. BRADFORD, formerly manager of the Cleveland branch office of the U. S. Light & Heating Co., has been appointed sales manager of the company, with offices at 30 Church St., New York City. Mr. Bradford became identified with the U. S. Light & Heating Co., manufacturers of U-S-L products, in 1909. After one year as manager of the New York branch office, he went to Cleveland for the purpose of establishing a branch office in that city. His appointment to sales manager comes after three highly successful years as manager of the Cleveland office.

MR C. C. BRADFORD.

About the affairs of the U. S. Light & Heating Co., Mr. Bradford has the following to say: "The U. S. Light & Heating Co. has experienced a most wonderful and rapid growth since it was organized four years ago and is today, without a doubt, one of the leading factors in the manufacture of specialized electrical apparatus, namely, storage batteries, electric starters and electric train lighting devices. Considering the already tremendous demand for apparatus in all our lines, and the fact that this demand is increasing rapidly, I believe one is thoroughly justified in predicting that the growth of our company in the future will be even more gratifying than it has been in the past."

MR. R. B. CLARK has been appointed acting manager of the Cleveland branch office of the U. S. Light & Heating Co., manufacturers of U-S-L storage batteries, electric starter and lighter and electric train lighting equipments. Mr. Clark succeeds Mr. C. C. Bradford, who is now sales manager of this company.

Industrial Items.

THE CUTLER-HAMMER MFG. CO., of Milwaukee, makers of electric controllers, has recently opened a new district office in Cincinnati, located in the Fourth National Bank building. The general increase in business has made it necessary to establish a permanent office in Cincinnati. Mr. Horace L. Dawson, formerly of the engineering department of the Cutler-Hammer Mfg. Co., and recently one of the sales engineers connected with the Chicago office, will be in charge of the new office.

THE H. W. JOHNS-MANVILLE CO., New York, announces that it has recently completed the installation of lighting fixtures to the value of $19,590 in the New York Central R. R. Co.'s new station at Rochester, N. Y.

ALLIS-CHALMERS MANUFACTURING COMPANY announce the removal of the sales and engineering offices of their mining machinery department from Chicago, Ill., to the Milwaukee Works at West Allis, on October 6, 1913. The Chicago shops will also be removed to Milwaukee in the near future. The advantages to be gained by concentrating all departments, both commercial and manufacturing, at one plant, are the reasons for this move.

FAIRBANKS, MORSE & CO. has moved the headquarters of the Southern department from Chicago to Atlanta, Ga., Mr. E. D. West, manager. This will greatly facilitate the handling of the company's large Southern business. Sales offices will be maintained at New Orleans, La., Jacksonville, Fla., Atlanta, Ga., and Richmond, Va. At each of these points a large stock of engines, electrical machinery, pumps, etc., will be carried for prompt shipment.

ELECTRICAL ENGINEERING

PUBLISHED MONTHLY

Vol. 45. DECEMBER, 1913 No. 12

PUBLICATION OFFICE
DALTON, GA.

EDITORIAL and ADVERTISING DEPARTMENTS
GRANT BUILDING ATLANTA, GA.

SUBSCRIPTION RATES

Domestic	$1.00 For Two Years
Canada	$1.00 Per Year
Foreign	$1.50 Per Year

Complaints of failure to receive ELECTRICAL ENGINEERING regularly or of any errors of any nature, should be promptly made to the Atlanta office.

Advertising copy or change orders for standing advertisements must reach the Atlanta office by the 5th of the month preceding the month of publication.

Entered at Dalton, Ga., Postoffice as Second-class Matter.

CONTENTS.

The $9,000,000 Anthony Brady Hydro-Electric Plant at Hale's Bar, Tenn., Completed and Formally Started.

Appropriate ceremonies accompanied the formal starting, on November 13, of the hydro-electric equipment in the plant of the Chattanooga & Tennessee River Power Company at Hale's Bar, near Chattanooga, Tenn. All Chattanooga took pride in suitably recognizing this important step in the improvement of the Tennessee river, coupled with the benefits to be derived from cheap electric power to propel her wheels of industry and transportation. The celebration under the auspices of a wide-awake chamber of commerce, was an unqualified success from the time two chartered steamboats left the wharf at Chattanooga for the plant, until a banquet to distinguished guests closed the first operating day of this important Southern development.

The completion of the Brady plant at Hale's Bar is interesting on account of several features. It represents the result of nine years of activity, and more than eight years of struggle with construction difficulties never before experienced by engineers or financiers in the building of any hydro-electric development in this or any other country. It represents an expenditure, largely on account of construction difficulties, of approximately $9,000,000 of American money, and the confidence of three men, two of whom are now dead, that such an expenditure was justified on a single development in the new South. These men were the late Mr. J. C. Guild and Mr. Charles E. James, of Chattanooga, and Mr. Anthony N. Brady, the late president of the New York Edison Company, of New York City. Mr. Guild, an engineer of high professional standing in the South, due to engineering accomplishments, as president and chief engineer of the Chattanooga & Tennessee River Power Company, conceived the plan for the practical utilization of the water power for generation of electrical energy made possible through proposals of the government in 1900 to construct a dam below Chattanooga to facilitate navigation of the Tennessee river. He died in February of 1907, without seeing his plans carried into full execution, but not without the personal satisfaction of conceiving and putting under way the work on this important development in October, 1905. Mr. James, a prominent promoter and capitalist, known as the "General of Industry in Chattanooga," was interested in the project by Mr. Guild, and to Mr. James belongs the honor of organizing the forces interested and keeping them intact through more discouraging reverses than have ever come to any one man on any one successful project. He, of the three originators, was the only one to see through human eyes the completion of the work. Mr. Brady, the third member of the promoting trio, was a personal friend of Mr. James who, when once convinced of the success of the plans, stood back of him with characteristic pertinacity and literally poured millions of dollars into the fissures of the Tennessee river at the power plant site until all the holes were filled, never seriously questioning the engineers who claimed that such holes must have an ultimate capacity. Considering the fact that Mr. Guild and Mr. James estimated the cost of constructing the dam, power house and lock, at about $1,500,000, and the equipment of power house and substation and the construction of transmission lines at about $2,000,000 more, the support of Mr. Brady was a vital factor in the work, and justly deserves all the credit that can or ever will be given to his memory. Another feature making this development interesting is the fact that the lock at the opposite end of the dam from the power house, is the largest single lift lock in the United States, and will provide valuable navigation facilities between Chattanooga and the Gulf of Mexico.

A statement by a weekly contemporary, that the Hale's Bar plant is the largest single hydro-electric development in the South, is incorrect. The ultimate station capacity is 43,862 Kva., while the station of the Georgia Railway & Power Company, at Tallulah Falls, Ga., nearly completed, will have a capacity of 60,000 Kva. Also a station of the Alabama Power Company in Alabama, to be soon completed, provides for 81,000 Kva of generating apparatus. The development is, however, none the less complete or important by not ranking first in size for the South, as will be noted from the technical details of design and construction as presented in the August issue of *Electrical Engineering* by Mr. Byron T. Burt.

From an industrial standpoint, of even greater significance than the total amount of power available at the Hale's Bar plant, is the fact that the Chattanooga & Tennessee River Power Company announces as cheap a rate for its output, if not a cheaper one, than any other concern in the South offers. It is lower even than that charged for Niagara power, or for power from any other plant in the North or Eeast. In fact, it is stated authoratively that the rate is the lowest in the United States. The demand charge is $1.00 per month per Kw., with a maximum demand based on a 7½ minute peak. The scale of rates is as follows: First 2,000 Kw-hrs at 1.5 cents; next 2,000 Kw-hrs at 1.25 cents; next 2,000 Kw-hrs at 1.00 cent; next 6,000 Kw-hrs at 0.75 cents; over 12,000 Kw-hrs at 0.05 cent. It will be observed that this rate is very much in favor of the small consumer, and favorable also to the medium and large consumer in both the fixed charge and the small quantity in each phase of the sliding scale which must be used before the next lower price prevails.

Although it is rather unusual to expect to realize in a short time a reasonable return on such a large amount of capital invested in a single plant, the progress of the city of Chattanooga is justifying the prophesy that in twleve years this city will have grown from one of 45,000 inhabitants to one of 250,000 with industries demanding electrical power to an equal if not greater extent than those cities which have had similar growth. With the industrial expansion of the South and the tremendous increase in demand for electrical power during the past ten years, no one has a right to a pessimistic view of the present excess of power in Chattanooga and surrounding territory.

While we have endeavored to give the promoters just credit in a small way for the work that has been accomplished and represented by the completion of this plant, in the remarks here presented, it is essential that the names of several other prominent engineers be mentioned who were responsible in no small way for the design and completion of the work. These men are: Col. H. C. Newcomer, government engineer for design of dam; Col. John Bogart, of New York, chief engineer, and engineer on design of substructure and power house; Thomas E. Murray, vice-president and general manager of the New York Edison Co., as consulting and designing engineer for the electrical installation with Byron T. Burt, general manager and resident engineer in charge of construction and Jacobs & Davies, successful contractors who completed the work.

Line Extensions—When to Begin and Where to Stop.

Any policy governing the extension of distribution lines to secure new and outlying business in the field of the average central station, is largely affected by local conditions, as the reports of the committee on this subject presented at the Chicago N. E. L. A. convention last June plainly showed. It is evident that any discussion of line extension involves in the main two sets of conditions. Those conditions where it appears altogether probable that the business to be secured will be profitable at once, and those conditions where it is plain that the immediate profit is very problematic but good prospects for a substantial future return. In handling the first set of conditions there are few difficulties and little hesitation in making extensions on the part of most progressive stations. The second set of conditions are, however, approached very cautiously by the majority of central station managements and a general policy of "hands off" adopted. This is in the main probably due to two reasons, but not excusable on account of these reasons. In the first place, there is little definite data as yet available or records of methods found most successful in running extensions that do not present possible business at the start and few companies are soliciting the work of experimenting for the benefit of those who may be in the same attitude as themselves toward the matter. A second reason is one that apparently tends to substantiate the first and seems to make the "hands off" policy a good one. Public service commissions are inclined to reason that the franchise which gives the privilege of supplying service to the public also carries with it the obligation to supply such service to all who may apply. Thus, while the central station looks favorably upon the large customer, who desires service to such an extent as to be willing to pay a part of the expense of making it possible to reach him, it has in mind the establishing of a precedent which a smaller customer will not like and will not agree to, and whose objection to same would probably be approved in an appeal to the commission when demanding service. It is thus argued that what is made on the large customer is lost on the smaller one and a considerable load is accumulated with a minus profit.

How, then, shall this matter be faced and worked out in this day and time when electric service is in demand by large and small consumers alike, and most stations with more capacity than kilowatts connected? The difficulties in the solution of this problem seem to start at the very beginning, for in planning a station layout the average management takes great pains in estimating the future demand and hesitates little over the capital required to properly equip a power station and install a rather elaborate distribution system. At this time, spending money seems to be the thing, and we have only to look about us to see that a large number of companies had a very generous inclination in this direction. All this money was spent, it must be remembered, with a faith in a certain future return. When, however, the first steep hill has been climbed and a large part of the "close-in" business connected, and the question of "outlying" load is one of natural consideration, the very liberal policy previously established of investing for future return, even with an average successful experience on which to calculate and a thorough engineering understanding of load factor, diversity factor, maximum demand, and the like, for the possible business, is changed and the question comes up, "Is the load worth while?" A negative answer to this in too many cases causes a halt in the progress of securing new business, and business that has every reason to be just as successful as that resulting from the liberal policy used in the start.

What we have said is, in part, simply a recital of the pessimist's way of looking at this situation, and enables us to say that there are not enough small and medium-size companies who are willing to extend the very policy upon which they have already made good, when the time comes for a solution of the new conditions that have to do with future business and the possible hindrances in the meantime. If it were possible for them to get far enough away from visions of these possible hindrances to view them in their true prospective, a solution would be seen in effective management and a progressive policy.

In analyzing the subject of line extension, it would seem that Mr. Alexander Macomber has good ideas as presented elsewhere in this issue. He maintains that there are two important considerations in a policy of line extension. First, any concern utilizing its capital in a public utility is entitled to and should get a reasonable return on its investment. Second, that such a concern assumes certain obligations to the community in general, the greatest obligation being the establishing and maintaining of service on broad-minded principles, the most liberal consistent with its responsibility and always a co-operation with the public and its interests to mutual advantage. In this he has expounded no new theory or given us an application of an old one, but simply re-worded the golden rule. There are those who have found this policy a good one in the central station field, and if the methods of these companies are investigated, it will be found that their basis of getting business is not far from the idea of Mr. Macomber, and that they are extending their lines, to all appearances, too liberally—yet successfully. There's a reason—if you would find it, learn the true meaning of the psychologist's term introspection, and apply it to your methods of doing business.

Care of Fans During Winter.

This is the time of the year when many electrical dealers find very profitable business in collecting, cleaning, overhauling and storing fan motors for their customers, putting them in good running order, ready to deliver when wanted in the spring.

The fan motor is a nicely adjusted piece of machinery, which should have reasonable care and attention if it is to continue to give good service year after year. A little oil in the bearings and a little attention in cleaning off the dirt which has accumulated during the summer, will result in improved operation and appearance.

In practice small motors and fan motors operate month after month, year after year, making in the aggregate thousands of millions of revolutions without any attention other than occasional perfunctory attempts at oiling. To be more exact, small motors of the type commonly employed operating at speeds of between 1,500 and 1,800 revolutions per minute make more than 100,000 revolutions in an hour of continuous service, or more than a million revolutions per day of ten hours' continuous service. This is at the rate of twenty-five million revolutions per month, or three hundred million revolutions per year, assuming that the motor or fan is operated only ten hours a day and only during the business days of the year. In practice such small motors as fan motors are frequently required to operate eighteen to twenty-four hours per day for many weeks at a time, and are expected to do so with practically no attention. When it is remembered that the electric meter is installed by an expert and is supposed to be often examined and tested, while small motors and fan motors are put in service by users whose familiarity with machinery of any kind is confined to the household sewing machine or the ice cream freezer, often suffering at the hands of the young tinker, yet seldom failing to respond to the proper connection to the lighting socket, it is little short of remarkable that small motors stand up as well as they do.

Cheap Electricity in Sweden.

At a recent meeting of the board of managers of the Goteborg electric light and power plant, a novel plan to introduce electricity into the 1 and 2-room flats was advanced. Of the 30,000 apartments of 2 rooms and kitchen or less in Goteborg, only 3,100 are supplied with electricity. The chief reason for this is the expense of installing a special meter for each 2-lamp apartment. The house owners have not felt inclined to go to such expense, and the tenants have not been willing to spend so much on apartments that they might occupy for only a short time.

The director of the electric plant proposes to join all the small apartments in a house with a common current limiter, the rental for the number of lamps for which the limiter is adjusted to be paid by the house owner to the electric company and the house owner to be reimbursed by additional rental for each apartment. This system has been tried in 4 houses averaging 21 apartments each, and the results have been satisfactory. The installation costs per house were reduced about 40 per cent. The cost of current will amount to 13.4 cents per lamp per month, or 26.8 cents per month for 2 lamps. At present the consumer pays $4.02 per year for two lamps plus the current limiter.

1914 Convention of Southeastern Section N E L A to be Held at Isle of Palms, Charleston, S. C.—(10 pt. LC) . :

At a meeting of the executive committee of the Southeastern Section of the N. E. L. A., at Charleston, S. C., November 6, the Isle of Palms, a summer resort near Charleston, S. C., was chosen as a meeting place for the 1914 convention to be held August 19, 20 and 21.

Preliminary plans were made for this convention and the chairmen of the various committees appointed by President T. W. Peters, approved by the executive committee as follows: W. Rawson Collier, sales manager of Georgia Railway & Power Company, Atlanta, Ga., chairman of rate committee; C. D. Flanigan, vice-president of Athens Railway & Electric Company, Athens, Ga., chairman of exhibits committee; C. M. Benedict, treasurer of Charleston Consolidated Railway & Lighting Company, Charleston, S. C., chairman of entertainment committee; E. C. Deal, vice-president Augusta-Aiken Railway & Electric Corp., Augusta, Ga., chairman of welfare committee.

General View of Plant of Atlanta Steel Company, Atlanta, Ga.

The Solution of an Increasing Demand for Power at Plant of Atlanta Steel Co.

(Contributed Exclusively to Electrical Engineering)

BY EARL F. SCOTT, M. E., MEMBER A. S. M. E., MECHANICAL ENGINEER, ATLANTA, GA.

Increasing Power Plant Capacity Through Installation of Mixed Pressure Turbines and Large A. C. Motor Drives Operated From Central Station Lines.

THE plant of the Atlanta Steel Company, located in the northern section of the city of Atlanta, Ga., manufactures merchant bars, wire and other products of the steel industry, such as nails, cotton ties, etc. The first equipment of the original plant was installed in 1898 for the purpose of making cotton ties and other small products such as nails, etc., and the company known as the Atlanta Steel Hoop Co., the name being later changed from this to the present one. The manufacturing facilities have since been gradually increased until now a variety of products are produced under the headings mentioned. With the installation of this additional manufacturing equipment, the power problem has been an important one and one that has involved interesting engineering features in its development from a power demand of about 3,000 Hp to one at the present time of more than 6,500 Hp.

Before discussing this power problem, we will review the nature of the original equipment of the plant as operated in 1906. The first boiler equipment consisted of 9 375 Hp. units making a total boiler capacity of 3375 Hp. This installation furnished steam for what is now known as the blooming mill engine, rod mill engine, and several other small engines about the plant. With the exception of the blooming mill and rod mill engines, all the other smaller engines have been replaced by electrical drives.

The bloom mill engine, shown in Fig. 1, is a double cylinder reversing rolling mill type, direct connected to a "2-high" bloom mill. It was operated non-condensing and capable of developing 1200 I. H. P. at 150 lbs. gage pressure, at ¼ cut-off and 40 Rpm. At full speed it is capable of developing 3000 I. H. P. This engine is equipped with a Stephenson link motion and reversing gear similar to that of a locomotive.

The purpose of this engine and apparatus is to roll the blooms or cast blocks of steel as poured from the open hearth furnace, from their original size down to billets about 4-in. square. These blooms are about 10 x 12 in. square at one end by 10½ x 12½ in. square at the other and about 6 feet long, weighing about 2,000 pounds. After these blooms are poured from the furnaces, they are allowed to cool, but before they are ready for the blooming mill they are passed through reheating furnaces or soaking pits where they are brought to a white heat. During this period, the gasses in the metal are worked or driven out, preventing blow holes or flaws in the material after it has been rolled down.

For rolling these billets it is readily seen that the engine design must be very rigid as the work is extremely severe. After the blooms have been reduced to sections about 4 in. square or into what is known as billets, they are passed along to a second mill, known as a six-stand continuous billet mill. This mill is new and while it logically follows at this point, we will discuss its details later as it forms a part of a later installation. This mill, however, reduces the 4-in. square sections to billets of about 1½-in. square, which in turn are carried to the rod mill for further reduction. These square bars, which are about 20 ft. long, are reheated in a furnace after which they are reduced to rods of various sizes and wire of different gauges.

The rod mill engine is of the simple Corliss type, with cylinder 36-in. in diameter and 48-inch stroke and when running at 90 Rpm at 150 lbs. steam pressure, develops about 1350 Hp. The belt wheel shown in Fig. 2, is 22 feet in diameter with a 48-in. face. The engine is both direct connected and belted to a semi-continuous roll mill of 12 stands. There are six rolls direct connected to the main shaft of engine through gear wheels and six rolls driven by the belt. In addition to these two main engines, several smaller ones were originally installed at different parts of the plant, which, as already stated, have been replaced by electric motors and about which we will say more later. To supply energy for lights and these motors, there are two other steam engines which still continue to play a minor part in the power equipment which we will mention. These engines generate current for general distribution about the plant and are of the following types: One tandem compound Buckeye engine driving a 300 Kw., direct current generator and one similar type driving a 200 Kw. direct current generator.

In 1910, the demand for power exceeded the capacity of the equipment and as the total available boiler space had been used, it became necessary for the officials to seriously investigate the power situation in the plant and a means for supplementing it most economically. After a thorough study of the local conditions, it was decided to use the exhaust steam from the two rolling mill engines which were operating non-condensing, through mixed pressure steam turbines. The details of this new installation are a most important one from an operating standpoint, as shown in the accompanying plan, and more fully described in what follows.

USE OF MIXED PRESSURE TURBINES.

The exhaust lines of the rolling mill engines were run to a common 36-inch main and thence carried to the location of the new turbines, which were placed in the existing engine room at the side of the two lighting engines mentioned above.

There were installed at this date, two 500 Kw. General Electric mixed pressure Curtis steam turbines, direct connected to 450 volt D. C. generators and designed to operate at about 5 lbs. back pressure with 27 in. vacuum. At the time of installation, it was calculated that not enough steam could be produced from the two steam engines to operate the two turbines at once, thus causing the selection of the mixed pressure rather than the strictly low pressure turbine. It was estimated that one machine, however, could run at full rated capacity from the exhaust of one of the engines, based on the requirement of about 30 lbs. of dry steam at this pressure per Kw. per hour for the operation of the turbine. Provision was therefore made for taking live steam into the turbines at times of insufficient supply of exhaust steam as will be described later.

FIG. 2: CORLISS ENGINE DIRECT CONNECTED TO 12-ROLL SEMI-CONTINUOUS ROD MILL.

Before going into the detail of the turbine installation and operation, we will discuss the steam lines and connections from engines to turbines required for this additional apparatus. As noted above the exhaust lines from the two steam engines were brought together at a convenient point and run to a Rateau steam regenerator shown in Fig. 3, which is nothing more than a very large cylinder about 9 feet in diameter by 30 feet long. This cylinder is kept about one half full of water and the steam at about 5 lbs. gage pressure enters it at the top near one end. This steam heats the water up to its temperature and so long as there is a full flow of steam from the engines to the regenerator, the water remains in a balanced state, but as soon as the flow of steam lessens, necessarily the draft on the generator from the turbine is such as to reduce the pressure in the cylinder and the water, which has a temperature of the steam, is immediately flashed into steam which in turn feeds the turbines during such periods as the flow from the engines is irregular. When the whole supply from the engines is cut off, there will be enough stored energy in this regenerator to run the 500 Kw. turbine for 3 minutes before the live steam valve on the turbine opens up. This valve is arranged and adjusted so that just as soon as the pressure drops in the turbines, due

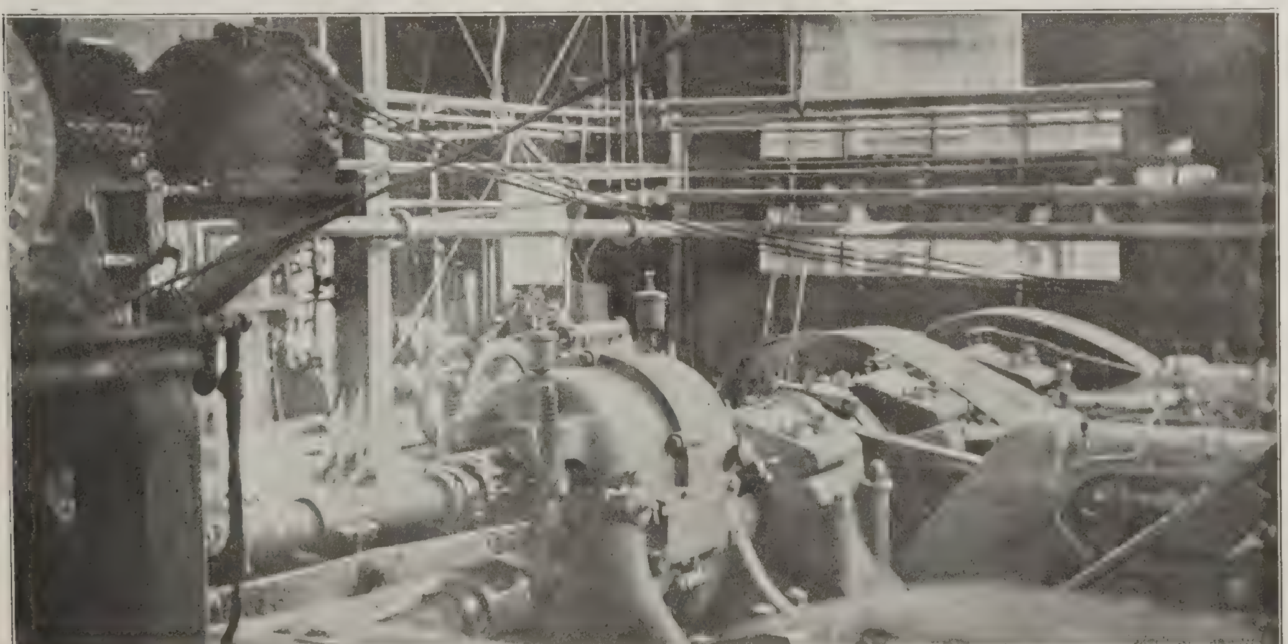


FIG. 1. REVERSING ENGINE DIRECT CONNECTED TO TWO ROLL BLOOM MILL.

to lack of exhaust steam from the engines, the live steam will be immediately admitted at 150 lbs. pressure and cause the turbine to maintain its normal speed.

This live steam at a pressure of 150 lbs. enters the turbine at a different point from that of the low pressure steam and necessarily the different pressures do not interfere, the design being such that the one aids the other through expansion and its own velocity. The steam from the regenerator leaves it through a dome on top of the cylinder as shown in Fig. 4 and very similar to the dome on a locomotive boiler.

The condensers used with the turbines to produce a 27-inch vacuum are of the elevated jet or barometric type as shown in Fig. 4 at the right and need but little comment beyond the fact that the condenser head is placed on the outside of the building and elevated above the turbine room floor about 35 feet as the hot well is about on the level with the floor. The dry vacuum pump for the condensers is located in an ante-room at one side of the turbine room, and is a horizontal crank and fly wheel machine steam driven with mechanically operated air valves. There is one machine for the two condensers. From the top of each condenser cone a 6-in. pipe is run down to a point near the vacuum pump at which point the lines are brought together with proper valves so that each may be cut out at will.

The water of condensation that might collect in the exhaust pipe from the turbine to the riser of the condenser, is taken care of by a pump and receiver located about four feet below the lowest point in this line. The condensing water is brought up practically to the plant through an 18-in. cast iron bell and spigot pipe line laid about 10-ft. below the ground surface. This line brings the water from a large pond by gravity and two centrifugal pumps handle the water up to the two condenser heads. Each pump is piped so that either may work on both condensers at will, by operating gate valves in the different lines. This arrangement is very good as one pump may be out of order and its corresponding condenser in operation.

The water from the condensers flows by gravity into a large open concrete hot well about 10-ft. square and 8-ft.

Fig. 4. Condensing Machinery and Regenerator for Mixed Pressure Turbines.

deep and from there by gravity back to the pond, entering same at such a point as to prevent its quick return to the intake. Provision is made, however, when the temperature of the atmosphere gets high as in summer, so that this water may be carried to a cold well about 500 ft. from the power house, through the same gravity return pipe that carries it to the pond, and instead of running to the pond as noted above may be pumped by a vertical submerged motor driven centrifugal pump, over eight cooling towers, shown in the general view of the plant, the water returning into the same pond as mentioned above and again allowed to start on its cycle towards the power plant. The circulating pump is operated by a vertical direct current motor, direct connected to the submerged pump through a vertical shaft.

As stated earlier in this article, the purpose of the turbine installation was to get increased power without increasing the existing steam generating plant of the mill, and this equipment has served the purpose very well. The current generated is used in driving large motors installed at different parts of the plant to take the place of the isolated engines that were costly to operate by means of long steam lines. With this installation the plant has been

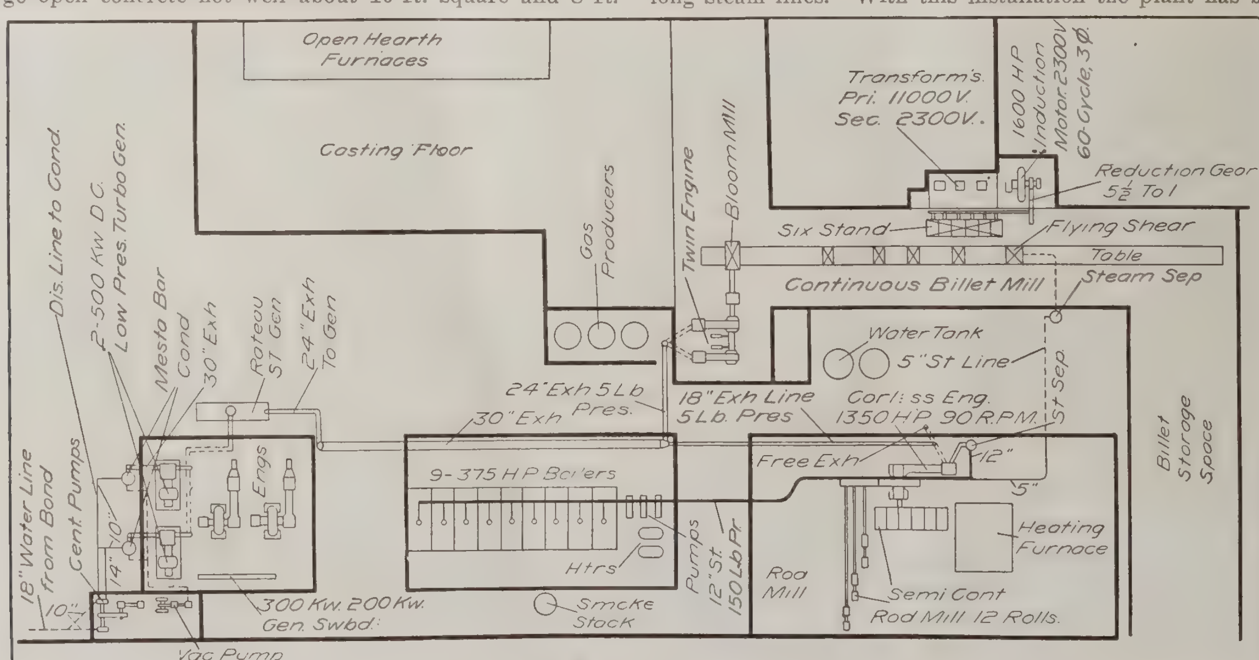


Fig. 3. General Plan of Plant, Showing Arrangement of Engines and Turbines.

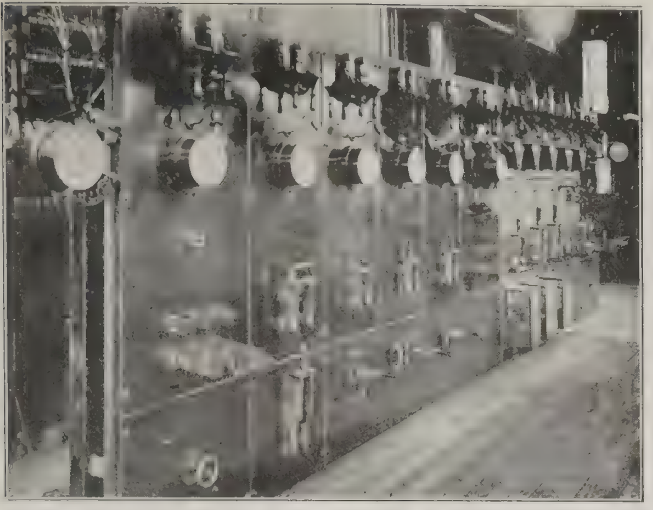


FIG. 6. SWITCHBOARD FOR LIGHTING ENGINES AND TURBINES, AND DISTRIBUTION BOARD FOR PLANT.

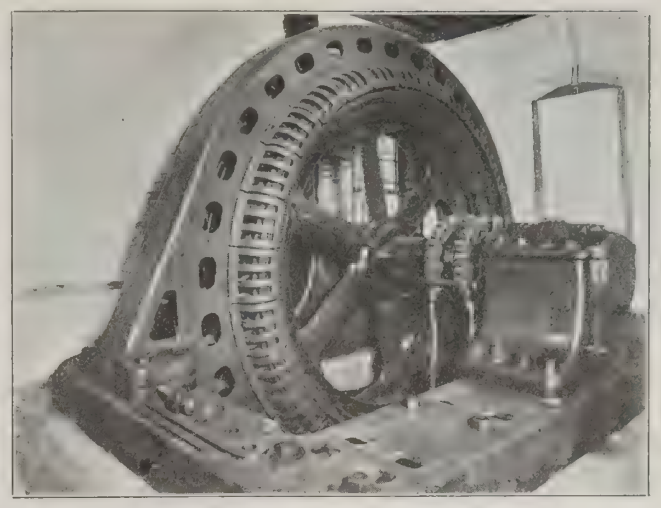


FIG. 7. 1600 HP. A. C. MOTOR DRIVING 6-ROLL CONTINUOUS BILLET MILL.

able to increase its output very materially and while it may not be said that the coal bill has been reduced, it is true that the management has been able to get a large increase in power capacity without increasing their steam generating plant, a decidedly important feature and one which does show a good saving in actual plant operation.

Through the installation of the new six-stand continuous billet mill in 1912, mentioned at the start of this article, the power question again came up as the total capacity had again been used by the present equipment. This time a large electric drive was selected to be operated from current purchased from an outside source. This installation called for a 1600 Hp. prime mover which was furnished in an induction motor driving the mill through reduction gears of a ratio of 5½ to 1. These gears are of the Herringbone type made of cast steel. The motor is of the General Electric induction type, 2200 volts, 60 cycle, 3-phase, running at 257 Rpm. The current is furnished by the Georgia Railway and Power Company and is brought to the plant at 11,000 volts, where it is stepped down to 2200 volts by three 500 Kw transformers placed near the motor.

The features of this electric drive are particularly interesting, first on account of the control and second on account of the method of speed reduction. The control apparatus and board is shown in Fig. 8, made up of 7 contactor panels, one relay panel and one starting panel. To start this large motor, the main oil switch shown on the panel at the left in Fig. 8 is closed, which throws full line voltage of 2200 on the stator with all resistance in the form wound secondary. The master controller may be used to give hand controlled acceleration if desirable, however the motor is usually operated on automatic current limit acceleration by setting the master controller on the full running position and closing one of the primary oil switches. The current limit relays permit the successive closing of the correct contractors at such times as the line current drops to a predetermined value for the preceeding contactor. The usual setting of such devices limits the current peaks

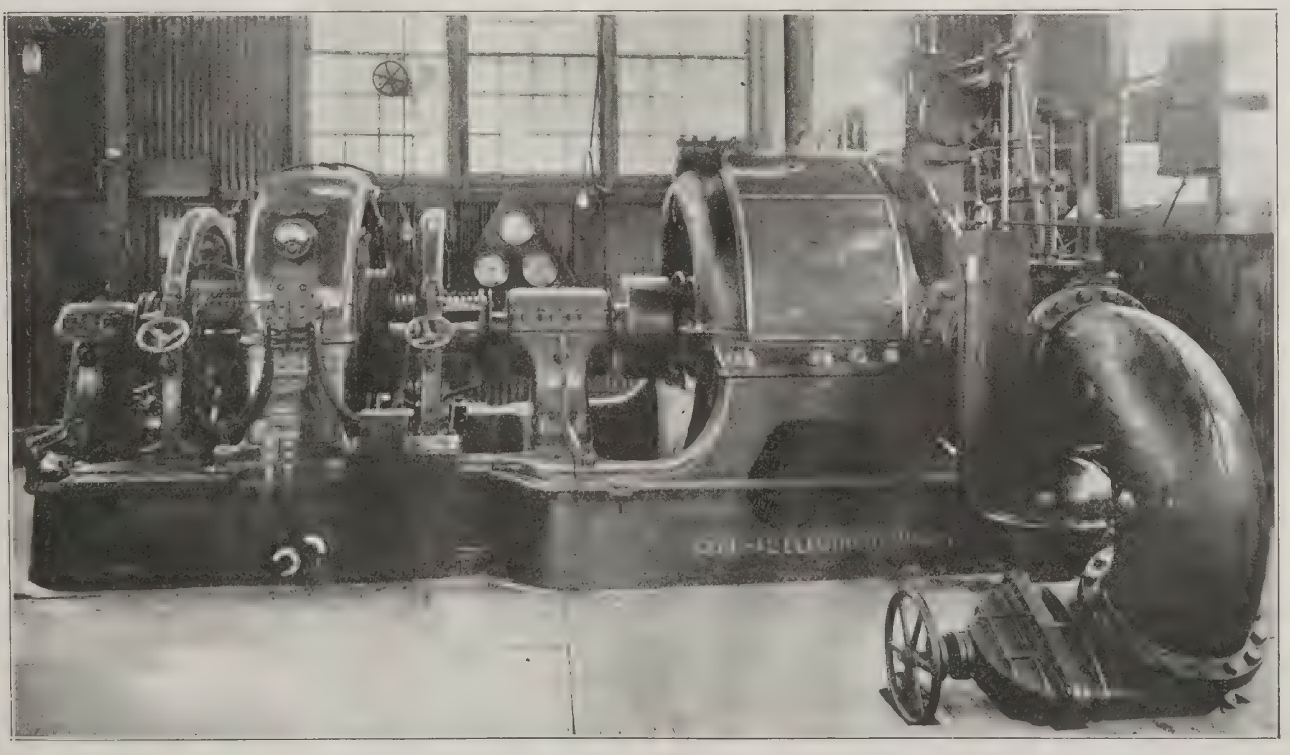


FIG. 5. ONE OF TWO 500 KW. MIXED PRESSURE CURTIS STEAM TURBINES.

FIG. 8. CONTROL SWITCHBOARD FOR 1600 HP. MOTOR.

during acceleration to 25% overload current. An interlocking system together with the current limit relays, prevents either too fast or too slow acceleration of the motor.

CONDITIONS DETERMINING THE NATURE OF ELECTRIC DRIVE.

The method of connecting large motor drives in steel mills for heavy service has been the subject of considerable discussion. When the installation of the 1600 Hp motor came up, the management had to decide for themselves the question of direct connection of the motor or connection through gears. The conditions which aided in the solution of this problem in this case are interesting and will be related in what follows. As already mentioned, the final decision was to connect the motor, shown in Fig. 7, to the 6-stand billet mill through a herring-bone set of gears with a ratio of 5½ to 1.0. The speed of the motor was selected at 257 Rpm for the following reasons. First, the flywheel effect of the heavy rotor of such a large motor was such as to produce a good effect on the operation of the motor in absorbing, as it were, the shocks due to sudden overloads in the operation of the mill. Second, the cost of the high speed motor in connection with the special steel gears and casing was considered less than the cost of a slow speed motor direct connected to the mill shafting. Third, the arrangement permitted the use of a "breaking-spindle" placed between the motor and gearing to prevent the possibility of wrecking the machine due to a severe overload.

The arrangement of this spindle is as follows: On the outside of the outboard bearing of the motor there is placed a flexible coupling connecting the 14-in. shaft of the motor to this "breaking spindle" which is only 4½-in. diameter. This spindle is connected to the pinion of the herring-bone gears through a second flexible coupling, making a continuous shaft from motor to pinion. This "breaking spindle" is designed to fail at 4,000 Hp. and since the motor will carry a momentary overload (2 to 3 seconds) in excess of this capacity, the arrangement offers a safe guard or protection to the motor. The motor in addition is designed to take care of a 75 per cent overload for about five minutes and a 25 per cent overload for two hours.

The mechanical operation of the herring-bone gears is worthy of consideration. The two gears are placed in an oil tight steel casing and operate submerged in an oil bath. With this arrangement, the high speed at which these gears run does not produce a noise that can be detected by placing one end of a metallic rod against the casing and the other end against the ear.

The cost of the complete steel gearing and casing was $10,000 which, added to the cost of the motor at 257 Rpm., was not more than the cost of the slow speed motor direct connected. The mechanical advantages mentioned above, which have worked out in practice all that was expected of them, proves conclusively that the selection of this unit was well studied before final decision was made.

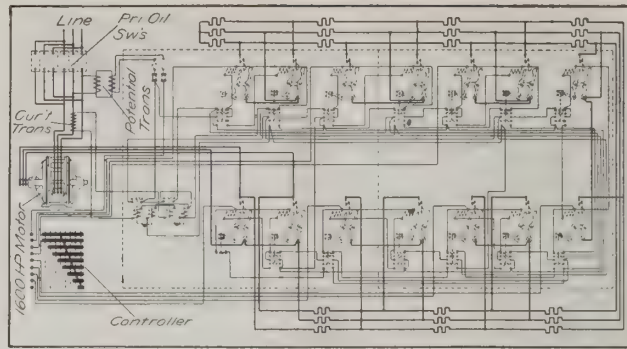


FIG. 9. DIAGRAM OF WIRING FOR MOTOR AND CONTROL APPARATUS.

The motor installation has now been in operation for eight months and besides proving successful as a unit, has again solved the problem of meeting an increasing power demand in the plant and it is probable that other units of this type will be installed in the near future.

New Wireless Stations Planned.

The Marconi Wireless Telegraph Company of America has recently made a contract with the Norwegian government for the erection of a wireless station in Norway, connecting with a station in Massachusetts. This service will make another link in the chain of Marconi stations which are being planned to give wireless service throughout the entire world. The Marconi Company has purchased sites for the proposed station on the Massachusetts coast and plans to erect the duplex system, by which wireless messages can be received and sent at the same time. The operation of the system will be on the same plan as that to be employed between the station now building between New Brunswick and Belmar in New Jersey and the new station in England. The Norwegian government is at present making arrangements according to Secretary Bottomly, of the Marconi Company, to connect with Sweden, Denmark, and the north of Europe. It is estimated that each wireless station will cost in the neighborhood of $500,000. Direct wires from the stations in Massachusetts will transmit the messages to New York and Boston.

Besides the new system between America and Norway, it is proposed to connect the United States with Honolulu by two stations to be erected in California at Bolinas and Marshalls. This system will be extended eventually to Japan and the Philippines. Stations are already being prepared in the former place, but so far it has not been possible to get concessions from the government for stations in the Philippines. There is also planned a wireless system connecting Europe and the United States with South America. The president of Brazil has recently signed a concession for a period of fifty years and every effort will be made to erect the necessary stations in the shortest possible time. A station will be constructed at Para connecting with New York, to be followed by a network of stations opening up cheaper telegraphic communications between the South American republics, the United States and Europe. These stations will be followed in a short time by a system of wireless communications with Australia, New Zealand, Egypt and India, until wireless messages may be sent to and from all parts of the globe.

Contracts have been awarded to the J. G. White Engineering Corporation, of New York, for the construction of the receiving and sending stations in New Jersey, California and the Sandwich Islands.

Important Considerations When Ordering Power Transformers

(Contributed Exclusively to Electrical Engineering)

BY H. G. DAVIS.

Section 3. Voltage Relations and Considerations With Rotary Converters.

FOR transmission of power to any great distance three-phase connections are used while for distribution lines of medium voltage three-phase and two-phase connections are used. In supplying motors and rotary converters we have two-phase, three-phase and six-phase connections. In changing from the two-phase or three-phase primary to the low voltage two-phase, three-phase or six-phase connections, it is necessary to know the direct current voltage of the rotary converter and also the method of connection to be used, as shown in Figs. 7 to 13.

RELATIONS WITH ROTARY CONVERTERS.

The ratio of alternating current voltages to direct current voltages at no load on the rotary and full load are given below. At full load on the rotary with constant impressed alternating voltage, the ratio of A. C. voltage to D. C. voltage increases slightly due to the drop in D. C. voltage under load. Single-phase rotaries have two collector rings, two-phase rotaries have four rings, three-phase rotaries have three rings and six-phase rotaries have six rings. The A. C. voltage ratio for two-phase as given, is for alternate rings which corresponds to a phase. The voltage between any two rings of the three-phase is the same. The voltage of a six-phase rotary is different for measurements between adjacent rings, alternate rings and diametrically opposite rings. These voltages correspond to different connections and should be known when transformers are to be ordered.

Table 1 will enable anyone to determine the transformer secondary voltage for a rotary to give a desired D. C. voltage. For a two-phase rotary, a two-phase transformer with secondary voltages (low tension) as given above can be used. A three-phase transformer used with a three-phase rotary must be Y connected on the low tension side if a neutral is desired and its secondary voltage must be the voltage desired between rings. If three single-phase transformers are used, a Y or delta connection can be used and the secondary voltages must be figured accordingly. For the six-phase rotary, which is the most efficient and inexpensive rotary, the secondary transformer connections determine the voltage required.

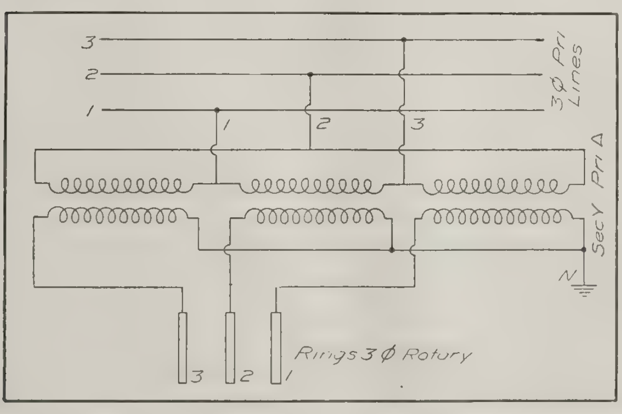


FIG. 7. DELTA PRIMARY AND Y SECONDARY CONNECTIONS TO 3-PHASE ROTARY WITH GROUNDED NEUTRAL.

N as shown on the diagram is the neutral Y grounded connection of the transformers and electrically connected to the neutral of the three-wire direct current side of the rotary converter.

TABLE 1. RATIO OF A. C. TO D. C. VOLTAGE FOR ROTARY CONVERTERS

Ratio of A. C. to D. C. voltage for rotary converters for determining transformer voltages with different connections:

	No Load Volts.	Full Load Volts.
With Direct Current	100	100
Single Phase	71.5	73
Two Phase (measured on diameter)	71.5	73
Three-Phase	61	62.5
Six Phase (measured on diameter)	71.5	73
Six Phase (measured on adjacent rings)	35.8	36.5
Six Phase (measured on alternate rings)	61	62.5

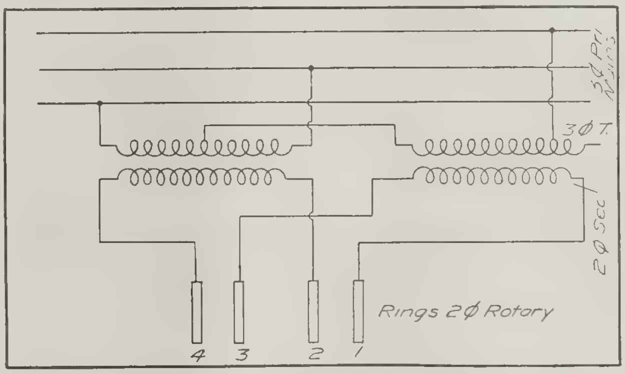


FIG. 8. THE SCOTT CONNECTION FOR TRANSFORMING 3-PHASE TO 2-PHASE.

The six-phase connections can be considered as two superimposed three-phase circuits and in this way the circuits can be more easily traced. The connection will require two banks of three single-phase transformers each, if the Y, delta or diametrical systems are used or two banks of two single-phase transformers each, if the T connection is to be used. The following table shows the secondary voltages for a rotary to deliver 600 volts D. C. when the different connections are used and different numbers of transformers.

TABLE 2. SECONDARY VOLTAGES WITH DIFFERENT CONNECTIONS.

Type of Rotary	Transformer Voltage	No. of 1-Phase Transformers
Single-Phase	429	1
Two-Phase	429	2
Three-Phase Delta	366	3
Three-Phase Y	212	3
Three-Phase T	366	2
6-Phase *2-delta	366	3 With Double Secondaries 6 With Single Secondaries
6-Phase, 2-Y	212	Ditto
6-Phase, 2-T	366	2 With Double Secondaries 4 With Single Secondaries
6-Phase, diametrical	429	3

*2-delta, 2-Y and 2-T means double delta: double Y and double T.

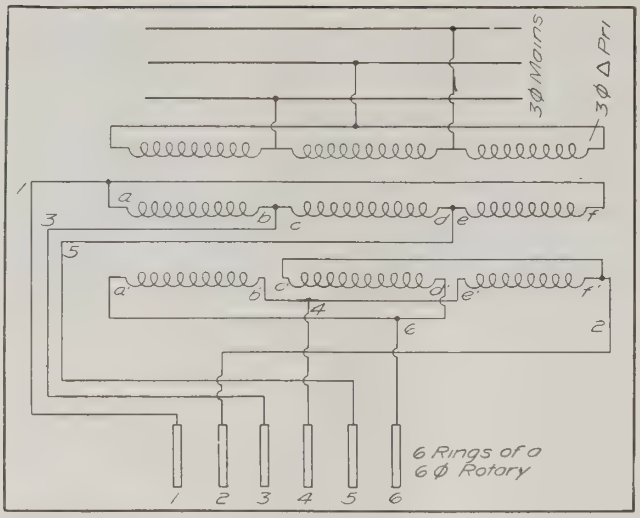


FIG. 9. THREE-PHASE TO 6-PHASE DELTA CONNECTION FOR 6-PHASE ROTARY OPERATION.

The double secondaries shown in the diagram are for three single-phase transformers or two banks of three transiormers with primary deltas identical and secondary deltas formed as shown. The voltage of each delta is the three-phase delta voltage, corresponding to the D.C. voltage required and given in the table. The secondary deltas are formed with individual coils connected in opposite directions so tnat the two deltas are displaced 60 degrees.

With the secondary voltages determined, the current rating of the transformers can be found. The Kva rating can easily be determined from the kilowatt output of the rotary, allowing for the losses in the rotary. For any connection with the number of transformers decided upon, each transformer must deliver its own proportion of power from which the rating for its connection can be given. Assume a six-phase, double delta with three transformers, each must deliver one-third of the power and table No. 1 shows that a three-phase, delta connection has a utility of 1 or the capacity required equals the power to be delivered. With a three-phase T with double secondaries, two transformers are required each to deliver one-half the power. The capacity of main and teaser transformers can be determined from Table 1 and utility = .866 or transformers

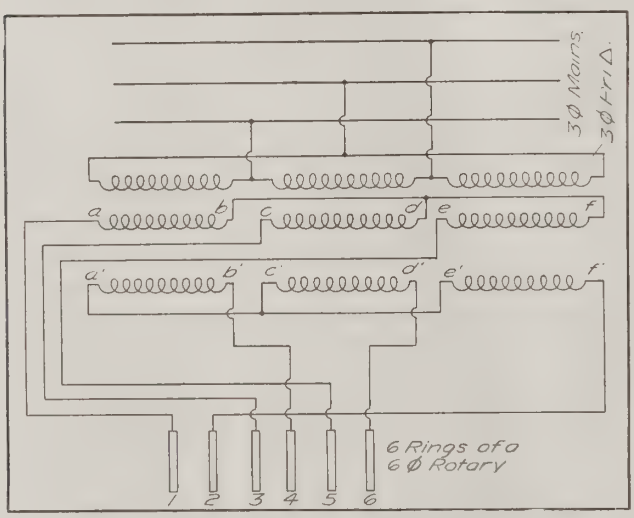


FIG. 10. THREE-PHASE TO 6-PHASE Y CONNECTIONS FOR 6-PHASE ROTARY OPERATION.

The secondaries are double secondaries of three single-phase transformers or two banks of three transformers with primary deltas identical and secondaries as shown. The neutals of the two Y's could be connected together and grounded for a three-wire D.C. network fed from the rotary. The two secondary Y's are formed by connecting the coils of the individual legs in opposite directions.

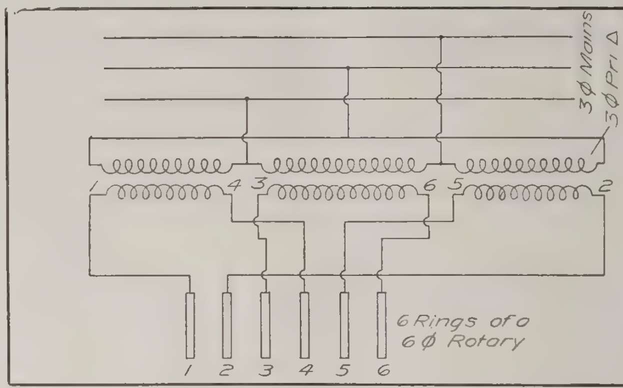


FIG. 11. SIX-PHASE DIAMETRICAL CONNECTIONS OF THREE SINGLE-PHASE TRANSFORMERS FOR 6-PHASE ROTARY OPERATION.

The two ends of each single winding are connected to rings of the rotary that come from diametrically opposite points of the rotary armature. For voltage of each individual secondary winding, see the table. If the middle point of the three windings is connected, the connection would be double Y.

must each be 15 per cent greater in Kva rating than the power required.

For a *T* or *Y* connection used with rotaries, the current in each lead enables the capacity to be determined. With field excitation for the power factor to be one or unity, the current in the a. c. leads of any rotary bears a definite ratio to the d. c. current. Thus: The three-phase alternating current and the direct current are practically the same or .943 times direct current. The two-phase alternating current equals three-quarters of the direct current or .707 × direct current. The six-phase alternating current equals one-half the direct current, or .472 × direct current. These are figures which, while not exact, are close enough for determining the current in the a. c. leads. These rotaries as referred to are shunt or compound rotaries. The split pole rotaries for special service have variable d. c. voltage for constant a. c. voltage and consequently have no definite ratio of voltage or current. These rotaries require special calculations and have no marked use in railway work or general use at the present time.

SINGLE VS. THREE-PHASE TRANSFORMERS.

The capacities figured above are for combinations of

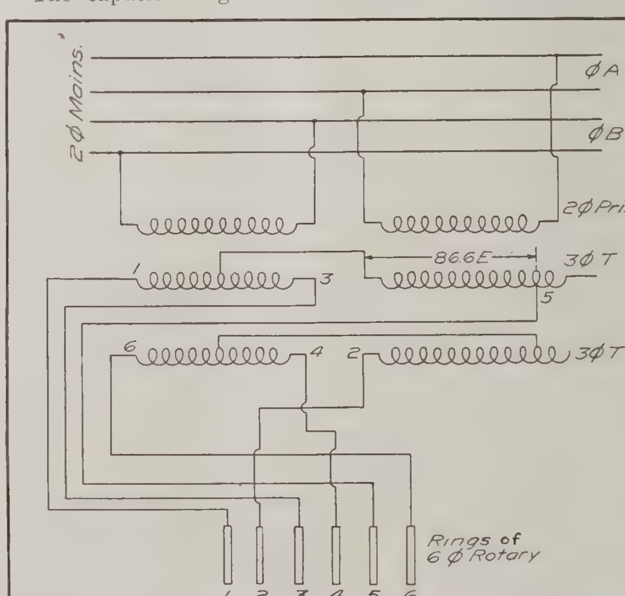


FIG. 12. THREE-PHASE TO 6-PHASE DOUBLE T CONNECTIONS OF TWO TRANSFORMERS WITH DOUBLE SECONDARIES.

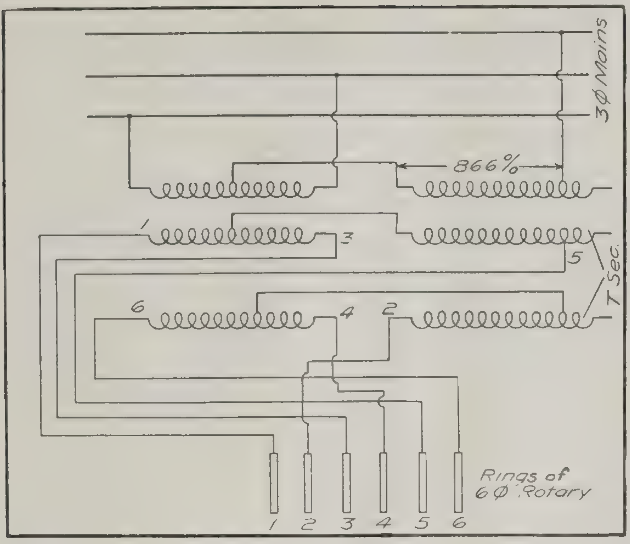


Fig. 13. Two-Phase to 6-Phase Double T Connections of Two Transformers with Double Secondaries.

single-phase transformers. Three-phase transformers combine the properties of three single-phase transformers in one piece of apparatus. The windings may be connected in either Y or delta as if single-phase units were used. The relative advantages of the Y connection and the delta connection are the same and, in the case of the delta connection, if one winding becomes defective, it is possible to operate with the V connection if the transformer is of the shell type. This is done by disconnecting both primary and secondary windings of the defective phase from the other phases and short circuiting each winding. One winding will then neutralize the other and the transformer will operate in a V connection. However, the transformer must be removed from service before the damaged phase can be repaired. Thus unless a number of three-phase units are used, this might be troublesome and cause an interruption in service. The three-phase units should have the same relation in capacity as single-phase units to allow for trouble and interruption in service. For distribution and lighting service in general, three-phase units are out of the question on account of size and because of the greater flexibility of the single-phase transformers when used. If two three-phase transformers are to be used with a six-phase rotary, this should be specified so that the secondaries can be properly connected. In general for obtaining the same service three-phase transformers cost less, occupy less space, are more efficient, are more simple in their outside connections and cost less in installing than a combination of single-phase transformers to do the same work. On the other hand, three-phase transformers cause a greater derangement of service in case of break down and cost more for repairs. Spare units required cost more than the units required for a single-phase combination. Also for a number of tap voltages a three-phase unit presents greater difficulties in bringing out the taps. For large power transformation three-phase units are most often used. Self-cooling three-phase transformers have a reduced rating compared to single-phase units which may be considered another disadvantage.

The next section of this article will take up different types of transformers.

The Design of Steam Plants

(Contributed Exclusively to Electrical Engineering)

BY EARL F. SCOTT, M. E., MEMBER A. S. M. E., MECHANICAL ENGINEER, ATLANTA, GA.

Section 7. Details of Piping Specifications and Foundations for Engines and Turbines.

SINCE the steam conditions for the plant discussed in sections 5 and 6 of the September and November issues, are different from the preceeding designs taken up, it will be necessary to give at this point a specification covering the apparatus. For convenience we will repeat the working conditions as follows:

Boiler pressure. A saturated steam pressure of 150 lbs. gauge will be used. This condition requires, therefore, an entirely different class of material from that used in preceeding designs, as superheated steam was used in those cases. All piping material for this plant will be extra heavy, but cast iron instead of cast steel. The pipe will also be somewhat larger than in the plant where superheated steam is used. This is due to the fact that the water in the saturated steam causes friction in the pipe lines and necessarily the high velocities must be reduced to overcome this. This condition is usually taken care of by placing a large header or drum between the boilers and engines, at such a point that it will not only be easy to run all boiler branches into it, but so that all machine leads may be taken from it. In this installation we will place the header near the partition wall on the boiler room side. This header will be elevated above the top of the boilers at such a height that the long radius bends running from each boiler outlet will enter the center of this header. There is no special rule as to the size of this header but it will be considered good practice to make it about 14 in. in this case, although smaller than is customarily used. However, the volume of steam at the pressure used is small, the header required need not be made as large as for a lower pressure. Again, the size of this header is somewhat determined from the number of machines connected to it. With this header as a reservoir, there is little tendency for a rapid flow of steam to the machines to cause the boilers to prime or throw water over into the piping system, to eventually reach the machines.

The branches from the boilers to the header and from header to machines should be made in sizes corresponding to the outlets, provided the lines are not long and, further, that the velocity thru the particular line does not exceed say 6000 feet per minute. This may be determined by a simple rule as follows. We have a machine using 150 lbs. of steam per minute at 150 lbs. gauge pressure, from which we get (150 lbs. $\times$ 2.7 cu. ft.) $\div$ 6000 $= 3\pi D^2$ where D $=$ .085. For small sizes it is thus seen that this consideration is not necessary.

The header should be made of one piece of pipe with nozzles welded on. This makes a substantial job for this service and is thoroughly practical, and most large pipe and fitting manufacturers can produce it. A specification for this header will be given later. The location of valves for this design should be the same as in the preceding article, namely at the header, where each branch enters or leaves the header.

The detail specification covering material for the live steam lines should be as follows:

VALVES. All valves for live steam lines shall be extra heavy, designed for 250 lbs. steam pressure, with cast iron body and bronze mounted, (outside screw and yoke preferable) gates or globes. Globe valves shall be used at the throttle of machines.

HEADER. The header shall be made of wrought steel pipe 14 in. outside diameter (O D) ⅜-in. thick. (Wrought iron pipe runs by inside diameter in sizes up to and including 12-in. and above 12-in the sizes are expressed by outside diameter with the thickness given, and these thicknesses range from ¼ to ¾-in. and thicker if desired. The thickness specified is enough for the pressure that we will carry and is flexible in working and for this reason is more desired than the heavier sizes.

All branches leaving the header shall have a nozzle welded into the header in such a manner that the surface shall be smooth on the inside as well as the outside and in each case shall form a smooth regular fillet of about one inch radius on outside. All flanges for ends of header (and intermediate if header is longer than a pipe length, about 20 to 23 ft.) and those of the branches shall be extra heavy, high hub, cast iron of Van Stone type. Flanges shall be finished at all points where the lap of the pipe comes in contact with the metal, and shall have full finished face and drilled holes. Each joint and nozzle shall be lapped back giving a face as follows for the different sizes of pipe: 5-in.—1⅜ in.; 6-in.—1½ in.; 7-in.—1½ in.; 8-in.—1½ in.; 9-in.—1⅝ in.; 10-in.—1¾; 12-in.—1⅞ in.; 14-in.—1⅞ in. etc.

With these faces sufficient bearing surface will be provided for the gasket and the face will not interfere with standard drilling of flanges for this service.

As the nozzles on the header are fixed, it is necessary that they be located accurately with reference to the machines they may serve and the outlets on the different boilers. This type of header is flexible and is also serviceable as the joints and possible leaks have been reduced to a minimum.

BENDS AND BRANCH PIPE. All bends and pipe 4-in. and larger shall have Van Stone joints. The flanges shall be high hub, cast iron, extra heavy dimension and finished as specified for the header. All joint faces shall be in accordance to the table given under the heading of "main header."

FITTINGS. All fittings shall be cast iron, extra heavy pattern, flanged for 3-in. and larger. The flanges shall be faced true to the axis of the fitting and have drilled holes to a standard templet. Fittings below 3-in. shall be tapped true to the axis of fitting with a good clean thread properly tapered.

GASKETS. The gaskets shall be the same as called for in the preceeding design, namely, Vanda, Laurol, No. 900 or Clingeret. This packing is of an asbestos composition, hydraulically pressed and stands heat and water equally well and has proven very serviceable for this character of work.

BOLTS. The bolts shall be a good grade of machine bolt with square heads, and cold pressed hexagonal nuts. (It does not pay to buy cheap machine bolts as it usually requires a wrench to take the nuts off and the time lost by high grade mechanics in taking off nuts ready to place material in position will more than pay for a high grade bolt, not to mention the fact that cheap bolts are less reliable as to actual strength.

Supports. All lines shall be supported in a manner to prevent undue vibration but to permit of free expansion and contraction. The header shall be supported by wall brackets and adjustable rolls fastened securely to the wall.

It is always desirable to place the main header in the boiler room side of the plant, against the separating wall between engine and boiler rooms. This location permits of easy connection from the boilers to the header and also places the header in such a way that the leads to the different machines may be taken off.

It is hard to define the best location or type of hanger for the branch lines as the local conditions control these in every instance, but a good turn buckle hanger will always suffice to give good results for these lines wherever there is overhead construction from which to hang them. Where this is not the case or where interferences such as overhead traveling cranes, it is necessary to resort to a floor support for the pipe work. This arrangement should be avoided as far as possible as it is not as substantial as the overhead support.

SEPARATORS. It is essential that steam separators be installed both on the turbine and reciprocating engine, but since each of these machines take steam in a different manner, each will require a different type of separator.

TURBINE SEPARATORS. Since the flow of steam to the turbine is continuous it will not require large volumes of steam, therefore all that will be required for this service is a machine to separate the water from the steam and give as nearly dry steam as possible at the throttle. The ordinary cast iron steam separator will serve this purpose, however, in selecting this separator it is necessary to guard against a drop in pressure in passing through it. The separators known as the baffle plate type will often cause a drop of from 0.5 to 5 lbs., due to the fact that the steam velocity is greatly reduced in passing the baffle plates. This feature can be overcome by using a centrifugal type which separates the water from the steam by centrifugal action. As the velocity of steam in this type of machine is not reduced there will be no reduction in pressure.

This drop in a separator may not seem a large item. We will, however, assume a drop of 2 lbs. in a baffle type separator, which amount is not excessive, and calculate the effect. With steam at 150 lbs. a drop of 2 lbs. is ¾ of 1.0 per cent loss on the total fuel bill for a 500 Kw turbine operating at 22 lbs. per Kw. This means in dollars and cents per year for the 500 Kw. turbine, 500×22 lbs. $= (11000 \times 24) \div 8 = 16\frac{1}{2}$ tons coal per 24 hours, which at $2.50 per ton = $49.50 per day and ¾ of 1 per cent of this $49.50 is 36 cents per day, or for $365 \times .36 =$ $131.40.

While the cost of the centrifugal separator is more than twice that of the baffle plate machine, a 5-in separator of the more expensive type would not cost as much as the saving in one year.

ENGINE SEPARATOR. Since the service of the engine is intermittent, that is starting and stopping, as it were, each revolution, and since it is desirable to have proper steam pressure at or near the throttle during the period the valve is open to prevent a drop in pressure in the cylinder or "wire drawing" through the ports, it is desirable to have a large storage of steam to prevent these troubles. This may be done by combining the separator with a large receiver cylinder in what is known as the receiver separator. These are usually made of wrought steel shells with baffle plates to separate the water. The baffle plate effect in this type of separator is not as objectionable as with the smaller types. The receiver of the separator should be 3 to 6 times the volume of the high pressure cylinder of the engine and preferably placed over the throttle or as near same as possible.

The separator specification is as follows:

TURBINE SEPARATOR. There shall be furnished a cast iron steam separator preferable of the centrifugal type suitable for 200 lbs. working steam pressure. Flanges shall match standard extra heavy templet and shall be faced and drilled true to axis of separator. The separator shall be vertical, horizontal or angle type as the case may be.

ENGINE SEPARATOR. There shall be furnished a receiver type of steam separator, having a capacity of 5 times the volume of the high pressure cylinder. It shall be suitable for 200 lbs. working steam pressure, and the shell shall be made of wrought steel riveted suitable for the service. The heads shall be of cast iron riveted to the shell and have extra heavy flanges faced and drilled. Flanges and nozzles shall be riveted on true to axis of shell. The separator shall be fitted with plates for separating the moisture from the steam and a drain outlet for carrying it off. The type shall be vertical, horizontal or special, as the service may require.

EXHAUST AND WATER LINES. Since the service under this heading, both for vacuum and atmospheric, is the same as that of the preceeding article we willl not discuss these headings. This applies also to the water lines, both low pressure, such as injection and pump suction and discharge, such as boiler feed and other discharge or pressure lines.

In our preceding design we discussed the building layout only in a general way on account of the fact that the design of the building for a plant of the size considered usually calls for an architectural design rather than an engineering one. In these smaller designs, however, we will discuss this part of the work appropriately, so that the layout will not be elaborate on account of cost.

The building for the design now considered should preferably be of brick construction. If, however, conditions make this too expensive, then a steel frame work with corrugated steel sides and roof may prove economical as well as serviceable. With this construction it would be desirable to have a brick fire-wall separating the boiler room from the engine room. This wall should extend through the roof of the building at least three feet and should be not less than 12 inches thick. The roof should be composed of steel trusses for either the brick or steel construction. If the brick construction is followed the most appropriate type of truss would be the rectangular truss having a slope of about one half inch to the foot, and should be about four feet deep at the narrow or outer edge. This would make each about five feet in the center or at the fire wall. The roof would slope in either direction from this wall. For ventilation it is desirable to provide a cupola or manitor, especially in the boiler room side. If this construction is not followed it is a good plan to place large ventilators in the roof.

On the trusses just described should be placed steel purlins usually best of a channel section, the size depending on the span from truss to truss and distance between purlins. On these should be bolted a nailing strip such as a 2 x 4-in. wood, to which a grooved flooring can be laid, say, of about 1¾-in. material and on top of this should be placed tar and gravel of proper composition roof.

The window frames for the brick construction should be steel construction with wire glass window lights. This is rather expensive but is consistent with this type of building.

The floor for the engine room should be of steel frame work with reinforced concrete slabs worked in between the steel work. This makes in connection with the brick building, a fire proof building, with the possible exception of the small amount of wood in the roof. A cheaper flooring for the engine room could be used by following out a regular mill construction of wood. This would require beams about 12 x 16 inches, depending on the width of the span, spaced about 8 to 10 foot centers, and on this should be laid regular mill flooring which is 1¾ to 2⅜ inches thick with grooves in it in which grooves is placed "splines" when the flooring is laid. This makes the floor practically water-proof as well as dust-proof. The boiler room floor should be concrete or brick, and if the concrete construction is used a space of brick laid on edge should be placed in front of the boilers, and grouted in with cement. This is done to prevent the heat from the boiler causing the concrete to crack.

As foundations for the different machines concrete usually proves least expensive as well as the most substantial. Since mass is the main requirement for this class of work, it is not so important to use a very rich mixture. A mixture of 1 to 3 to 5 makes a good foundation. This is made up of one part portland cement, 3 parts clean sand, and 5 parts of crushed stone, or hard burned brick as the case may be, since the particles of cement fill the voids between the grains of sand, and the sand and cement mixture in turn takes up the space between the stones, it is readily seen that we will not get a total conglomerate as large in volume as the sum total of the material put in, but it may be expected to get from .55 to .60 of the total. From a mixture where the above proportions are used, in a total number of parts amounting to 9 cubic feet a resulting mixture is secured of $9 \times 6 = 5.4$ cu. ft. of concrete.

The engine foundation must be massive in order to absorb the vibrations from the reciprocating parts, the overall dimensions of which is furnished by the engine builders. For turbines, the requirements for foundations are not nearly so great as to size or mass. This is due to the fact that the rotating effect from the turbine does not set up heavy vibrations. Turbine foundations therefore, can usually be made hollow, to allow for pipe connections and openings for air ducts for cooling the generator.

The foundations for the smaller machines, such as pumps etc., require but little attention. A slab of concrete will suffice for this work. The main feature in setting such machines is placing them high enough above the floor line to make them convenient for repairs and operation.

The boiler foundations can be made of concrete or brick as the conditions may warrant. Concrete is in most cases the most economical. The boiler setting or brick work should be installed under the supervision of the boiler erecting superintendent as they are familiar with the special requirements for this class of work and would insure a better job than some local man not accustomed to such work.

Electric Production of Ferrochrome.

A new industry has just been started at Trollhattan, Sweden, in which the electric furnace is used for the reduction of ores. Two furnaces are now in operation, using 3-phase, 50-cycle current at a voltage varying between 45 and 60. Four grades of metal are being made, containing 5, 6½, 7½ and 9 per cent of chromium, and the finished product is shipped to various European countries. The process is a secret one and entrance into the works, which is owned by the Ferrolegeringar Aktiebolag, is forbidden. The manager, Engineer Louis Lucchese, who is also the inventor, explained that as yet no patents had been applied for and hence the only protection was secrecy. The output for the year 1913 will reach about 1,200 metric tons, and this will be increased in 1914 to 2,500 tons, with further extensions in 1915. It is stated that the furnace requires 1,700 kilowatt hours per ton of metal reduced and that the results thus far obtained are very satisfactory.

Money spent for good ventilation is always a good investment. Workers need air, plenty of it, pure and fresh, to be efficient.

Good mineral oil makes a good commutator lubricant, but it should be used sparingly.

High Speed Passenger and Freight Service of Oakland, Antioch & Eastern Railway in California

BY C. E. HEISE AND G. B. KIRKER.

Details of First American Interurban Electric System to Adopt High Speed Train Service With Chair Car, Observation and Sleeping-Car Accommodations.

IN October of 1907 the Indianapolis and Louisville Railroad placed in operation the first high voltage direct current electric railway equipment in the United States, for city and suburban service. Since this time 1200 volt apparatus has passed through the development stage and is now practically considered standard for interurban roads and there are now 28 roads operating or preparing to operate high voltage equipment over an aggregate of 1964 miles of road bed. Of this distance, 273 miles, distributed among 22 of the 28 roads, is over 600 volt tracks. California heads the list with 448 miles of high voltage track under construction and operation. Oregon is next with 325 miles in operation and 300 miles planned, Michigan next with 242 miles under construction, Texas fourth with 178 miles, Iowa fifth with 175 miles, Pennsylvania sixth with 132 miles and the Carolinas following closely with 130 miles in operation and plans for extensions of 400 miles.

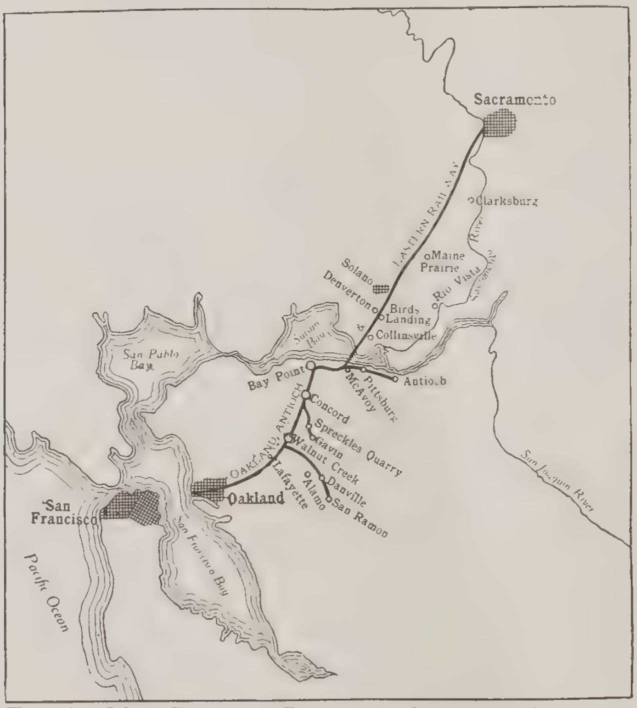


Fig. 1. Map Showing Route of Oakland, Antioch, and Eastern Railway.

Three-phase generation and transmission is appliable and used with a majority of the D. C. high voltage railway systems, the conversion of alternating current to direct current at 600 volts being made by rotary converters or motor generator sets.

Voltages of 1200 or more are not to be considered as superseding 600 volt operation for the voltage to be used on any system depends upon the conditions and nature of service. For the congested service with large numbers of small equipments, the 600 volt system is considered most economical. On the other hand for interurban lines with heavy equipment operated by long headways and with light freight service, 1200 volts or more is most economical while for trunk line operation probably 2400 volts is most suited. The high direct current voltages do not now present serious difficulties and there seems to be an inclination to use something like 5,000 volts in the near future on trunk line railways with heavy grades.

The hauling of freight by interurban railways and regular inter-town and city passenger service has been successfully worked out in all sections of the country but it has remained for the Oakland, Antioch and Eastern Railway Company of California to introduce a new service for American interurban railways. This road is now operating between San Francisco and Sacramento, high-speed passenger trains with a speed of 55 to 60 miles per hour and providing chair-car and sleeping-car service.

Fig. 2. Shepard's Canyon Tunnel Through Contra Costa Hills.

Heavy 62-ton locomotives are used equipped with field control. The field control is used to secure a large starting or tractive effort at a minimum of current consumption and further allows high speed running when desirable. With the exeception of about five miles in Oakland, where the trains run over a 600-volt system, the voltage is 1,200 D.C. with overhead catenary construction. The distance between Oakland and Sacramento is 85 miles, the entire distance from San Francisco Ferry depot to Sacramento depot being 93 miles.

In what follows a description of the overhead construction, equipment and operation is presented by courtesy of the *Electric Journal*, the information and illustrations being taken from a recent issue:

FIG. 3. TYPE OF SUBSTATION OF OAKLAND, ANTIOCH AND EASTERN SYSTEM.

Starting from the "Key Route" pier at Oakland, the electric trains of the Oakland, Antioch & Eastern Railway run over the 600-volt system of the "Key Route," a distance of approximately five miles to the western terminus and depot of the Oakland, Antioch & Eastern Railway, where a stop is made to pick up passengers. Leaving Oakland, the grade is 1.5 per cent for some distance, increasing to 4.1 per cent for about 4,000 feet, then there is a level tangent about 300 feet long and the up-grade for the balance of the distance to the western portal of Shepard Canyon tunnel is 2.4 per cent. This tunnel is the only one on the system piercing the Contra Costa hills, and has a length of approximately 3,700 feet, and slopes to the east on a uniform grade of 1.9 per cent. Leaving the tunnel, the road extends through Redwood Canyon, one of the most picturesque spots in the state, the grade continuing to descend in a generally eastern direction and varying from 1.9 per cent to practically level track, until the village of Lafayette is reached, 16 miles from the Oakland terminus. From this point, the road traverses a rolling country through the towns of Walnut Creek and Concord. This section, while really not far distant from San Francisco in an air line, has had its development held back because of lack of transportation facilities. From Concord, the road extends to Bay Point, a rapidly growing manufacturing center, where there is a junction with the trans-continental Southern Pacific and Atchison, Topeka & Santa Fe Railways.

Leaving Bay point, the tracks parallel the trans-continental railroad systems for some distance and then cross beneath them through an underpass some 1,600 feet in length, thus eliminating the danger of a grade crossing at this point. From this underpass, the tracks extend to the South Ferry slip, where the electric trains are run onto the car ferry boat "Bridgit" and transferred across an arm of San Francisco Bay to the North Ferry slip on Chipp's Island. The United States government has given the company permission to erect a bridge across this channel, but several years will be required to construct it and the car ferry boat will serve until the bridge has been completed.

From the North Ferry slip, across Chipp's Island and Van Sickle Island, the road extends over marsh lands and sloughs to the main land, passing through the Montezuma hills and continuing through practically level country, and entering the city of Sacramento over a steel bridge crossing the Sacramento river.

After leaving Oakland the road is built on the company's private right-of-way the entire distance through to Sacramento, and in Sacramento the company has its own franchises and terminal sites, which are most favorably located. The line throughout is standard gauge, single-track, with a total of about 30 sidings, each of ample length. Standard 70-pound rails with electrically welded bonds are used. The entire length of line is very efficiently protected with electric block signals.

OVERHEAD CONSTRUCTION AND SUB-STATIONS.

Flexible single catenary overhead construction has been adopted as standard. The trolley is 4/0 grooved, hard drawn copper. Mounted on the poles above the bracket arms, are cross-arms, carrying the 1,200-volt direct current aluminum feeders, the telephone wires and the block signal wires. Submarine cables cross Suisum Bay and Montezuma Slough, carrying the feeders, the telephone and the block signal circuits. Upon leaving the Oakland depot and continuing over the entire length of road up to the drawbridge, at Sacramento, the trolley voltage is 1,200 volts direct current.

Five sub-stations have been constructed. The one at Concord is of reinforced concrete, but the standard type of construction adopted for the remaining sub-stations, consists of a structural steel framework covered with galvanized corrugated iron.

The standard unit adopted for these sub-stations is covered by the following description: A 750 Kw. two-bearing, synchronous motor-generator set consisting of one 750 Kw. compound-wound, 1,300-volt direct current commutating pole generator, speed 514 r.p.m., is mounted on common shaft and bedplate with one 1,080-horsepower self-starting synchronous motor, wound for 11,000 volts, 3-phase, 60 cycles; and one 19 Kw., direct current, 125 volts, direct connected exciter, complete with necessary field,

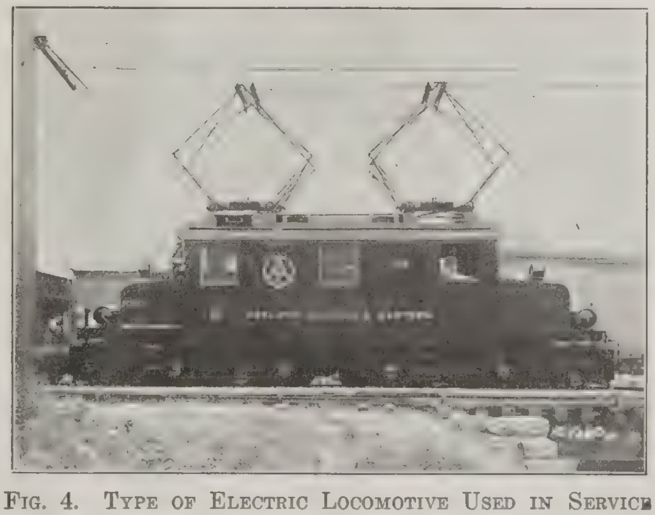


FIG. 4. TYPE OF ELECTRIC LOCOMOTIVE USED IN SERVICE BETWEEN SAN FRANCISCO AND SACRAMENTO, CALIF.

rheostats and apparatus for starting set from the alternating current side. The switchboard equipment for each motor-generator consists of a synchronous motor panel; a direct current generator panel, and a negative circuit breaker panel.

Also in each sub-station there are three direct current feeder panels.

ROLLING STOCK.

The standard passenger car was adopted after careful consideration and consists of a combination car containing passenger, smoking and baggage compartments. It has an over-all length of approximately 56 feet and seats 50 passengers. Each of the 14 interurban passenger cars of this type is equipped with four 600-1,200-volt commutating-pole railway motors and hand-operated multiple unit control. The control is designed for full speed operation on either 600 or 1,200 volts, a change-over switch making the necessary change in motor and grid resistance connections.

Fig. 5. Type of High-Speed Combination Baggage, Smoking and Passenger Car.

The total weight of the car, including air-brake equipment, but without live load, is 87,300 pounds. The balancing speed of this equipment on level tangent track, with an average voltage of 1,200 volts, is about 50 miles per hour. With an average voltage of 1,100 volts, the balancing speed on level tangent track is approximately 48 miles per hour. The gear ratio is 22:55. Each of the motor cars is intended to be capable of hauling a 25-ton trailer car. There are 14 trailer cars at present and each is equipped with master controllers so that a combination train may be operated from any car. There are also two combination passenger and express cars of similar description.

To take care of the heavy through passenger business between San Francisco and Sacramento, two type 2-4-0, articulated truck, high speed electric locomotives are used, with four commutating pole, field control, 600-1,200-volt motors and unit switch control. Each locomotive is capable of hauling five steel passenger trailer cars, weighing 37.5 tons each, on level tangent track with 1,100 volts on the trolley, at a balancing speed of about 56 miles per hour. When hauling only three of these passenger cars, the balancing speed, under the same conditions, will be approximately 60 miles per hour. Each locomotive has a total weight of 62 tons, of which 43 tons is carried on the drivers and 19 tons carried on two radial pony trucks. The draw-bar pull is transmitted through the main truck side frames and each driving axle is equipped with an independent geared motor. The driving wheels are 42 inches in diameter and the gear ratio 26:47.

With forced ventilation the locomotive is capable of exerting continuously, a tractive effort of 4,400 pounds on normal field with an average of 500 volts, and 8,500 pounds for one hour on normal field at approximately 45 miles per hour with 1,200 volts, while with clean dry rails, the locomotive is capable of exerting momentarily a maximum effort of 21,500 pounds. The motors have a nominal rating of 250 horsepower with forced ventilation.

For handling the freight business, there are two 47-ton freight locomotives, each equipped with four motors and hand-operated unit-switch control, and using a gear ratio of 17:56 with 42-inch wheels. Each locomotive is capable of developing a full-load tractive effort of 16,600 pounds at a speed of 10.6 miles per hour with 600 volts, or a continuous tractive effort of 5,200 pounds with 600 volts, or a maximum tractive effort of 24,500 pounds. Each freight locomotive is provided with two independent dynamotor-compressors, each having a capacity of 25 cubic feet of free air per minute. The passenger cars are equipped with roller pantagraph trolleys and the passenger locomotives with double shoe, sliding pantagraph trolleys.

The road was opened for service between Oakland and Bay Point in April, 1913, and through service between Oakland and Sacramento was inaugurated on September 3, 1913. Power is purchased from a long distance hydroelectric power transmission system at 11,000 volts, 3-phase, 60-cycles, delivered to the various sub-stations.

Use of Electrical Appliances in Norway.

The use of electric appliances is limited in Norway, notwithstanding the fact that electricity is used everywhere and that it is furnished to consumers at very low rates. Appliances having the largest sale are electric irons, fans, chafing dishes, one and two-hole broilers, and small hot and cold air blowers for drying the hair. The cost of electric current furnished householders is 6.97 cents per kilowatt hour. For technical purposes the rate is 5.36 cents per kilowatt hour. On yearly contracts the rates are lower—5.36 cents per kilowatt hour for domestic use, and for technical purposes $24.12 per horsepower up to 15, and $18.76 per horsepower if more than 15 horsepower is used.

Electricity is used for heating purposes and for general cooking to a very limited extent. A few householders, where space is limited or the use of coke stoves impractical, employ electric heaters and ranges, and a few amusement places, in operation for only two or three hours a day, find electric heating convenient. With coke at $4 or $4.50 a ton, and wood $2.50 or $3 a load, heating and cooking by electricity are considered too expensive at the present price of electric current, though a contemplated reduction in rates may bring about decided changes. The original cost of electric appliances is also too great to permit of their universal use. A few appliances are now being manufactured in Norway, but the majority are imported from Germany, with smaller quantities from the United States, Sweden, and England.

Man's mind is a magnet that either attracts or repels other minds, depending wholly on the current of this man's thoughts. If you start out in the morning with a chilling, blighting, cross-grained lot of thoughts, you are sure to find plenty of trouble before the clock strikes six. The day will be a mirror, and reflect your own disposition—it will reveal your actions. No one has a little bit of use for a crabbed character. Everyone, eventually, will smile at the good-natured, cheerful, optimistic man.

Considerations in Planning and Designing Industrial Lighting Systems

(*Contributed Exclusively to* ELECTRICAL ENGINEERING).

BY D. R. SHEARER, E. E.

THE intentions upon which industrial enterprises are based are of many kinds, but by a process of elimination, may be reduced to the fundamental desire to utilize capital for the production of dividends. The use of capital and the production of satisfactory dividends depend on so many factors of variable importance that many years of close attention to detail may not bring the coveted attainment to some, while others blindly stumble on success. Not until recently, in fact since efficiency engineering became prominent as an economic factor, has detailed study of the generic industrial factors been made. These are so many in number that we must eliminate all but the very fundamentals of a successful enterprise, leaving the subsidiary principles for consideration under other headings. These basic factors of success, (three in number) are: proper machinery and equipment, economical operation and efficient workmen.

Equipment is merely a matter of money, for money will finance the plant and secure the services of skilled engineers to design, erect and install. It is moreover in the province of the consulting engineer to see that the operating layout of the machinery is designed for economical production, for minimum handling of material and finished product and for maximum speed in output of production.

In regard to efficient labor, here many otherwise promising plants fail from success. The workman must have a desire to do, he must have an interest, be it personal or pecuniary, in his occupation and he must be in physical condition to carry out this desire with the least waste of time and energy. In addition to this, a feeling of satisfaction and of well being is a psychological aid to human efficiency. In other words, if machines are kept in repair, well oiled, furnished with favorable conditions looking to satisfactory operation, so should our workmen be kept, physically and mentally in perfect condition as far as factory and plant environment can attain this end.

Many factors here which go to sum up the attitude of labor to commercial output, such for instance as fresh air, sanitation, proper temperature and pleasant surroundings, but none of them is of such marked importance as light. However odd as it may seem, little attention has been given to this fundamental of efficiency until recently. Were it not for the human element in production, light could be dispensed with in the ordinary industrial plant without effecting efficiency of operation; thus illumination is entirely a factor bearing directly upon the labor element, and therefore not easily evaluated in terms of dollars and cents nor even in efficiency percentages. The very fact that the human side of the question is very complex and cannot be calculated definitely tends to minimize the importance of conditions bearing upon this essential prerequisite to production.

Light being such an important element of industry, it becomes necessary to determine at the beginning of any study in the lighting requirements of a specific manufacturing plant, just what kind of illumination is necessary and in what quantity or intensity and from what direction shall it be furnished. Naturally and logically we must attempt to supply normal illumination, which is of course diffused daylight, throughout the whole cycle of day and night operation with as little variation as possible. Windows, skylights, properly painted walls and ceilings, and certain other architectural and engineering details may be arranged to supply approximately normal lighting throughout the daylight hours when weather conditions are satisfactory, but during the night and on dark days we must have recourse to artificial illumination.

Artificial illuminants are many and here again much must be eliminated for certain assigned reasons, leaving the field chiefly to electricity. Gas, though cheap ordinarily, is not sufficiently flexible or adaptable to variable conditions met in practice, introduces a more pronounced fire hazard; requires considerable upkeep; liberates a large quantity of heat; vitiates the air by consuming the oxygen and replacing it with carbon monoxide and dioxide; and finally is not convenient or easily controlled in more than single units. Several other proposed illuminants may be placed in the same category with commercial gas for industrial lighting. Electricity, on the other hand, is economical; flexible and adaptable to innumerable conditions; safe; convenient and always satisfactory if properly installed to conform to recognized standards of lighting.

Two sources of electricity are available to urban manufacturing plants, or rather we may secure current for lighting by two methods; manufacture it for local consumption or buy from the central station. Either method may be preferable under certain conditions and it is wise, as a usual thing, to employ an engineer to determine the most economical source available under the conditions obtaining in any peculiar instance. Almost without exception the small enterprise should purchase from the central station, equitable rates being assumed; but as a plant increases in magnitude it can more nearly approach central station economy and in many cases can produce current more efficiently than the average commercial electric plant. This may be accounted for by the fact that certain expense factors such as line construction and upkeep, transformers, losses, etc., are absent in the care of an isolated plant. A rational comparison, however, of central station vs. isolated plant is a problem of no mean proportions and cannot be considered in this connection.

Admitting that electricity be used for furnishing illumination, we still have three general types of lamps to select from, each having certain predominant qualities and each with its staunch advocates, *viz.*, arc, vapor and incandescent, light sources or lamps. Arc lighting has long been in the field and has been very satisfactory in the proper place. However, since the introduction of tungsten incandescent lamps in large units, and with more efficient types of reflectors, the arc lamp is being gradually replaced with more economical lighting units. Vapor lamps have a very bright future but in the present state of development, are subject to certain inherent drawbacks, both as to light quality and mechanical features. The same, in general, may be said of flaming arcs. Among several kinds of incandescent lamps the wire drawn tungsten is now the only one considered except in rare cases, and it is to this type of lamp we must look at present for our most satisfactory illuminating work.

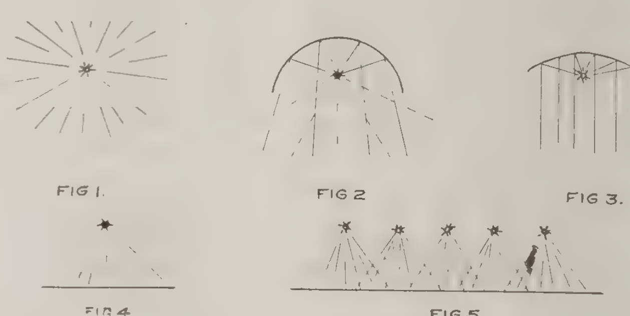
Primarily industrial lighting depends on three factors; quantity or intensity, location of light sources and reflection coefficients as applied to the lamps used for the purpose of lighting a certain individual plant. These functions of illumination may be varied to some extent owing to their complex inter-relationship, but when economy and installation costs enter into the problem, we are circumscribed within certain bounds.

The problems to be met in designing the lighting equipment for a new plant or one under construction are inherently different from those existing in an enterprise already in operation. As a concrete example, we may determine location of windows or machinery, color of ceiling and side walls, and certain reflective and diffusive characteristics of building construction in a new plant looking to economy from a lighting standpoint, but we must accept certain fixed conditions in the old plant and arrange our lighting equipment as best we can. Incidentally this points to the fact that adequate illumination should be given more serious attention in the initial design of a building.

Before taking up industrial lighting in constructive detail, it may not be out of place to mention certain fundamentals of light. Let us assume a point source of light in space and consider it under three conditions—bare; covered with a reflecting shade; and at the focus of a parabolic mirror reflector. Figs. 1, 2 and 3. In the first instance we have the light flux distributed in all directions equally diminishing in intensity as the square of the distance from the light source, or in other words spherically. In the case of the reflector, the spherical flux is reflected in a definite direction to a restricted spherical angle, so that the intensity per unit area on a plane of effective illumination is greater for the same radial distance. For instance, suppose a point light source at the center of a sphere of assumed radius illuminates the interior surface of the sphere with a definite intensity per unit area, and we place a reflector on the light source in such a manner as to restrict the light flux to one-fourth the surface formerly illuminated. We shall increase the intensity on this restricted area four times, less the amount of light absorbed by the reflector; hence we could double the radial distance and still have the same unit intensity as when the entire interior surface of the sphere was lighted.

Considering the parabolic mirror reflector, we find that theoretically all reflected rays leave in parallel lines and hence suffer no dimunition of intensity with distance except the percentage absorbed by particles of foreign matter in the air and the reflecting mirror. In this instance our law of squares does not hold good. It is to be noted that the bare light source and the light source at the focus of a parabolic mirror form two extremes in light control and that all types of commercial and industrial reflectors fall between these extremes in efficiency. This relation, together with the coefficient of reflection or reflective efficiency, must be taken into account in all calculations for illuminating design.

Another point in which we are liable to assume fallicious relations is the variation of intensity on the working plane for differing ceiling heights. Naturally if we hang one lighting unit a given distance above a plane, we must increase the intensity of this unit four times to double the given distance above the plane and retain the same unit intensity. If we increase the number of such units, however, this relation does not continue, especially if the ceiling and side walls are light tinted and have a large reflective coefficient. This mutual inter-relation of several light sources in a room may be roughly illustrated in Figs. 4 and 5. From this it appears that by the use of properly arranged lighting units with reflectors and good surface reflection, we are enabled to vary the distance of the lamps from the floor without materially altering the average unit area intensity. With a distributive lighting system of this kind, it is a very difficult matter, attended with laborious calculations, to determine the intensity of any given unit surface, hence it is usual to assume an average uniform intensity over the whole working plane deducted from the number and intensity of units and the reflecting coefficients of the reflectors, walls and ceiling.



FIGS. 1 TO 5. SHOWING USE OF REFLECTORS AND INTER-RELATION OF LIGHT SOURCES.

Four systems of light application are in common use; general, distributive, specific and complex. General lighting or illumination secured from large units placed near the ceiling well up out of way, is admirable for certain effects where high working plane intensity is not necessary, but an evenly diffused illumination of low intensity is sought. In this case much light is absorbed by side walls and ceiling and allowances for this must be made. Arc lamps in various types are used extensively, as well as tungsten units in the 250 and 500-watt sizes, which are really more efficient and reliable. Either arcs or tungsten units may be used for indirect general lighting which, though less efficient, is in some cases very desirable. It is to be noted that, when using indirect light, much care must be exercised in securing suitable ceiling reflecting surface. It is nearly always advisable to have a certain amount of general illumination regardless of the system used in conjunction for working light.

The intensity desired and the area to be illuminated having been determined, a certain standard unit is assumed and the required number calculated. The floor area is then divided into a corresponding number of equal squares and the units placed in the center of these squares. This system of locating units is shown in Fig. 6.

Distributive lighting is secured by the use of a large number of small units, usually suspended with a suitable reflector directly over the machine or work to be lighted. In this case a much higher available intensity per watt may be secured on the working plane but sharp shadows may cause some trouble. It is necessary, also, to use every precaution in order to keep the direct rays from striking the eyes of the workmen. With the distributive system, it is nearly always advisable to supply some general illumination in order to obviate sharp shadows and create a more cheerful atmosphere, in which to work. Fig. 7 illustrates a layout of mixed distributive and general lighting showing two intensities.

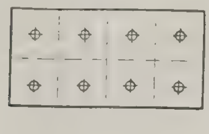


FIG 6.

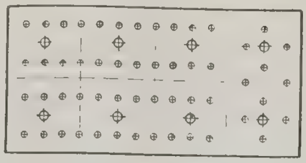


FIG 7.

FIGS. 6 AND 7. LAYOUT OF LIGHTING SYSTEM.

A system of illumination that has lately come into vogue on account of its extreme efficiency is the specific or localized lighting arrangement. This contemplates the installation of very small low voltage lamps in small concentrating reflectors and is susceptible to many applications with innumerable variations. In this type of installation, high unit area intensity is secured by concentrating the light flux on a very small area, usually only a few inches.

As applied to clothing manufacturing plants, six-volt, six candlepower tungsten candelabra or ediswan base lamps are placed in a small special concentrating reflector and adjusted to throw a small ellipse of light directly on the needle of the machine. The Pernel system is an outcome of this type of illumination. A small 6-volt transformer is placed on each bank of the machines and supplies current for twenty to thirty of these units, feed wires at standard voltage being run to the transformers. A certain percentage of general illumination should be supplied with a system of these small units, however. As the lamps used in the small reflectors are usually only 6-watt rating there is possibility of very great efficiency. The light is placed directly where wanted, there is none wasted, and the glare is kept well away from the eyes of the machine operator. As a whole, this type of installation is remarkably economical and satisfactory and a brilliant future is predicted for it.

Under the head of complex lighting systems we can class all illumination by means of two or more of the previously mentioned types of installation. It must be noted that each plant or commercial enterprise has a distinct individuality and much care with quite an amount of discernment must be used in designing a system to meet the specified requirements or given conditions in a plant. It is not a problem for the ordinary electrical contractor nor for the average electrician to attempt, but is one worthy of the best talent to be obtained. The correct solution means an annual saving of many times the charges for such work made by a competent engineer. Owing to the fact that the enterprises of which we are speaking are so varied in operation and construction and possess so much individuality, it is necessary that this paper be restricted to generalities, in a sense, dealing only with the fundamentals or functions of illuminating work. It is necessary also that much of the detail work be left out at present to be considered in a subsequent article.

The plans for the lighting of a given installation are based on three factors; use of the light, qualitative requirements, and quantitative considerations, or in other words what is to be illuminated? What quality of light is necessary? What quantity must be used for the given installation, or what intensity per unit area on the working plane? The time has ceased to be when any industrial lighting system can be installed satisfactorily in a haphazard way or by those unacquainted with the factors of illumination and their functions. Too much of the human element—too much time and money are needlessly sacrificed by inadequate or badly designed systems of lighting for any plant owner to allow first cost alone to deter him from securing the best engineering advice possible before attempting a lighting layout of any magnitude. The time spent in preliminary work and in studying conditions is not wasted but is the foundation upon which to design accurately and surely.

Perhaps it may be well to add a few words regarding the possible types of wiring, as upon this, to some extent, depends the electrical efficiency of a lighting system. Two schemes of distributing electricity for illuminating work are in general use; the centralized and the distributive. In the former all 660 watt branch circuits are run from cabinets or sub-switchboards, these in turn being connected by individual feeders with the main board where the current is usually metered or supplied. In the latter system, several large feeders are run throughout the buildings and branch circuits are tapped off through cutouts, either singly or in groups wherever needed. The centralized system, though somewhat higher in first cost, is much to be preferred as a usual thing.

Two methods of installing the wiring are available, conduit work and open wiring. Of the two, rigid conduit is far more satisfactory and detracts less from the appearance of a plant building. At first, the cost of conduit work appears excessive, but this is not so if initial cost plus upkeep expense per year be apportioned out over the total life of the equipment. When conduit is used, the wires are adequately protected from mechanical injury, deterioration, accidental shorts and other troublesome details obtaining in the use of open wiring.

The entire lighting installation should be made to conform strictly to the N. E. Code rules and the actual work should be done only by experienced workmen. By good workmanship, the value of the system is enhanced; the amortization period is increased, the fire hazard decreased and the effective cost lowered. If the suggestions embodied in this outline are followed out in a given installation, the lighting system will be found to add immeasurably to the health and happiness of the employes, to the output of the plant and to the operating economy as a whole. When the question of lighting an industrial enterprise comes up, let it be remembered that the following recommendations should be considered carefully with a view to economy and satisfactory operation. (1) Secure the services of a competent engineer to advise and plan, and see that designs are made in detail. (2) Have in mind the welfare of the employe in proportioning and distributing the light. (3) Use adequate illumination of the proper intensity and properly locate the lighting units. (4) Study the probable effect on the plant efficiency of the proposed installation of lamps. (5) Do not attempt to procure the cheapest possible installation, but employ competent workmen, use good material and conform to Code rules. (6) See that the lighting system, after the initial installation, is kept in the proper state of repair.

The Chararteristics of the Hotel as a Central Station Load

An Analysis of Conditions With Data for Four Hotels.

BY CHAS. A. COLLIER.

HE supplying of light and power to office buildings and large hotels has been a subject much discussed by advocates of isolated plants and central station managers. These discussions heretofore have had to do largely with conditions in Northern and Western cities where, on account of the existence of a large number of isolated plants of long standing, there has been considerable favorable argument for the isolated plant. With the increasing number of such large buildings now being constructed without private plant equipment, even in these cities, any data on the operating conditions is of decided interest and benefit to the central station and the building owners alike. The information and data given in what follows is of particular value in this connection inasmuch as the conditions are those of an important Southern city where, in spite of the fact that a number of isolated plants are being operated, a majority of the new so-called "sky-scrapers" and hotels are purchasing power from a central station company. The material we present here is taken from a paper by Mr. C. A. Collier, assistant sales manager of the Georgia Railway & Power Company, of Atlanta, Ga., read before the convention of the Southeastern Section of the National Electric Light Association, in August of this year:

There is probably no other type of customer that offers to the central station a larger revenue from the sale of current, or affords a more advantageous subject for advertising than the hotel. The advertising value of the hotel arises from the fact that the future prospect can see a type of business that has been heretofore manufacturing its own electric current, but is now purchasing this service from the local central station. However, looking at the hotel only as a consumer of current, it is found that very few types of commercial business, some industrial plants excepted, consume as much energy per Kw. connected as does the modern hotel. For instance, the combined average load factor of the hotels *A* and *B*, the data on which is given in this article, is approximately 20 per cent, whereas the load factors of the other types of business are only as follows:

Office buildings ....7 to 15 per cent.
Department stores ....8 to 10 per cent.
Newspaper publishers ....8 to 14 per cent.

In other words, the ability of a hotel to absorb current is almost double that of any other large commercial consumer.

A factor certainly to be considered in connection with this comparison, is the relatively small peak of a hotel load, and the absence, in comparison with other types of business, of the large "valleys," representing the hours of the day when little or no current is used. In fact, the hotel, during every hour of the day, is a considerable user of current (Figs. 2 and 6), and especially is this true if the hostelry operates a machine for refrigeration and ice making, as the ice making is largely done during the night hours, as shown in Fig. 6. The fluctuations due to the change in seasons is also less than for almost any other type of business, as shown in Figs. 1, 4 and 5.

VITAL CHARACTERISTICS OF HOTEL LOAD.

Before taking up in detail the hours of use, load factors, etc., of the hotel load, a general summary of installation features and consumption of four hotels in Atlanta, Ga., is given in the following table:

TABLE 1. LOAD DATA FOR FOUR HOTELS.

	Hotel A	Hotel B	Hotel C	Hotel D
Lighting load in 50 watt equivalents	3,200	2,600	454	2,500
Connected power load in Hp.	150	128	20	160
Heating load in sq. ft. of radiation	16,000	12,000	3,963	12,000
Annual lighting consumption, —Kw-hrs.	307,000	334,000	19,288	118,500
Annual power consumption, —Kw-hrs	153,000	177,000	3,056	183,000
Annual steam consumption, (Building heat) Lbs. ...	6,400,000	4,800,000	1,565,000	4,880,000
Kw-hrs. per 50 watt lighting equiv. per year	96	128	43	95
Kw-hrs. per Hp. per year	1,020	1,383	152	1,045
Condensation in Lbs. per sq. ft. radiation per season....	400	——	398	400
Load factor of lighting in per cent	22	29	9	21
Load factor of motors in per cent	16	21	2.5	17
Maximum monthly consumption—Kw-hrs.	45,000	51,300	2,840	
Minimum monthly consumption—Kw-hrs.	27,700	36,000	1,240	

Particular attention is called to the yearly consumption of Hotels *A*, *B* and *C*, as these three hotels represent distinct types of loads as follows: Hotel *A* is a modern, large building, thoroughly equipped with motors throughout, but having no ice machine. Hotel *B* has the same general characteristics as *A*, with the addition of a 10-ton ice machine. Hotel *C* is a small hostelry, with no power other than one elevator, and Hotel *D* is equipped with individual motor drive and is the most modern hostelry.

As shown in Fig. 1, the power and light consumptions follow one another, as regards usage, very closely; the lighting and power are nearly simultaneous, and there are no night and early morning loads of any consequence. With hotel *B*, Fig. 4, the monthly power peak drops off as the monthly lighting peak increases, due to the fact that the refrigerating machine during the winter months has a minimum of work, with the result that the combined consumption of light and power vary only slightly from month to month. With Hotel *C*, Fig. 5, there is no power peak worth speaking of. This amply illustrates the fact that a pure elevator load is not the best of business, and should serve as an encouragement to the central station to push

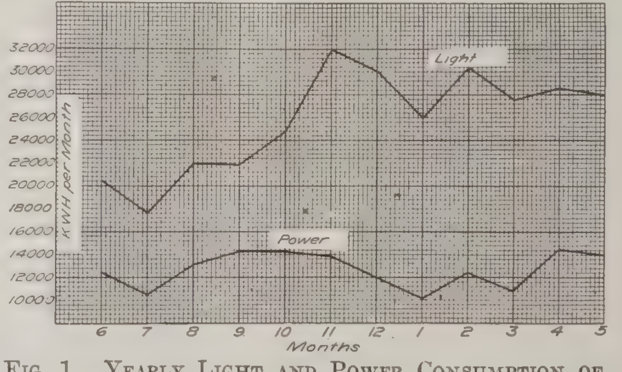


FIG. 1. YEARLY LIGHT AND POWER CONSUMPTION OF HOTEL A.

the installation of some additional motor apparatus. In fact, here a small refrigerating machine, say of 5-ton capacity, would serve a double purpose; that is, the increasing of the current consumption, and consequent flattening out of the load curve, and saving to the hotel management of money by eliminating the purchase price of ice. For the sake of comparison, the minimum and maximum monthly consumptions of current for Hotels *A, B* and *C* are tabulated in Table 1, and show conclusively the advantage to central station of the ice machine in increasing the commercial load.

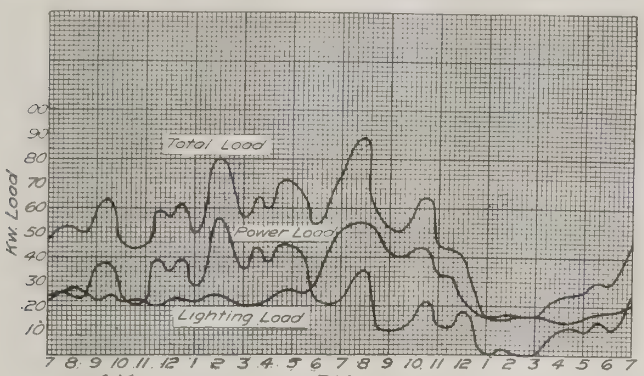


FIG. 2. HOURLY LIGHT AND POWER DEMAND OF HOTEL A FOR MONTH OF JULY.

Referring to Fig. 3, we have the typical hourly loads, as shown by actual readings for the month of January. Analyzing these three loads, heat for building, steam for cooking, and light and power, we find that, as the guests begin to arise, we have the first small lighting peak, when the load then settles down until afternoon, with no appreciable increase until afternoon. Note the size of the peak between 7 and 8 p. m. and 10 p. m. There is here no ice machine to fill in the valley. Note how the first steam cooking peak begins at 7 a. m. and how it falls off in the afternoon, to rise again in the evening. Also note that the steam heating and lighting peaks do not lap, but occur at opposite ends of the day.

Referring now to Fig. 2 and Fig. 6, which represent typical hourly load curves of Hotels *A* and *D*, we get a very good idea of several of the important factors upon which the current demand of a modern hotel depends. In Fig. 2, the point most strongly impressed is the very irregular power demand; the power coming simultaneously with the lighting peak. As has been mentioned, this hotel operates no ice machine. The result is no consumption of power is shown from 1 a. m. to 3 a. m., and the building has a very irregular demand curve, and a peak large in proportion to the average demand. These last two factors mean that the sudden fluctuation in current demands will cause more or less difficulty in voltage regulation which, if not carefully watched and taken care of, will cause unpleasant unsteadiness of light. On the contrary, with Hotel *D*, Fig. 6, we find in the total load curve an absence of abnormal peaks, and a fair usage of service in the early morning hours. This condition is due almost solely to the steady operation of a 10-ton ice compressor. Attention should also be called to the effect this ice machine has on the diversity factor.

STEAM HEATING CONDITIONS.

The greatest talking point of the advocate of the isolated plant is the claim that if engines are installed, the steam heating will cost nothing. There is probably no greater error generally made that for the lack of specific information, goes so often unquestioned. As a matter of fact, not over 30 per cent of the steam necessary for building heating in this section is available as exhaust steam. And of the available 100 per cent of exhaust steam, not over 30 per cent of it can actually be used for heating during the heating season.

As an illustration, Hotel *A* has installed 16,000 square feet of radiation. This radiation condenses during the heating season, approximately 5,600,000 pounds of steam, of which over 60 per cent is condensed during the months of January and February, leaving only 2,240,000 pounds

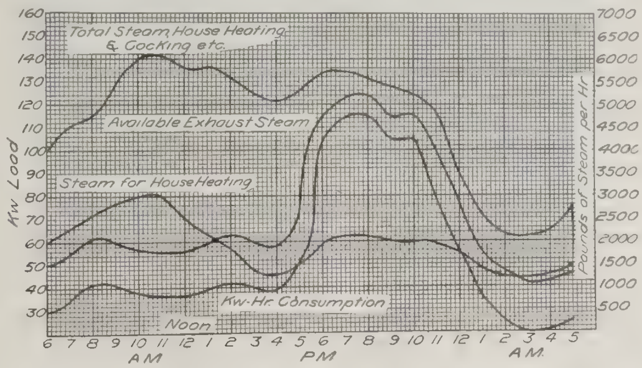


FIG. 3. HOURLY STEAM AND KW-HR DEMAND OF HOTEL A FOR JANUARY.

of steam to be condensed in November, December, March and April. The Kw-hrs. consumption during the four months, November, December, March and April was 169,000. Taking the figure arrived at by the committee on steam heating of the N. E. L. A., namely, 60 pounds steam per Kw-hr., we find that the exhaust steam available during the above mentioned four months is 10,140,000 pounds, or practically five times the steam heating demand. Despite even this large excess, actual running tests show that the steam heating demand in the early morning hours is so great that it exceeds the output of exhaust steam available, resulting in live steam having to be supplied to the heating system.

In connection with the using of exhaust steam for heating, it must be remembered that there are few systems, indeed, that show no back pressure. This back pressure directly affects the operation and economy of the engine, due to the fact that not only is the horsepower of the engine greatly reduced, but the steam consumption per Kw-hr. output due to the cylinder condensation is greatly increased. Therefore, the net result shows very little gain in the direction of economy. In fact, Hotel *A* can be heated from low pressure boilers at a total over all cost of $2,500 per annum. This $2,500 per annum would be re-

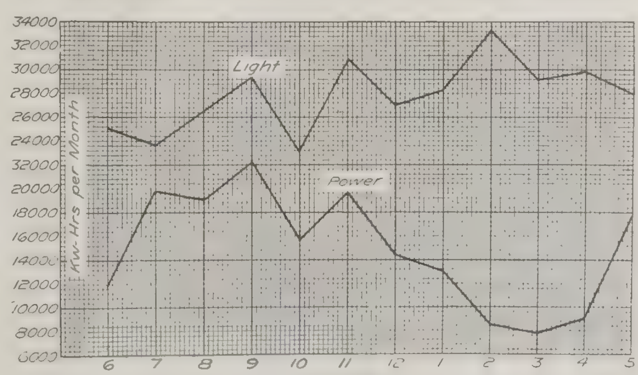


FIG. 4. YEARLY LIGHT AND POWER CONSUMPTION OF HOTEL B.

duced to a maximum of only 30 per cent of $2,500, or $750, by the use of exhaust steam from the engines. This $750 is offset several times by the saving in the purchase of current from the central stations.

The question arises as to the supply of steam for hot water, cooking, etc. In Hotels *A*, *B* and *D*, this proposition is handled by boilers of approximately 50 horsepower, two in each hotel, the labor required being negro firemen at a wage somewhat lower than if an isolated plant was operated. This is due to the fact that except in the morning and at meal time, there is no heavy demand for heating and cooking, so the necessity of close attention or heavy firing, is out of the question.

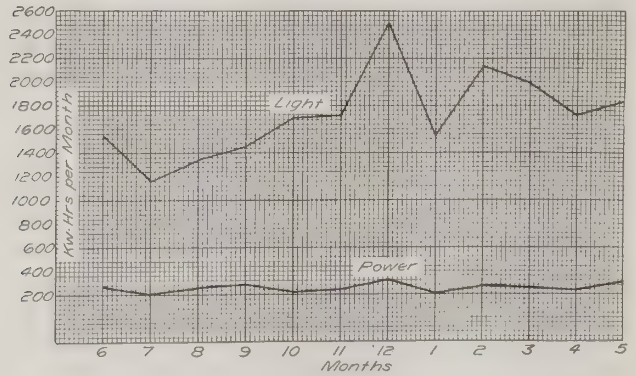


Fig. 5. Yearly Light and Power Consumption of Hotel C.

ISOLATED PLANT OPERATING COST.

The items of consumption of light, heat and power and the hours of use thereof, have been carefully considered and it might now be in line to consider the cost of supplying the hotels with the service from an isolated plant. As will be noted, Hotels *A*, *B* and *D* are quite similar in connected loads, consumptions, etc. Assuming that a plant of the proper size, type, etc., were installed to supply these buildings, each individually. The type of the necessary plant, and the conditions that must surround same for satisfactory operation, have already been mentioned earlier in this article. Crediting each plant with one engineer and two firemen, and the additional coal, etc., which are directly chargeable to the steam heating, we find the cost of manufacturing per unit of current to be very close to 4 cents per Kw-hr., including all charges. The remaining credit for exhaust steam for heating being very small, it will hardly affect the cost per Kw-hr. at all. The above figure will, of course, vary somewhat, with the cost of fuel, labor, etc., but generally speaking, it is about correct.

ELECTRIC AND STEAM EQUIPMENT OF A MODERN HOTEL.

It will no doubt be of interest to here note, in a general way, the electrical and steam equipment of a modern hotel. In Hotel *D*, we have an installation exactly in line with the best recommendations of the central station. One that bears out in every detail the claim of the central station that electric service can be purchased, while steam is furnished by the hotel, at an overall figure considerably less than the overall figure for isolated plant operation. Here, steam for cooking, hot water heating, etc., is furnished from the hotel's boilers, while steam for building heating, electricity for lighting and power is purchased. It might be well to here mention that the purchase of steam for building heating, offers little or no saving to the hotel company, but the big saving is realized by the purchase of electric current.

STEAM EQUIPMENT.

For the purpose of furnishing steam for cooking and hot water heating, there are installed two 40-horsepower internally-fired Scotch Marine boilers. The boilers operate at approximately 40 pounds pressure, supplying steam for soup kettles, boilers, hot plates, chafing dishes, coffee and tea urns, and other similar cooking devices, and to the heaters used for supplying hot water to the various parts of the hotel. Likewise, exhaust steam from the cooking apparatus and boiler feed pump, supplies such distilled water as is necessary for the purpose of ice making, it rarely being necessary to furnish live steam for this purpose.

No steam for building heat is supplied from these boilers, but this service is purchased from the central station through an American District Steam Heating Company system.

MOTOR INSTALLATION.

All of the various machines, and every piece of apparatus requiring power, is equipped with individual motor drive. The method of driving, the location of each motor, its horsepower, type and speed has been worked out as an individual proposition, with the result that there is little left to be desired by the advocates of the individual drive. There is a total of 20 motors of 163.5 horsepower. All motors, excepting the ¼-horsepower elevator signal motor, and the ¼-horsepower beer pump, are 220-volt D. C. Two ¼-horsepower motors are 100 volts, D. C.

LIGHTING INSTALLATIONS.

The hotel is equipped throughout with Mazda lamps in sizes from 15 watts to 40 watts. The main dining room, lobby and ball room, are illuminated by large cluster lights, in fixtures of bronze, so arranged as to have all lamps horizontal. These are round bulb frosted lamps without shades. The bed rooms, halls, sample rooms, etc., have the lamps placed against the ceiling, with proper reflectors.

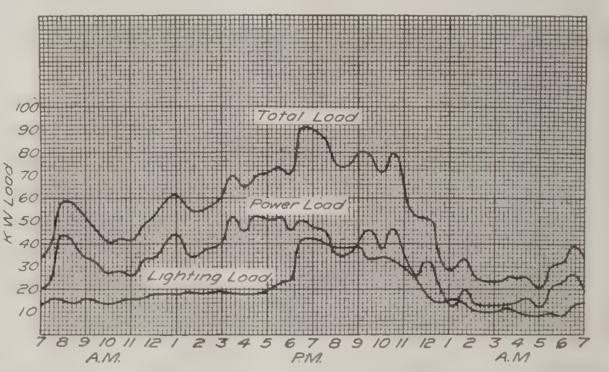


Fig. 6. Hourly Light and Power Demand of Hotel D for Month of July.

In addition, such wall brackets, and floor receptacles as were deemed necessary, are located in each room. In the convention hall, provision has been made for stereoptican and small motor operation by means of special floor outlets. All of the various circuits, both light and power, are controlled from a central switchboard, laid out in such a way as to permit of any section of the hotel wiring being cut out without interference with the remaining circuits.

In this article, the most important points only have been discussed, but the many small reasons that recommend the hotel as a desirable central station customer, are probably of almost as much importance as the larger ones. The net result is, that the more carefully the hotel load is analyzed, the more attractive it appears.

Principles Governing Central Stations in Making Line Extensions

BY ALEXANDER MACOMBER.

Methods of Handling Line Extensions and Rulings of Public Service Commissions Thereon.

THE question of when to begin and where to stop in making line extensions, is one which the average size central station has asked or will have to ask itself and supply its own answer. What others have done and are doing, however, forms a means of comparison and encourages some action in analyzing local conditions. In a paper presented before the New England section of the N. E. L. A. last September by Mr. Alexander Macomber, gave some interesting suggestions as regards methods of handling extensions and the consideration given the subject by 114 New England central stations. In this paper he says: One of the most remarkable developments of the past decade, in the operation of public utilities, has been in the meaning of the word "Service." The education of the central station company and its efforts to give service has been paralleled only by the education of the public in what it may demand. That a realization of these mutual interests is apparent to the progressive company is evidenced by the attention now given to the various phases of central station business relative to service to the community. A consideration of one phase of central station service, namely, the extension of lines to afford service to the public is the object of this paper.

Line extension from one viewpoint, may be divided into two classes, namely, those representing good business, being profitable financially from the start, and again those which may not at first prove profitable but are undertaken on account of future possibilities or other reasons. The former class needs no consideration here, it being the desire to obtain data relative to methods of handling the latter class that this paper was undertaken. The writer was assured that this would be largely a compilation of statistics, indicating the methods followed, and accordingly one hundred and fourteen central station companies in New England were requested to answer certain inquiries on the subject. Eighty responded, or seventy per cent of those considered.

On the basis of the answers received, one is convinced that the one hundred and fourteen central stations referred to have one hundred and fourteen different and distinct methods of caring for line extensions of this nature. Under these conditions it is hardly possible to present any detailed comparisons or descriptions. Treating the matter, however, as a general proposition—on what basis are unprofitable extensions made—the eighty responses may be classed as follows:

I. Extensions made with assistance of customer......	58
II. Extension made as matter of policy or in hope same will become profitable........................	14
III. Extensions not considered	8
	—
	80

A brief analysis of these classifications as far as the general data submitted permits, indicates the methods followed in handling this proposition.

1. EXTENSIONS MADE WITH ASSISTANCE OF CUSTOMER.

Considering first the practice of those companies that require the customer to share the burden of these extensions, the following classification appears:

(a) *Customers Pay a Part of Construction Cost.* Out of the eighty companies, twenty-six require payment for the whole or part of the first cost. In case of part payment the amount is usually that portion of the investment which will make the whole proposition a feasible one. Twelve concerns of the twenty-six state that this payment on the customer's part is later rebated to him, this rebate taking different forms, as lump sums, percentage of the gross earnings of the extension or a fixed percent of the customer's monthly bill.

(b) *Customer Pays Return on Cost.* Twenty-three out of the eighty replies favor obliging the customer to give only a guarantee of income. Fifteen of the twenty-three base this return on a percentage of the cost of construction, while eight ask for "interest and depreciation." The percentage guarantee varies from 10% to 50%, the average number settling on 20% to 25%. It is often required that this guarantee be given for from two to five years or more, in several cases this guarantee ceasing when a definite return is reached.

(c) *Customer Pays Part Cost and Gives Guarantee.* Ten of our eighty companies take no chances and require the customer to pay all or part of the cost of the extension and also guarantee the income as a certain percent of the cost. The percent appears to be about the same as noted above.

2. EXTENSIONS MADE AS A MATTER OF POLICY.

Fourteen companies report that extensions of this nature are made either as a matter of policy or in the hope they will become profitable. The customer is not required to assume any obligation. One is inclined to believe, however, that concerns in this class are not as liberal as others, as propositions without guarantee naturally are examined closer and confined to smaller limits. In fact, many commented that such extensions were not made except as a last resort. "Policy," in this connection appears to have a varied definition, extending from liberal service to the public to an exceptional instance of the influence of the local alderman.

3. EXTENSIONS NOT CONSIDERED.

There are eight companies who state they do not make extensions which are unprofitable at the start. The attitude of this class is covered by the statements of several that a central station should not be forced to do any part of its business at a loss. It is probable, however, that a strict examination of this class would swing some of them into other columns, for after all, the term "unprofitable" extensions is a bit misleading, in that extensions made under the conditions treated are not in most cases a source of actual loss, for the terms under which they are made provide for the burden of investment and endeavor to insure interest on the money invested.

COMMISSION RULINGS AND COMPANY OBLIGATIONS.

Data relative to actual decisions of Commissions in specific reference to the matter of line extensions as here treated is very meagre, the writer being able to locate but one actual ruling of this nature which occurred in Ohio, being a complaint against the Cincinnati, Milford and Loveland Traction Company to compel electric service.

This is a complaint by two residents of Milford, Ohio, that having made application for service, the company refused to furnish them with it unless they bore the initial cost of installing poles, wires, and other equipment required. The Ohio Public Service Commission in its decision, on May 9th, 1913, says:

(a) "The Commission further finds that the tariff, rules and regulations of defendant on file with this Commission do not provide that the cost of such installation shall be borne by the applicant. . . . That defendant, by the laws of Ohio and by the franchise granted to said defendant by said village, is required to furnish its service and product within said village to the applicants therefor, and that defendant cannot require said applicant to bear the cost of such installation, in and around neighborhoods and localities where defendant's transmission system has been heretofore extended."

(b) "That said defendant has heretofore supplied its other customers and consumers with its service and product without requiring such customers and consumers to bear the cost of installation, and that, by reason of defendant's requiring the applicants herein named to bear the cost of such installation, defendant has unjustly discriminated, and is now unjustly discriminating against said applicants."

The Company was ordered to supply the service.

It is obvious that this phase of "service" under consideration, is a subdivision of the broad question of "reasonable service" and "reasonable return" on the money invested. This probably offers a fertile field for Commission and court decisions usually in connection with the establishment of rates. The subject is admirably treated in Professor Wyman's "Public Service Corporations" and a brief abstract of this is worth attention.

"On various important public services the obligation undertaken is to serve the community in general. . . . This problem may be dealt with from two points of view. One side is the exterior limitations beyond which the service need not be rendered; the other regards the obligation to render service within these limits. Thus a gas (or electric) company may not be called upon to serve beyond the municipality for which it has been chartered, but must it lay its lines through every street? . . . When the particular services are separately considered the law will seem too indefinite to be practicable, but when all cases are taken together . . . working rules may be attained. . . . As the law now stands there are various cases as to the supply of water and gas and the installation of electricity . . . but hardly enough as to any one as to make workable law. It is plain that the existing facilities must in many instances be developed in readiness to give service beyond the present lines since what has really been undertaken is the proper service of the whole community dependant upon the established company.[1] Certainly all premises situated within the network of existing mains and within convenient connecting distance should be served.[2] But the law will soon require, if it does not already, that the existing mains must be gradually extended as the growth of population in the community which the corporation has undertaken to serve demands the expansion.

All must be qualified as in a recent New Jersey case[3] dealing with gas supply where it is said

> 'In short, is not the obligation to supply a dwelling with gas . . . subject to the limitation, that there shall exist a reasonable expectation that the consumption shall be sufficient to warrant the necessary expenditure?'

The undertaking to serve a community does not therefore lay the company open to outrageous demands in individual cases, but to such service as the community considered as a whole may demand.[4]

CONCLUSION.

As noted previously, the methods adopted in adjusting this question of line extensions are quite varied. Assuming that a reasonable return is to be required on the investment and the customer is to help in carrying the proposition during its otherwise unprofitable period, it is rather noticeable that in many cases there does not appear to be any definite way of analyzing the situation to show how the burden should be divided and to make clear the relation of the company and the customer. The practice of one concern seems particularly reasonable and several others evidently have used similar methods. A certain extension is to cost, say $1,000. Now the capital invested is entitled to interest, depreciation, etc., say 10%, and a reasonable return on its capital, say 6%, making a total fixed charge of 16% or $160. Then assuming the operating ratio is 70%, that is, out of every dollar of income thirty cents remains to meet interest, depreciation and profit, thus a gross income of $533.33 must be realized on the $1,000 investment to net the $160. Until this gross income is reached the extension *per se* is unprofitable. Just how the difference between this income and the first revenue received may be adjusted depends largely on local conditions and one hesitates to offer any general prescription.

The underlying principles governing the problems considered here seem, broadly speaking, to be but two, namely, that any concern utilizing its capital in a public utility is entitled to a reasonable return on the investment involved; and again, that such a company assumes certain obligations to the community in general, its most important being to render its service in the most broad-minded and liberal way consistent with its own responsibilities, cooperating with its public to their mutual advantage.

The proposition of reasonable return on investment is now certainly accepted as axiomatic in the operation of public utilities. True, just what the "reasonable return" is, offers a happy field for argument and it must be solved in connection with the second principle noted, namely, a broad-minded interpretation of our obligations. It is interesting to note from the data gathered that ninety per cent of the companies considered are in general acting along these lines in solving this particular problem of central station service.

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[1] Illinois—City of Chicago v. Mutual Electric Light & Power Co., 55 Ill. App 429 (1894).
Massachusetts—Weld v. Gas & Electric Light Commissioners, 197 Mass. 556 84 N. E. 101 (1908).
New York—Moore v. Chaplain Electric Company 88 N. Y. App Div. 289 85 N. Y. Supp. 37 (1903).

[2] New York—Jones v. Rochester Gas & Electric Co. 7 N. Y. App. Div. 465, 39 N. Y. Supp. 1105 (1896).
Oregon—Haugen v. Albian Light & Water Co., 21 Oreg. 411 28 Pac. 244, 14 L.R.A. 424 (1891).

[3] Public Service Corp. v. American Lighting Co. 67 N. J. Eq. 122, 57 Atl. 482 (1904).

[4] Inhabitants of Quincy v. Boston 148 Mass.. 389. 19 N. E. 519 (1889)

Some Practical Testing Methods for Use on Electric Circuits

(*Contributed Exclusively to* ELECTRICAL ENGINEERING).

BY H. N. KELLEY.

CIRCUITS are often tested for the presence of voltage by touching the conductors with moistened fingers. This method is only safe where the voltage does not exceed 250, and is often very convenient for locating a blown-out fuse or for ascertaining whether or not a circuit is alive. The outside wires and the neutral wire of a 110-220-volt, three-wire system can be determined in this way by noting the intensity of the shock that results by touching different pairs of wires. The method must be used with caution and be certain that the voltage of the circuit does not exceed 250, before touching the conductors. This method of testing on a large system using a variety of voltages is one to discourage and the "tasting" method for the presence of low voltages confined entirely to bell and signal work, where the voltage is very low.

Polarity of direct current circuits can be determined by holding the two conductors in a glass vessel of water, as indicated in Fig. 1. It may be necessary to pour a little common salt or acid into the water. Bubbles will form only on the negative conductor indicating the presence of current and the polarity of the circuit. Care must be taken not to touch the conductor ends together and cause a short circuit.

The magneto test set is one of the most valuable testing instruments to the practical man because of its simplicity and the fact that it is always ready for service. Fig. 2 shows the circuit and Fig. 3 a perspective view of a testing magneto. The apparatus consists of a small hand-operated alternating current generator in series with a polarized electric bell. Alternating current will ring bells of this type. If the external circuit connected to the terminals of the magneto is closed and the crank of the generator is turned, current will flow and the bell will ring.

The resistance through which magnetos will ring is determined by their design. An ordinary magneto will ring through possibly 20,000 to 40,000 ohms. Electrostatic capacity effects must be considered when testing with a magneto. When testing long circuits, such as telephone lines or circuits that are carried in cable for a considerable distance, the bell of the magneto may ring, due to capacity, and indicate a short circuit, whereas the circuit may be perfectly clear or open. Circuits associated with iron, such as field coils of generators, may have considerable inductance. With highly inductive circuits under test, the magneto may "ring open;" that is, the bell may not ring at all, even though the inductive circuit connected to it be actually closed. In ordinary wiring work the effects of capacity and inductance are usually negligible and the true condition of the circuit will be indicated by the performance of the magneto bell.

A telephone receiver in combination with one or two dry cells constitutes an excellent equipment for certain tests. A "head" telephone receiver, as shown in Fig. 4, is usually preferable to those of the watch-case type, because it is held on the head by the metal strap, allowing the unrestricted use of both hands. Metal testing clips—suspender clips will do—are soldered to the flexible testing cords. The telephone receiver is extremely sensitive and will give a weak "click" even when the current to it passes through an exceedingly high resistance. In using this device, one clip is gripped on one conductor of the circuit to be tested, and the other clip is tapped against the other conductor. Prolonged connection should be avoided, because it will "run down" the battery. A vigorous click of the receiver indicates a closed circuit, while a weak click or none at all, indicates an open circuit. After some practice by observing the click through a known resistance, it is possible to approximately determine the resistance of the circuit under test by the intensity of the click in the receiver. When the battery and receiver test set are connected to a circuit having some electrostatic capacity, the receiver will give a vigorous click when the clips are first touched to the circuit terminals, even though the circuit be open. With successive touchings the click will diminish in intensity if the circuit is open, but will not diminish appreciably if the circuit be closed.

The advantages of the telephone receiver over the magneto for work of certain classes are as follows: (1) The receiver and battery outfit costs little. (2) The outfit can be made so compact that it can be carried in the

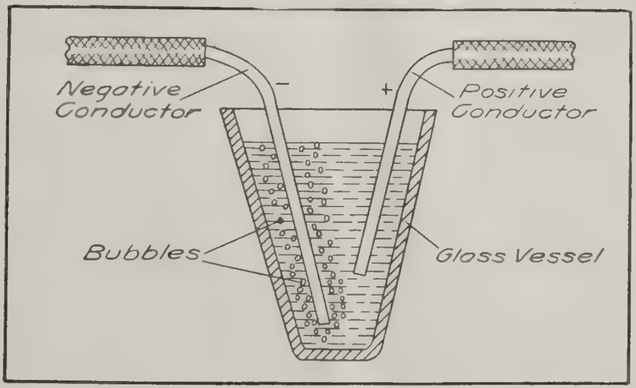


FIG. 1. DETERMINATION OF POLARITY WITH CONDUCTOR ENDS IN WATER.

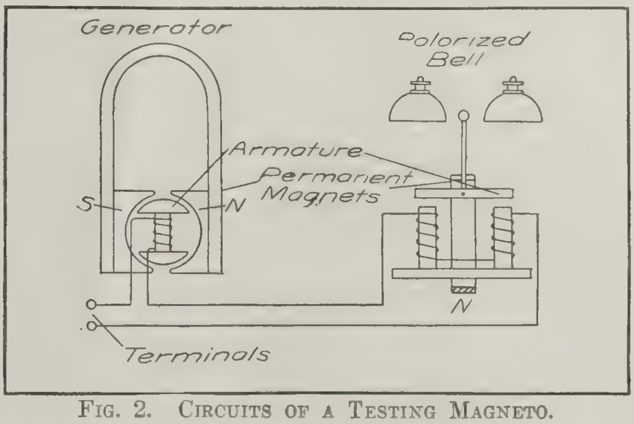


FIG. 2. CIRCUITS OF A TESTING MAGNETO.

pocket. (3) In making insulation tests with a magneto the circuit may "ring clear"; that is, the bell will not ring, apparently indicating high insulation resistance, whereas the circuit may not be clear, but instead the magneto may be out of order or its local circuit open. With the telephone receiver a slight click is produced even when testing through the highest resistance. The absence of a click usually signifies an open in the testing apparatus itself. Thus the telephone receiver indication is positive.

A telegraph sounder is sometimes used for testing. It is connected in the same way as the telephone receiver of Fig. 4, and is adaptable for rough work. When the circuit under test is closed and the flexible cord clips are touched to the circuit conductors, the sounder clicks. Where the circuit is open there is no click. One good feature of the sounder method is that the click is audible at a considerable distance from the instrument.

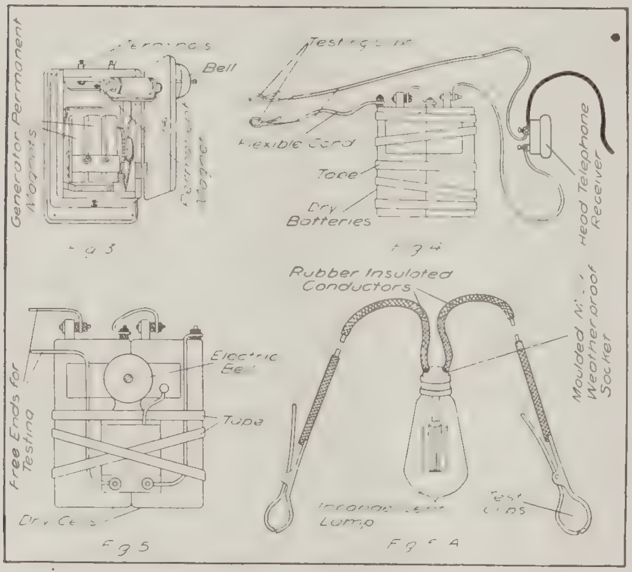


Fig. 3. Assembly of Testing Magneto. Fig. 4. Head Telephone and Dry Battery Testing Set. Fig. 5. A Testing Lamp Outfit.

An electric bell outfit for testing is shown in Fig. 5. When the free ends for testing are touched to a closed circuit of not too high resistance the bell rings. Where the circuit is open the bell will not ring. Flexible cord can be used for the testing conductors of the outfit and testing clips can be provided as in Fig. 4.

A test lamp shown in Fig. 5-A, consisting merely of a weatherproof socket of molded mica, into which is screwed an 8 candlepower carbon or 5-watt lamp of the voltage of the circuits involved, is very convenient for rough tests on interior lighting, and motor wiring systems. Porcelain sockets are undesirable because they are so readily broken. Brass sockets should not be used because they may fall across conductors and thereby cause short circuits. Testing clips like those of Fig. 4 may be soldered to the ends of the leads which are moulded in the socket. Some uses of the testing lamp are given in a following paragraph, and it is very convenient for testing for defective fuses.

The testing out of a concealed wiring system for proper connections is illustrated in Fig. 6. It is assumed that the wires are installed and that the locations of runs are concealed by the plastering. Only the ends of the conductors are visible at the outlets. It is necessary to identify the conductor ends at each outlet. These tests are usually made with the electric bell outfit shown in Fig. 5, because the sound of the bell will indicate a closed

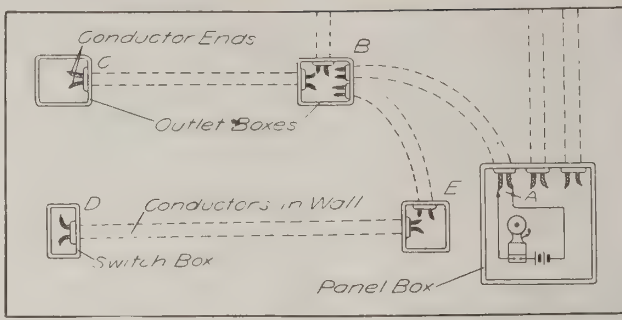


Fig. 6. Testing Out Wiring for Proper Connections.

circuit to the wireman in a distant room. Hence, a single man can test out such a system. In testing out, first skin the ends of all of the conductors and see that no two wires are in contact nor any one with the outlet box. Next select a pair of conductors as *A* in Fig. 6, preferably the pair that serves the group and connect the bell outfit to the ends of the pair as shown. Then proceed to the outlet *B*, (Fig. 6) at which the pair of conductors should terminate and successively touch together the ends of all the wires that terminate in that box until a pair is discovered that when touching the ends together the bell rings. This identifies one pair. Tag this pair so that it can be readily found again and repeat the process on some other pair. Continue this until all of the conductors are identified.

A method of testing out the connections for three-way switches is shown in Fig. 7. When finally connected the circuit should be as shown by the top connections. It is assumed that the conductors are in place and concealed within walls or ceilings and that only the ends are visible at the outlets, as at Fig. 7. First, identify the feed conductors and bend the ends back at the outlet box as at *A*3. Next, twist together, temporarily, the bared ends of any two of the conductors at each of the switch outlets as at *A*3 and *C*3. The conductors having their ends thus twisted together will be the switch conductors. Now, at the lamp outlet, or outlets, identify the short-circuited switch conductors as directed in a preceding paragraph and connect and solder these switch conductors together as at *B*3. Connect the remaining conductor ends at the lamp outlets to the lamps, *B*4, connect one of the feed conductors to the center point of the three-way switch *A*4, and connect the other feed conductor to the lamp wire. The switch con-

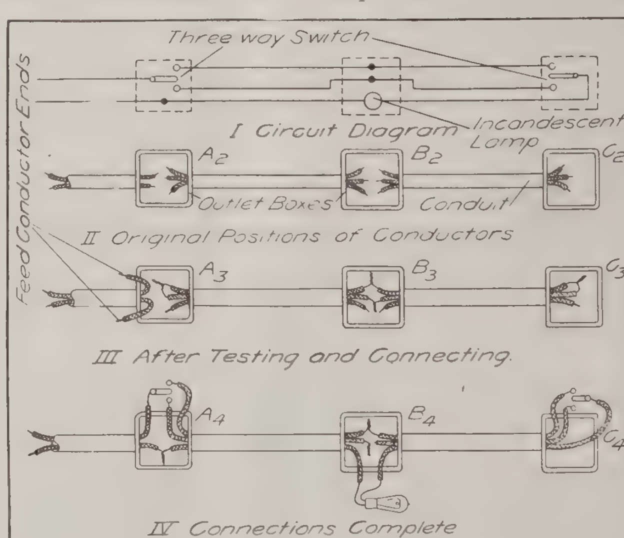


Fig. 7. Testing Out Three-Way Switch Connections.

ductors are connected to the two points of the switch. At C4 the same procedure is followed.

In testing out a new wiring installation for faults, each branch-circuit, main and feeder should be treated individually. It is usually impracticable to test an installation as a unit, as open switches and loose connections in cutouts may render such a test worthless. If a test is made from the cut-out, on the two conductors of each individual circuit, the above mentioned possible elements of uncertainty are eliminated. Test each side of each circuit separately unless the lamps are in position.

Open circuits in multiple wiring installations are usually readily located. If the lamps are in position and lighting voltage available, it can be impressed on the circuit. The lamps on the generator side of the open will then burn, while those on the far side will not, which localizes the open. Where lighting voltage is not available, all of the lamps can be taken out of the sockets and each of the sides of the circuit can be grounded at the cut-out. Then a telephone-and-battery, a bell-and-battery, or a magneto test set can be connected temporarily and successively between one line and ground and between the other line and ground at each outlet on the branch. When the test set indicates an open circuit, the open is between the tester and the ground made at the cut-out. The test for short circuits on a multiple system is made by temporarily connecting a test set across the terminals of each branch and circuit at the cut-out. If there is a short circuit on the lines under test, its presence will be immediately evident.

The test for continuity of multiple wiring circuits is made by temporarily connecting a test set across the terminals of each branch cut-out and successively short-circuiting (one at a time) the sockets of the branch with a screw-driver, a nail, or other metal object. The test set will then indicate whether the wiring of the circuit is open or closed. Where lighting voltage is available and plug cut-outs are used, a lamp can be screwed into one socket of the cut-out and a plug-fuse into the other. Then the tester can proceed from socket to socket and short circuit each. Where the circuit to the socket is continuous, the lamp will light when the socket is short-circuited.

The test for grounds on a multiple wiring installation is made by temporarily connecting between line and ground a test set of one of the types hereinbefore described. If the test set indicates a short circuit, the line being tested is grounded.

The testing of three-wire circuits to identify the neutral is effected as suggested in Fig. 8. Where the neutral is grounded, a test lamp can be successively connected between each of the three conductors and ground, as in Fig. 8—*I*). When the ungrounded wire is touched to the neutral wire it will not burn, but when touched to either of the outside wires it will burn. A method that can be used with either a grounded or an ungrounded neutral is illustrated in Fig. 8—*II*. Connect the two test lamps in series successively between one of the line wires and the other two. When connected across the two outer wires, both lamps will burn at full voltage, but when connected between one of the outer wires and neutral they will burn at only half voltage. The "touching" test, described in a previous paragraph, can also be applied.

The testing of lighting fixtures prior to installation is best accomplished with a voltmeter, as in Fig. 9. The test for short circuit and continuity is illustrated at *I*. If the voltmeter does not give a reading with the lamps out of the sockets, the fixture wiring is clear of short circuits. After the test for short circuits has been made, each socket is short-circuited with a metal object—a screw-driver is frequently used—and if the voltmeter indicates the full voltage of the circuit each time a socket is short circuited, it signifies that the current to that socket is continuous.

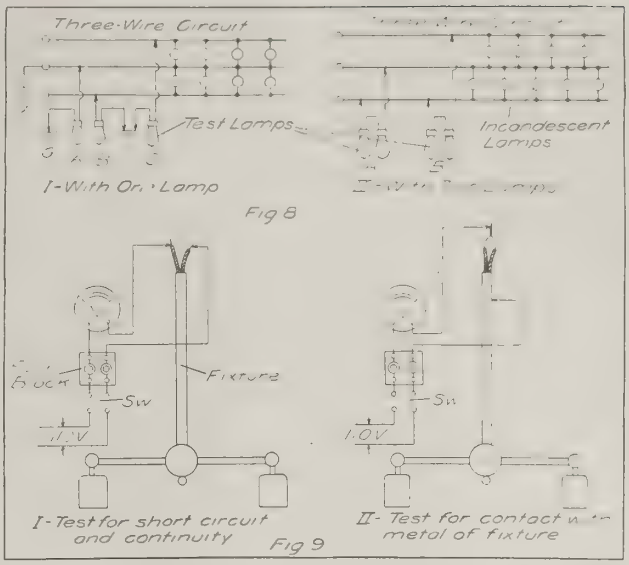


FIG. 8. LOCATING NEUTRAL WIRE WITH A TEST LAMP.
FIG. 9. METHOD OF TESTING OUT FIXTURES.

The fixture can be tested for grounds as at Fig. 9—*II*. If there is no deflection of the voltmeter with one lead from the voltmeter touching the metal work of the fixture and the other successively touching each of the fixture conductors, the fixture is clear of grounds. Be certain that one voltmeter terminal is in actual contact with the metal work of the fixture and not insulated therefrom by the lacquer finish. This test should be made with the lamps out of the socket.

The Possibilities in Good Lighting for the Electrical Contractor.

BY A. D. CURTIS.

The conservation of vision movement which is growing in strength every day in all sections of the civilized world is an important effort on the part of those who are aware of the great injury being done the eyes and health of the people by exposed lighting units and planned to alleviate this condition. It is unnecessary to go into detail here of the great increase of eye trouble, nervous disorders, etc., as statistics, investigations of governments, proposed laws, and formation of conservation of vision societies, all show this.

The further increase of the brilliancy of the incandescent lamp by the perfection of the tungsten filament to satisfy the cry for more light, has still further aggravated conditions. The continued use of the present lamps and the proposed manufacture of the half-watt lamp, means one of three things: (a) laws against exposed brilliant lights; (b) subduing the brilliancy of these lights, or (c) the general application of lighting from invisible sources.

Having briefly outlined the conservation of vision movement and its source, let us briefly see what it means to the electrical contractor, and why he should give serious consideration to its possibilities. It was Herbert Kaufman, if the writer is not mistaken, who said: "Opportunity lies off the beaten track." That's why there is so much of it. There's more room alongside the trail than in the path itself. We are always surfeited with unimportant things and men. Those who adopt conventional vocations and do not alter the conditions under which they work, soon find themselves battling for a living wage. But originality grows more precious every year. If you can discover a new goal, develop a new territory, or an unapplied principle, you are worth your own figure to civilization. Here is where the opportunity for the electrical contractor comes in. While his work is covered up and soon forgotten and he pockets his profit or loss to look for another contract he should not forget that his recommendations as regards lighting and his construction work in connection with same, largely determine the extent of his future business. Supposing that he should devote what might be compared to a week's solid study in his past school days, to the latest developments in lighting methods, and the correct application of the tungsten lamp in lighting interiors of all kinds? This is what it would mean to him: (a) He would know much more about illumination than 999 out of every 1,000 other electrical contractors. (b) His advice would be sought for and he would receive preference on contracts for wiring, etc. (c) On the completion of this work, he would naturally continue further and supply the lighting equipment used. (d) This would be a standing advertisement for him. (e) He would no longer be looked on as merely an electrical wireman or electrician. (f) More pride would be his in his business, and he would no longer wish he had followed another calling, and next and best; (g) his profits would be larger.

A realization of the truth of the foregoing is found in the earnest endeavor of many members of the Electrical Contractors' Association along the lines mentioned.

A new field is now open to the electrical contractor in the bettering of lighting conditions. The possibilities and great desirability of lighting by the various scientific systems, the newest of which is the indirect system, has in the past few years been proven, and the effect now sought is expressed by the term "illumination." The change has come so suddenly, yet so quietly, that few men understand the "why" of good lighting or illumination. Books off the press but a few years are obsolete. Illuminating engineers are few. The layman knows little of lighting, and less of illumination. Earnest men of science are investigating and pointing out the evils of irrational illumination. Equally earnest engineers are working out appliances and equipment to meet the emergency. All energy now exerted is done to meet a public demand. The ground has but been scratched—the movement but just started.

The possibilities for the electrical contractor are very great, for he, more than others, comes first in close contact with the users of artificial light.

Water Power and Irrigation Works in Southern India.

Construction has just been started on an important extension to the famous water power scheme at the Cauvery Falls in the native State of Mysore, from which at present 10,000 horsepower is transmitted 92 miles to the Kolar gold fields, and about 2,000 horsepower somewhat lesser distances to the two cities of Bangalore and Mysore, where it is used for electric lighting and industrial purposes. The new extension will increase the water power available for the gold mines at Kolar by 7,000 horsepower, and also will permit a fair increase in the power for use at factories in Bangalore. The original installation, which took place in 1900, cost $2,866,667, and the new electrical installation will cost $466,667.

There is, however, to be a further large expenditure of about $2,666,667 on a huge dam and reservoir across the Cauvery River at the town of Kannambadi, about 15 miles distant from the city of Mysore. This is to be used for increased water power and for irrigation.

All the electrical equipment for the new installation will be manufactured in the United States. Already a contract has been signed for the purchase of two 1,500-kilowatt generators and twenty 1,750-kilowatt high-voltage transformers, together with switchboard gear, to be supplied by the General Electric Co., of Schenectady, N. Y., at a cost of about $150,000. Leading electrical firms in England and Germany bid competitively with American firms on this equipment, but the English bids were about 20 per cent higher than the accepted bid of the American firm, and in the case of German firms their guaranties were not considered so satisfactory as those of the American firm. The new turbine installation, as in the original plant, will be from Zurich, Switzerland. In the new installation the voltage will be raised from 35,000 to 70,000 volts.

An interesting feature of the new high-tension line installation will be the use of iron poles with crossarms having porcelain insulators, which are to be supplied from Pittsburgh, Pa., at a cost of $200,000. This iron-pole construction is deemed advantageous on account of the white ant difficulty with timber, and also because of local scarcity of tall enough trees for poles.

The first Cauvery Falls water-power scheme was at the time of its inception one of the most important long-distance transmissions in the world, and attracted much special interest in the United States at the time, because it was one of the first notable instances of American manufacturers and American engineers participating so prominently in a great project so far from home. This scheme was originally carried out, and has always been subsequently managed by American engineers appointed for this purpose by the Government of Mysore, and the electrical equipment which has always proved most satisfactory was all manufactured in the United States. The present electrical engineer in charge, and who will also direct the new installation, is Mr. C. F. Beames, a citizen of New York State.

National Association of Purchasing Agents Organized.

A new organization with regular headquarters at New York City has been organized to be known as the National Association of Purchasing Agents. Its membership will be made up of purchasing agents of industrial corporations, railroads, steamship lines, street railway, gas and electric companies, with sub-association organizations in all sections of the country.

The objects of the organization are: (1) the formation of the purchasing agents and buyers into a national body; (2) mutual acquaintance, and the resulting privilege of exchanging ideas and opinions; (3) the standardization of purchasing routine and methods; (4) the investigation and certification of new appliances and materials; (5) the improving of existing methods for the diffusion of market information; (6) the gathering and dissemination of data relating to the subject of buying; (7) the standardization of specifications, and other features that will probably be suggested in the future that will be of benefit or interest to the purchasing agent or buyer.

An active campaign is to be inaugurated in all the principal commercial centers for the securing of new members. Purchasing agents and buyers interested should communicate with the temporary secretary, E. B. Hendricks, P. O. Box 1406, New York City.

National Association of Sign Manufacturers.

The organization of a National Association of Electric Sign Manufacturers has recently been announced. The objects of the association are expressed under the following headings:

1. To combat hostile sign legislation; to change unfair and restricted city ordinances pertaining to electric signs, and to oppose taxes and licenses on signs.

2. To disseminate a knowledge of the benefits of electrical advertising. (This will be accomplished by means of advertisements, photos and write-ups in the popular magazines, trade papers in all lines, and through the press associations).

3. To generally promote the welfare of its members.

4. To maintain a bureau in charge of a secretary which shall guard members of the association against employing agents or salesmen who have proved dishonest with other companies.

5. To establish an "Association Standard" for high quality of material, workmanship and design, and to impress on the public the merit of "Association Standard" goods.

6. To combat the growing evil of stealing sketches and matching prices.

Individuals and firms interested in affiliating with the National Association of Electric Sign Manufacturers can secure further information by addressing the secretary, Lloyd E. Brown, 315-321 South Warren street, Syracuse, N. Y.

Promotion of Water Power Development in Georgia.

A committee has recently been appointed by the Georgia Chamber of Commerce to be known as a Water Power and Water Power Development Committee, whose duties shall be to enlighten farmers on the possibilities of and arouse their interest in the use of electric power and development of small water powers in their vicinities to reach out for manufacturers of other states and to promote the possibilities of irrigation as applied to intensive farming.

The Georgia Chamber of Commerce has placed at the head of this committee on Water Power and Water Power Developments, Mr. Chas. F. Howe, a consulting engineer of Macon, who was one of the first to realize the great possibilities of the water powers of the state and to invest his time and money in bringing their consummation to pass. Mr. Howe has been connected as chief engineer with the organization, development and placing in operation the great development at Jackson, owned by the Central Georgia Power Company. He also investigated and had surveys made on the Oconee, Ocmulgee, Flint, Broad and Ocoee rivers, as well as other rivers of this and other states. Associated with Mr. Howe are the following gentlemen: Messrs. S. W. McCallie, state geologist, Atlanta; B. M. Hall, consulting engineer, Atlanta; who has been employed by the government for irrigation purposes and water power development in the West and in Porto Rico; Paul Norcross, Atlanta, of the Solomon-Norcross Company, hydraulic engineers; G. F. Harley, hydraulic constructing engineer, of Columbus; W. A. Carlisle, Gainesville, who has been closely identified from its inception with the North Georgia Electric Company and the Georgia Power Company; Nisbet Wingfield and the construction of the great dyke to protect the city from flood water, Augusta, Ga., who, as city engineer, has had charge of the water powers of that city; Chas. A. Caldwell, a well-known engineer of Macon, and C. D. Flannigan, of Athens, another pioneer of water power development of this state; together with a number of other gentlemen equally well known and specialists in their line.

The Georgia Chamber of Commerce makes this announcement accompanied by a statement that citizens must realize that it costs vast sums to harness water powers of the state, interest must be paid on this money, dividends returned to those who hazard fortunes, machinery must be renewed, transmission lines maintained, etc., and that only through co-operation can the greatest good be secured. It is, therefore, confidently expected that this committee will use their utmost endeavors to foster the interests of Georgia through the use, by its citizens, of the water powers at hand, as well as inducing manufacturers and capitalists to come from other states.

Society for Electrical Development.

During the first half of November over two hundred applications for membership in the Society for Electrical Development were received at headquarters, largely as a result of the vigorous campaigns carried on by the sales organizations of various member companies. The total membership is now nearly 900 companies who have pledged nearly $160,000 to the society's funds. It is believed that the membership will soon total more than 1,000 and that the society's prescribed minimum fund of $200,000 will be completed by January 1.

It will be of interest to manufacturers, as well as to the other branches of the electrical business, to know that forty-one manufacturers have taken out membership in the society, aggregating over $80,000 annually as their subscription to this very important trade movement. The particular group of forty-one referred to are members of the Electrical Manufacturers' Club, at whose meeting last week at Hot Springs the society was a live topic of discussion, both in the meeting and the lobbies. The affiliation with the society of the other members of the club is being carefully considered, and their co-operation will undoubtedly raise the subscriptions from this particular group to over $100,000 annually.

The society's objects, plans and methods of membership need only to be really understood to make a successful appeal to those who have not yet joined as it has done to the 900 and more companies in membership. It is in effect a wonderful opportunity for the electrical business to blaze a new trail in creative market development that will be in keeping with the great achievements in electrical research, engineering and manufacture. An interesting pamphlet has been prepared covering concisely the principles, plans and method of membership which will be sent on request to the Society for Electrical Development, Engineering Societies Building, New York.

Opportunity has no something for nothing proposition. it demands a good price, which must be paid with brains and hard work.

New Business Methods and Results

Representing Interests of Central Station, Electrical Jobbers, Dealers and Contractors.

Old and New Methods for Securing Holiday Business.

Christmas time is of special importance to every electrical merchant and central station. It is the one season of the year when people are in a receptive mood. They are asking themselves and each other, "What shall I give?" Suggestions are welcome and eagerly sought. It is, therefore, the opportune time for the dealer in electrical appliances and the central station to present the suggestion of electrical gifts, and provide the means for those interested to act upon the suggestion.

It is an established fact that few Christmas gifts are purchased as a result of deliberate and thoughtful investigation; most of them are chosen on the impulse of the moment. Something is seen or read about that strikes the fancy and purchased or sent for forthwith. More likely even, the matter of selection is neglected altogether until the last moment, when the first gift that appeals is the one purchased. The problem, therefore, of affecting the selection is largely a psychological one, and success of any suggestion is attained by directing a strong appeal to the right people, in the right way, and at the right time. Mr. Wilhoite, of Chattanooga, in a comment published in this issue, has expressed the idea, perhaps as concisely as anyone could, when he says that his company is not planning to "do anything out of the ordinary, but simply to lift the ordinary out of the commonplace." The idea here is that sound merchandising methods, rendered especially attractive, are to be relied upon to get the Christmas business, and will. Permanent trade is not built up by the use of sensational methods, but rather by a careful study of the conditions, a selection of desirable new methods, and the use of every means to make the old and well-tried methods still more effective.

A study of Christmas merchandising plainly shows that there are only two avenues of publicity that are recognized as standard, namely, the show window and the newspaper advertisement. As stated in a preceding comment, we have to deal with receptive minds, and what is needed is a strong and continuous appeal covering the entire shopping period. The fact must be realized that by far the greater number of Christmas goods are selected on sight, and for this reason nothing can take the place of attractive window displays. Further, nearly every possible electrical customer reads the newspaper and even searches it for suggestions, hence the necessity for liberal advertising for at least a month preceding Christmas. There is no special general advice that can be given for either advertising or window display during the holiday season, except that such should be prepared with unusual care, and feature those devices most suitable for gifts. The primary appeal should be made to the sense of luxury, owing to the strong tendency of mankind to indulge himself at this season.

As regards the distribution of literature, especially as regards the enclosing of manufacturers' leaflets with the monthly bills, we are inclined to look upon such methods as of doubtful value at any time, and especially at Christmas time. Such literature may have a general educational value, but as an incentive to immediate action it is worthless. Its chief defect is in the absence of a personal appeal. For example, if a lady should write or inquire concerning an electric toaster, and should be sent or be handed a descriptive leaflet of same, she would be enlightened, but wherein is the appeal, such as made by the newspaper advertisement or window display, when she is in the mood for or even searching for a suggestion of a gift, which mission the descriptive leaflet has?

There is, however, one piece of advertising that can be used to great advantage. The idea is not new, but its application to electrical merchandise may be, namely, the use of a booklet of suggestions for Xmas gifts, arranged according to price and kind of article, with pages of gifts for men, young ladies, children, the mistress, and in fact, members of a complete family. On the men's page would be shaving mugs, cigar lighters, desk lamps, etc. On the children's page would be electric corn poppers, toy transformers, Christmas tree lights, etc. Only brief descriptions need be given in the case of novelties, with the range of prices, the idea being to offer a suggestion. If tastefully worked up it will have a good change of being carefully laid aside for reference. As regards methods of distribution, we would suggest mailing such a booklet under a 2-cent stamp, handing it out over the counter, at the cashier's window, or given out by solicitors, or by all of these ways. Do not send it out with bills. It looks cheap and is not as a rule effective.

These are, we believe, the principal methods. Of course, there are others of more limited application. Solicitation in general is impracticable, because the people cannot be reached in the time desired. There is, however, one exception to this. Solicitors are not as a rule very busy on routine during the week or ten days preceding Christmas, and it is often a good idea for each one of them to make up a list of 50 or so of their well-to-do customers, and heads of families, and call upon them informally at their offices or places of business, and make suggestions as to the purchase of washers, vacuum cleaners or the like for gifts. Such suggestions will be gratefully received, and should be the means of closing up a number of sales. Of course, this plan presupposes a cordial acquaintance between the solicitor and his customers. The telephone may also be used for calling up a limited number of lady customers, for the purpose of extending a personal invitation from the commercial manager to visit an Xmas display.

In taking up the general arrangement of the showroom, Mr. Southwell, of Macon, Ga., mentions the provision of a "Rest Room." The idea is good, so good, indeed, that it should be strongly (but modestly) featured wherever possible. A card of invitation can be profitably used, being mailed to lady customers or enclosed in the booklet already mentioned. In fact, it would probably pay to send out two separate invitations, one early and the last one about a week before Christmas.

It is, perhaps, unnecessary to say that the rest room should not be such in name only, but should be just what its name implies—a secluded apartment with courteous attendants, all conveniences and comfortable accommodations for mothers with children. Best results would probably be secured with no obligation expressed or implied to purchase anything. It would not, however, be objectionable to arrange tempting displays or cause the persons using the rest room to pass to and from it through a main show room. As to the decorations, apart from the window display, care should be taken that they are neat and in good taste. They should not be so elaborate as to divert attention from the goods on sale. A Christmas tree of suitable proportions, not overdressed, illuminated with electric lights, a few wreaths, and some greens twined about convenient posts, should be ample. The goods should, of course, be displayed in holly boxes and tied with ribbon.

As to prices, there is but one thing to be said: sell at list or at the recognized retail price. There is rarely any excuse for cutting prices, and none at all at this season. All purchases should be delivered a reasonable distance free of charge, and should on request contain a Christmas greeting from the donor, and in all cases should contain a card permitting exchange if desired.

A great many other plans and schemes have been suggested for obtaining holiday business. A few of them are of distinct value, others are flat failures, and still others are simply based upon the principles of good merchandising, but have no especial seasonable value. It would seem, however, from a study of contemporary periodicals, and from the answers which have been received from the question, "What are your plans this year for Christmas?" that the foregoing remarks about covers the methods that are considered of value. We shall, however, gladly welcome any further suggestions from our readers for record and comment in our next issue on this subject.

In conclusion, we venture to propose a plan which, so far as we have knowledge, has never been tried by any public service company, although it has been in successful use by banks. This is the organization of a "Christmas Club," the persons joining paying in 25 to 50 cents each week for 50 weeks, and before Christmas receiving the entire amount with interest. The central station can do the same thing, offering, perhaps, a larger rate of interest on condition that the amount shall be applied to the purchase of an electrical device. Ten per cent would not be too much. The plan could be easily modified to allow persons to join at any time. A display card reading: "Ask about our Christmas Club—begin to buy your gift now by depositing 25 to 50 cents each week and watch it grow. We return to you 10 per cent more than you pay in—ask us about it." This or some other message displayed on a proper card in a good location should lead to excited inquiry and some good business at Christmas time.

A. G. Rakestraw.

N. E. L. A. Safety Committee.

President McCall, of the National Electric Light Association, has appointed the following new safety committee: Martin J. Insull, chairman, Middle West Utilities Co., Chicago, Ill.; Charles B. Scott, secretary, Middle West Utilities Co., Chicago, Ill.; Sidney W. Ashe, General Electric Co., Pittsfield, Mass.; Alexander Taylor, Westinghouse Co., Pittsburg, Pa.; J. B. Douglas, United Gas Imp. Co., Philadelphia, Pa.; H. W. Moses, Boston-Edison Co., Boston, Mass.; H. L. Lucas, Philadelphia Electric Co., Philadelphia, Pa.; T. A. Kenney, Commercial Power Co., Jackson, Mich.; Victor T. Noonan, Rochester Railway and Light Co., Rochester, N. Y.; Dr. E. B. Rosa, U. S. Bureau of Standards, Washington, D. C. The committee will meet shortly and consider plans for a safety campaign in the N. E. L. A.

It is to be noted that the executive committee of the Empire State Gas and Electric Association has also appointed a safety committee to work in behalf of the association throughout New York state. W. P. Strickland, New York and Queens Electric Light and Power Company; Henry Flood, Central Hudson Gas and Electric Company; W. L. Bruce, Westchester Lighting Company; A. T. O'Neill, Syracuse Lighting Company, and Victor T. Noonan, Rochester Railway and Light Company, compose the committee. Mr. Noonan, secretary of the Rochester general safety committee has for some time been very active in this work, delivering addresses and launching the movement wherever interest is shown. It is to be expected that much good will result from their organized safety work and sincerely hoped that the movement will soon become national in scope.

COMMENTS FROM READERS.

Clare N. Stannard, Secretary and Commercial Manager of Denver Gas & Electric Light Company, Denver, Colo., Describes Successful Window Lighting Campaign.

The sign and illuminating department of the Denver Gas & Electric Light Company, has been quite successful in the use of the following window lighting scheme: When we find that a prospect is interested in window lighting, but hardly sufficiently interested to decide to make the investment necessary for wiring, large tungsten units, glassware, etc., required for a perfectly illuminated window, we suggest that he allow us to make a trial installation. We then run to the window a temporary stage cable and install in the window some drop fixtures kept on hand for this purpose, equipping same with 250 or 500-watt tungsten lamps and the necessary Holophane reflectors or shades. We are thus enabled to demonstrate to the prospect the efficiency of good window lighting.

In addition to making the installation as above outlined, we station a man in front of the store at night who reports to the merchant the next morning the number of people passing the store between dusk and midnight; the number of people stopping and looking in the windows, and even in some instances informing the merchant of some of the remarks made by people interested while observing the windows. Almost without exception this has resulted in an order being given for a permanent installation. We thus secure a consumer on the flat rate from dusk until midnight every night in the year.

Mr. L. J. Wilhoite, Contract Agent, Chattanooga Railway & Light Company, Chattanooga, Tenn., Describes Plans for Securing Christmas Business.

We are not going to attempt anything out of the ordinary in the way of schemes to secure Christmas business, but we are going to take the ordinary away from the commonplace and endeavor to get results by employing the same old tactics. Our mailing list is being crowded to the limit with advertising matter appropriate for the holiday business supplied us by the manufacturers of the various heating apparatus. We shall continue to mail this material until the night of December 25. In addition to this, we are planning to send post cards to every customer on our lines, suggesting electrical devices appropriate for the season.

Last year we spent a considerable amount of money mailing out so-called personal letters to customers, calling their attention to the desirability of electrical gifts. This year we are cutting out this feature of advertising inasmuch as the results did not seem to justify the expense. Instead of this direct by mail method, we are going to enclose attractive folders, pamphlets, and other material describing the goods, furnished us by the different manufacturers interested.

We are planning to work our show window overtime until Christmas. An expert has been employed to trim the windows every Monday morning from now until Christmas, and in fact, as long as this party desires to keep the job. Very few central station windows are a credit to the central station business because few central station men know how to fix up windows in a way to attract the public. We have purchased heating devices extensively, on the theory that we can sell this product once we have it. Considerable money has been tied up in this apparatus, and it is "up to us" to dispose of it by December 25. This idea has been instilled into the minds of our entire organization, and everyone is working and talking electrical Christmas gifts.

We expect to do practically continuous newspaper advertising during the month of December, as we find that after all is said and done, the best way to secure good business is to give articles the proper publicity.

The only thing I can recall in the way of something new in Chattanooga to secure Christmas business, is the arrangement we have made with the principal electrical contractors in town. Through this arrangement we are going to supply them with all the heating devices they can sell, turning same over to them and adding barely enough to their cost to pay us for our trouble in the transaction. The heating devices are all sold at list, and an El Stovo costs the same one place as it does another. Last year we sold electrical devices at about 15 and in some cases 10 per cent above cost and advertised the "sell at cost" idea. This year we are going to change our plans and handle the business as any other merchant would, spending the profit which we expect to make in advertising the articles. As to which plan will be most successful in increasing the K. W. connected, we will hardly be in position to know until after January 1st.

A. H. Sikes, Sales Manager, Athens Railway & Electric Co., Athens, Ga., Describes Window Displays Which Have Brought Results.

We have used several window displays recently that have attracted a great deal of attention. One of these has accomplished results which I believe have never before been realized in the South. I refer to the washing machine display shown in Fig. 1. Manufacturers have spent considerable money at times advertising washing machines in the South without appreciable results, due to the fact that they have used the same arguments as in the North, where conditions are not the same. The illustration shows a model laundry on the right, and the interior of a negro cabin on the left. The cabin was arranged in a typical way, being papered with newspapers, dirty, and filled with vermin. Cockroaches were pasted on the glass and stuffed rats placed among the dirty clothes on the floor. At the time this window was used we mailed letters to prospects,

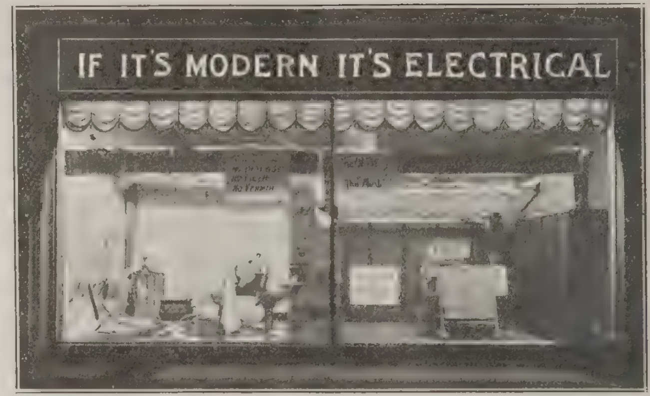


FIG. 1. A WINDOW DISPLAY THAT SOLD WASHING MACHINES.

and published comments from physicians and health inspectors regarding the spread of disease by sending laundry to negroes. We are selling washing machines, which is proof of the success of the campaign.

We have obtained a fair appliance business from the students of the University through the use of a window trimmed up as a college boy's room. This window attracted the students of the University of Georgia at this place. It also attracted the attention of the girls at the Lucy Cobb university, and they asked permission to trim a window themselves, a photograph of which is shown. These windows undoubtedly have attracted more attention than any others in Athens.

During the latter part of November, a representative of a lamp company visited Athens and instructed our salesmen in scientific illumination. It is the writer's opinion that this instruction is going to bring results. The lectures given were delivered before the architects and contractors of Athens, and considerable interest was taken in the subject of lighting layouts. We have appointed a committee to organize an electric club and secure speakers once a month to talk on various subjects.

We are making extensive plans for the holiday trade, depending principally on our window displays and the newspapers for publicity. We are starting our third flat iron campaign of the season. On August 1st of this year 87 per cent of our residence customers had irons and when we dispose of the 150 now on hand, our territory will be practically saturated. We are now planning our Christmas advertising (November 11th) and will have the entire

FIG. 2. A WINDOW SHOWING A COLLEGE GIRL'S ROOM.

FIG. 3. DEMONSTRATION OF ELECTRIC COOKING AS WINDOW DISPLAY AT ATHENS, GA.

campaign made out within the next week, believing that plans for same should be definitely arranged at an early date. The illustrations used for our advertising will be obtained from the General Electric and other manufacturing companies interested in securing Christmas business. We shall endeavor to make our coming holidays electrical ones.

An illustration of a window display used last week (Nov. 10 to 15) is shown in Fig. 3. The J. C. Lysle Milling Company, Jackson, Miss., furnished demonstrations and supplies and cooked a large variety of things in the window on electric utensils and electric ovens. The demonstration brought a great many people in the display room and resulted in good sales for us. The demonstrators stated that the electric ovens were far superior to any others of the various methods they had used. It is the writer's belief that this company will use electric devices in all the towns they demonstrate in hereafter. This scheme is one which central station companies can well take advantage of for it is the best new business "getter" I have yet used.

W. E. Clement, Commercial Agent New Orleans Railway and Light Co., New Orleans, La., Outlines Rental Campaign of Tungsten Pendants.

The renting of tungsten pendants has been successful in ourterritory, as we have something like 3,000 of these pendants on our lines for which we are charging a rental of 30 cents per month covering all sizes from 100 to 250 watts inclusive. The 500 watt pendants we furnish to "free renewal" customers without charge replacing arc lamps on this same basis.

The accompanying illustrations show a copy of the form

APPLICATION FOR MAZDA PENDANT FIXTURES.

To NEW ORLEANS RAILWAY & LIGHT COMPANY,
(N. O. & C. R. R., L. & P. CO.)

(RENTAL BASIS.)

New Orleans,........................191......

The undersigned hereby applies to the NEW ORLEANS RAILWAY & LIGHT CO., (N. O. & C. R. R., L. & P. CO.) for the loan of ....(......) Mazda Pendant Fixtures, same to be installed at........................Street: and hereby agrees to pay for the maintenance $..............per month for a period of..............months.

Regulations and conditions, endorsed hereon, are hereby made a part of this contract.

The NEW ORLEANS RAILWAY & LIGHT CO., (N. O. & C. R. R., L. & P. Co.) agrees to install the enclosed Mazda Pendant Fixtures free of charge, provided the necessary wiring for each Fixture has been done in accordance with the rules and regulations of the Louisiana Fire Prevention Bureau and the City Electrician.

ACCEPTED ....191..
New Orleans Ry. & Light Co.
(N. O. & C. R. R., L. & P. CO.)
By ....

....
Consumer.
By ....

FIG. 1. CONTRACT USED IN RENTING PENDANTS.

of contract which we are using and the type of fixture which we are installing. The arc lamp trimmers in our employ look after cleaning both the outer and inner globes of these pendants, calling at regular intervals and reporting lamps which have turned black. Our regular

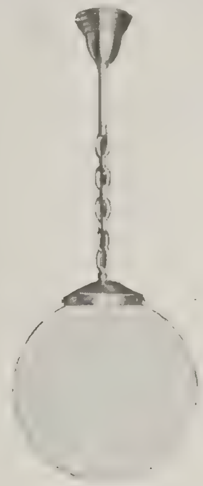


FIG. 2. TYPE OF PENDANT RENTED AT NEW ORLEANS.

trouble department looks after changing burned out lamps upon call, this being taken care of either by the night or day force as the case may be. The pendants under this arrangement are never out more than an hour or two after the office has been notified.

We are much pleased with the progress we have made in this campaign and find practically no trouble in securing business of this kind. After securing the business it develops satisfied customers.

S. H. Alexander, New Business Manager Public Service Electric Co., Newark, N. J., Outlines Methods for Handling Christmas Business.

For the purpose of securing Christmas business this year, we plan to decorate our show rooms and windows with Christmas green, etc., and in the larger offices will display and sell electrical merchandise from specially constructed and decorated booths in show rooms. All merchandise will be wrapped in attractive packages, tied with ribbon and sealed with Christmas seals.

We shall endeavor to suggest to our patrons the advisability of selecting useful gifts this year and by grouping and arranging the appliances attractively with table cooking devices, irons, heaters, etc., in separate places in the show room will enable the salesperson to take care of the customer and talk intelligently on the particular article at his table. Attractiveness of display, the writer believes, will do more toward selling goods than anything else.

We are further considering the advisability of making up three, four or five articles in sets at a price lower than the entire number of articles could be bought for separately. While the profit will be cut somewhat with this method, it will create larger appliance sales and we think catch the eye of the bargain hunter. Our main object during the holiday season will be to attract people into our show rooms, by beautiful windows and the sending of literature to customers. After we get them in, we shall courteously tempt them by our various displays of useful appliances grouped and arranged in such a way, with proper surroundings, that it will be next to impossible for them to leave without purchasing something. We shall keep show rooms open evenings during the month of December.

Arthur Williams, General Inspector, New York Edison Co., New York City, Outlines Christmas Policy of New York Company.

We shall no doubt follow essentially the same lines of advertising that we have done in former years during Christmas time, that is a half page advertisement in all of the daily papers of New York, giving suggestions about different electrical apparatus appropriate for Christmas gifts as well as a list of manufacturers and agents from whom such devices can be bought.

We will also send out folders with bills, offering suggestions in regard to electrical devices for presents. We shall also place Christmas trees in our district offices illuminated with miniature bulbs and electrical presents on them.

W. L. Southwell, Commercial Engineer Macon Railway and Light Company, Macon, Ga., Writes:

During the Christmas holidays I expect to open up an electric shop in the shopping district of Macon and display electric heating and other devices, giving demonstrations of cooking, etc. This shop will be fitted up attractively and serve as a rest room for shoppers during the holidays.

E. S. Roberts, Commercial Agent Savannah Electric Co., Savannah, Ga., Describes a Demonstration at a Local Fair.

We have just closed a week's exhibit (November 8th) at a demonstration fair at which we used a booth and demonstrated appliances of all kinds. Meters were used to show the consumption of each device. Various sizes and types of tungsten lamps were also shown and plenty of literature given away that should interest a prospective customer. This demonstration has done considerable good besides making possible numbers of sales of appliances.

During November we plan to make our show windows attractive and with the December 1st bill, will send out folders calling the attention of our customers to electrical appliances suitable for Christmas presents. We shall continue our window displays backed by newspaper advertising during December.

Growth of Business of Mobile Electric Co., Mobile, Ala.

The Mobile Electric Company has made an increase of 157 per cent in output of electrical energy since the management of the property was assumed by H. M. Byllesby & Company in 1906. This has been accomplished with an approximate increase of only 18 per cent in population served and an increase of 53 per cent in number of customers. The company was organized in May, 1906, combining two electric companies which were formerly engaged in competition.

When the management was assumed by H. M. Byllesby & Co., the output of the combined companies was averaging 84,000 kilowatt hours weekly. For the week ending November 15, 1913, it was 216,218 kilowatt hours. The combined load of the two properties at the time they were merged, as compared with the connected load of the Mobile Electric Company on September 30, 1913, is shown below:

	May 1906	Sept 1913	Inc.	Percent Increase
Number Customers	4,293	6,595	2,302	53.6%
Kilowatts Lighting Load Connected	4,126	8,397	4,271	103. %
H. P. Motor Load Connected	1,100	4,522	3,422	311. %
Total Kw. all Purposes Connected	4,946	11,771	6,825	137. %
Miles of Pole Line	107	136	29	27. %

During the past year the company has installed new coal and ash handling machinery of the latest type in the power house, which has enabled a reduction in the operating force and produced better coal economy. This has decreased operating expenses materially and the increase in net earnings has been greater proportionately than the increase in gross earnings.

Mobile is destined to be a gulf port of increasing importance. It is situated slightly closer to the Panama Canal than New Orleans and has the advantage of a better, safer route. The United States government has spent millions of dollars in improvements to the harbor and is spending large sums of additional capital in increasing the depth of the channel to admit large vessels. The Mobile river together with its tributary rivers, the Alabama, Tombigbee, Warrior, Cahaba, Coosa and Talapoosa comprise 2,000 miles of navigable streams and form one of the largest systems of navigable waterways in the United States.

All Byllesby electric properties, according to reports for the first week of November, showed net gains in connected load of 476 customers with 327 kilowatts lighting capacity and 1,458 horsepower in motors. New business contracted for, but not connected included 1,062 customers with 1,550 kilowatts lighting capacity and 603 horsepower in motors. The output of these properties at this date was 7,481,596 kilowatt hours, a gain of 14.5 per cent over the corresponding date of 1912.

T. W. Peters, Commercial Agent of Columbus Railroad Company, Columbus, Ga., Installs Attractive Sign.

The commercial activity of the Columbus Railroad Company, and the results secured by T. W. Peters, commercial agent and president of the Southeastern Section of N. E. L. A., has received comment in these columns at various times. To one visiting Columbus, it appears that the company has a decidedly diversified load and a good share of the possible business, yet every once and sometimes twice in a while, a considerable new load is secured—the result of a demand created by good commercial methods. Mr. Peters has recently installed a spectacular sign of no small size shown in Fig. 1.

This sign was sold to the Chero-Cola Company, of Columbus, and is 40 feet square containing 1,000 lamps. The sign is operated to show a bottle of Chero-Cola being emptied into a glass and frothing over in a very realistic manner. The slogan "There's None So Good" then flashes on with the name and a big five cent mark.

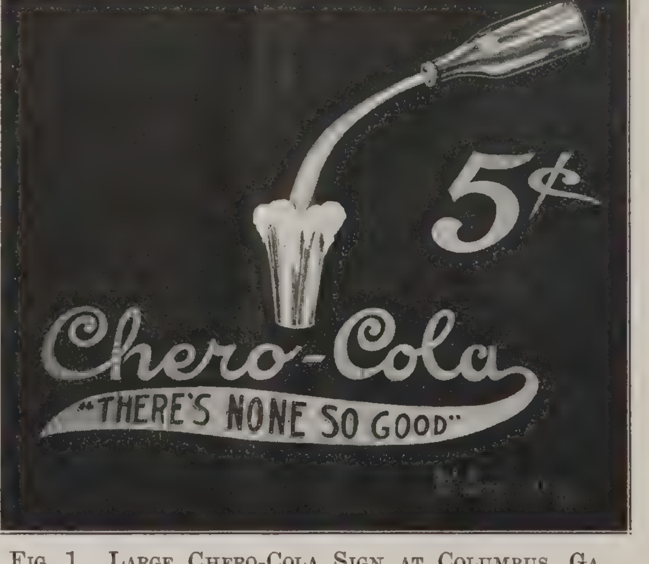


FIG. 1. LARGE CHERO-COLA SIGN AT COLUMBUS, GA.

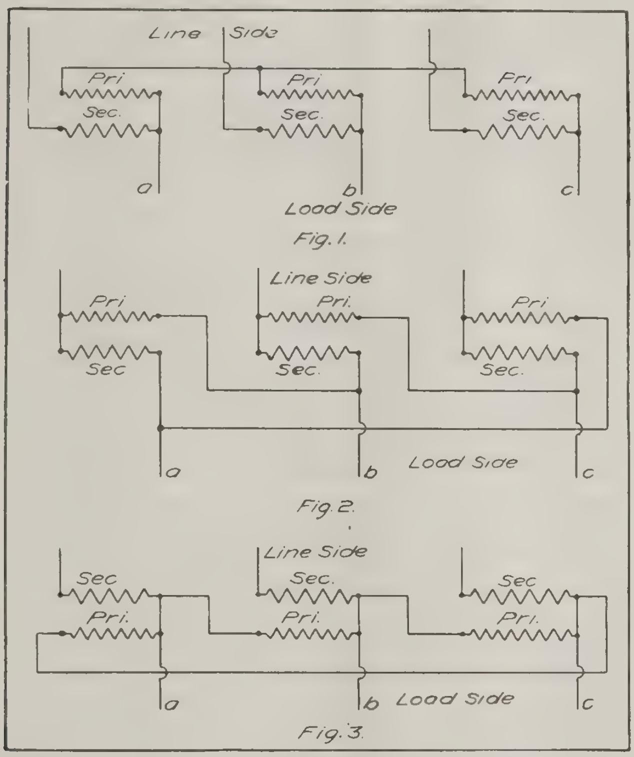
Questions and Answers from Readers

Readers are invited to make liberal use of this department for discussing questions, obtaining information, opinions or experiences from other readers. Discussions and criticisms on answers to questions are solicited. However, editors are not responsible for correctness of statements of opinion or fact in discussions. All published answers and discussions are paid for.

VOLTAGES SECURED BY CONNECTING 3-PHASE TRANSFORMER FOR OPERATION AS AN AUTO-TRANSFORMER.

Editor Electrical Engineering:

(415) Kindly publish a method or formula for calculating the voltages, *a-b*, *b-c* and *a-c* for each of the arrangements shown in Figs. 1, 2 and 3. Three standard 3-phase transformers are used. L. C. J.



FIGS. 1, 2 AND 3. CONNECTIONS OF 3-PHASE TRANSFORMERS FOR OPERATION AS AUTO-TRANSFORMERS.

COSTS FOR A. C. AND D. C. SYSTEMS.

Editor Electrical Engineering:

(416) Please furnish information or data comparing the cost of installation, losses in transmission and operation of alternating current and direct current systems for general power and traction purposes. S. M. J.

CUTTING OUT COILS OF D. C. GENERATORS.

Editor Electrical Engineering:

(417) The writer would like some reader to explain what effect the cutting out and bridging of one armature coil would have on the action of a multipolar, 500-volt D. C. generator with lap-wound armature. Also, give some rule or other information for determining how many coils can be safely cut out of a generator or motor in case of an emergency. Some electricians claim that a generator can not be run with any coils out of the armature, but the writer has known of motors being operated with several coils cut out. The question is how far can this be carried and what is the effect? C. A. H.

HOW CAN DUST BE TAKEN OUT OF COOLING AIR FOR TURBINE?

Editor Electrical Engineering:

(418) I would like to know how to construct a suitable screen or other means to exclude dust from entering the cold air duct which conveys cooling air to the generator of a Curtis turbine. We have to contend with saw dust, cinders of wood and ashes. F. T. Heins.

CHANGING 220 VOLT A. C. MOTOR TO 110 VOLT.

Editor Electrical Engineering:

(419) Please advise how to change a 220 volt A. C. motor to a 110 volt A. C. motor of same speed and horsepower. W. A. C.

RATE FOR SELLING LIVE STEAM.

Editor Electrical Engineering:

(420) We desire to supply a laundry with live steam at 100 pounds pressure for use in mangles and ironers. Our plant is two blocks from the laundry, and of 300 Kw capacity, coal costs about $2.00. Please show a method of calculating a rate of charge for the steam service. If any rates are known for such service, give same and the method most economical and satisfactory to measure the steam supplied. W. A. T.

LIGHT ABSORPTION OF GLASSWARE.

Editor Electrical Engineering:

(421) What per centage of the total light of an incandescent unit is absorbed by enclosing glass globes such as used in ornamental street lighting. State for density of glassware that is such that the filament of a 100-watt lamp cannot be seen 14 feet from level of street. H. E. R.

Antidote for Coughing in Storage Battery Room.

Editor Electrical Engineering:

(422) The writer would like to secure information on the subject of tuberculosis of the lungs as produced by poisonous gases. A friend here (Southern India) is ill in a hospital with this trouble and I desire information for the benefit of other operators. What antidotes if any should be used when a fit of coughing comes on during the process of charging lead storage batteries. I dare say that managers of large stations using storage batteries in America can give vital information. If there are any books or pamphlets on the subject, please suggest names of publishers with addresses. E. J. Lopez, Indian Government, Telegraph Dept., Southern India.

Electrolysis from Alternating Current. Ans. Ques. No. 372, by Mr. Bliley.

Editor Electrical Engineering:

The subject of electrolysis from alternating current has been given some study and discussion before the American Institute of Electrical Engineers and the decision reached as stated by Mr. Bliley, that there is electrolytic action from alternating current which, however, is much less in extent than with direct current. In the A. I. E. E. transactions for 1907, Mr. J. L. R. Hayden, of the General Electric Company, states that alternating current electrolysis is not a phenomenon like direct current electrolysis, but is of the character of a secondary effect. That is, the action of the positive half wave is not quite reversed by the action of the negative half wave, leaving a small difference, rarely exceeding one-half of one per cent of the electrolytic action of an equal direct current. He says further that alternating current electrolysis varies from practically nothing to somewhat less than one per cent of the direct current electrolysis, varying with the chemical nature of the electrolyte and practically independent of the current density. A protection from alternating current electrolysis, Mr. Hayden states, may be absolutely obtained by the superimposing of a small quantity of direct current upon the alternating, the amount of the current being only 1.5 per cent of the alternating current.

A committee on electrolysis was appointed by the American Electric Railway Association in January of this year, and a report rendered at the recent Atlantic City convention covering the corrosion of underground conductors and giving considerable data. An investigation on the subject of electrolysis is also being carried on by the United States Bureau of Standards, under the direction of the government, and it is expected that much valuable data and information will soon be available. W. E. White. (N. Y.)

Meaning of Term Phasing-in. Ans. Ques. No. 397.

Editor Electrical Engineering:

The term "phasing-in" simply means getting into phase. It may refer either to the connection of two A. C. generators or to connecting a synchronous motor or a converter in service. In Fig. 1, two sine curves are shown that may represent the emfs of two A. C. generators. If connection should be made between these at some point *X* or *Y* for instance, there would be a rush of current set up due to the difference in potential between the machines, but if

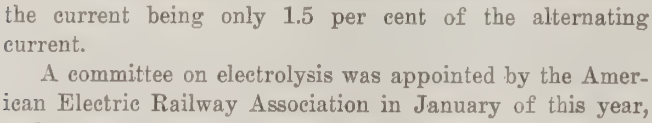


Fig. 1. Diagram Showing Voltage Relations When Phasing-In a Machine.

connection is made at the point *Z* at a time when the two machines are generating the same voltage, and are running at nearly the same speed, there will be no such rush of current, and they will tend thereafter to keep in phase. This operation is termed synchronizing and the proper moment for throwing the machines together is determined either by means of a lamp which alternately shows up bright or dim according to the phase displacement, or by means of a synchroscope, an instrument which shows by the position of its pointer, the phase relationship of two circuits, and also by the rotation of the pointer the amount of difference in frequency between the circuits.

The Refillable Fuse. Ans. Ques. No. 398.

The principal objection so far made against the use of the refillable fuse seems to be in the uncertainty and possibility of reproducing the original condition of manufacture. Theoretically it would seem an easy thing for anyone with intelligence to refill certain types of fuse and secure dependable results, but in practice it is found that so many different conditions affect the fusing point of the metals employed, as to render refilling impracticable. In the days when fuse wire was permitted, it became a common practice to over fuse circuits. In spite of repeated instructions, warnings and trouble, employes could not be depended upon to properly re-fuse a circuit. The introduction of the enclosed fuse came about as a result of efforts to compel some kind of uniformity in fusing of circuits. Now if refilling fuses is allowed, we will have, although not perhaps to as great an extent, a return to the slipshod methods in use before enclosed fuses came into use. No doubt, there are many operators who would conscientiously refill fuses with wire of the proper size and reproduce as nearly as possible the original conditions, but it is quite possible that in the many cases a cartridge fuse marked at say 5 amperes, might contain almost anything in the way of fuse wire. Therefore, the Board of Fire Underwriters has considered it preferable to limit the refilling of fuses entirely to the manufacturers of them.

Testing Out Sign Wiring. Ans. Ques. No. 400.

The burned-out branch can be readily located by starting on one end of the sign and taking out every sixth or eighth lamp, and inserting in its place a short-circuiting plug. As soon as the bad circuit is reached, all of the other lamps in the sign will light, while the burned-out branch will, of course, remain dark.

Meter Connections on 3-Phase, 4-Wire Systems. Ans. Ques. No. 402.

It is true that the four-wire, three-phase system requires more meters than the three-wire. In the second case each circuit requires two meters, while in the first case it requires three meters. However, the increased cost of meters would not appear to be the principal factor in determining the choice of distribution systems as the three-wire circuit with delta connections has other advantages.

Changing Series Arc to Series Tungsten System. Ans. Ques. No. 403.

Any series arc system can use series tungsten lamps, or can be used entirely for tungsten lamps, provided the current required is the same as used by the arc lights. In this case it will be necessary to use 6.6 ampere tungsten lamps. These come in different sizes from 32 to 350 candlepower, each one taking from 5.7 to 62.6 volts. The number, of course, which can be accommodated on one circuit is such that the total voltage required shall not exceed the capacity of the machine. If the present machine has been supplying, say, 50 arc lamps, estimating the voltage at 80 volts per lamp, the total would be 4,000 volts, therefore neglecting drop in the conductors such a machine would supply 110 of the 200 candlepower lamps or 220 of the 100 candlepower or 375 of the 60 candlepower, etc. It is only necessary to add the voltage of the individual lamps together plus the drop in the conductor, to obtain the total voltage necessary at the terminals of the machine.

A. G. Rakestraw.

The Present Fuse Situation, Referring to Article by Mr. McIntosh and Answer to Ques. No. 398.

Editor Electrical Engineering:

Mr. McIntosh, in an article in the November issue of *Electrical Engineering*, entitled, "Essential Features of the Present Fuse Situation," discusses the fuse situation appropriately, especially as regards plant operators. In the last three sentences of his article he says much in few words. Let us realize a speedy decision in line with his suggestions.

The writer is at a loss to understand why the refillable type of fuse shell, as now manufactured and sold, is not approved by the underwriters when properly used. The argument that it will be abused is not strong if not absurd, in those cases where electrical installations are in charge of an electrical engineer, as all systems of any consequence are today. Again, the argument that the fuse element cannot be properly replaced does not seem consistent with the simple features of such an operation. If an electrician is capable of selecting the proper size of non-refillable shell, he must be credited likewise with an ability to select a proper size of fuse wire for refilling the refillable type of fuse shell, when all that is left for him to do is to insert it and adjust for proper contact—work no more intricate than many other operations the ordinary electrician daily performs which the underwriters pass as good and free from fire hazard. Over-fusing seems to the writer, the only logical argument against this type of fuse, an argument which also holds good with the non-refillable fuse, for what is to prevent soldering a fuse wire on the shell of the ordinary non-refillable fuse to increase its capacity? It is to be noted further that there is a tendency to have on hand a spool of fuse wire for use when cartridge non-refillable fuses fail, and the writer asks if the miscellaneous use of such fuse wire does not increase the fire hazard much more than the use of the refillable fuse under any circumstances?

The writer believes, as stated, that the situation in the larger plants needs no comment, as such are in charge of competent electrical engineers who follow good practice in regard to operating conditions, and are capable of making sure that fuses are properly used. In the smaller plants, with conditions as they are and non-refillable fuses used with the tendency to liberally use fuse wire and copper wire through lack of an everlasting supply of standard fuses, certainly conditions could not be worse with the use of the refillable fuse under greatest abuse when in many hundreds of cases where they are properly used a large economy would be made possible. Can we not logically accuse the underwriters of prejudice in favor of the non-refillable fuse and to blame entirely for the present situation? The writer uses refillable fuses and intends to continue to do so until something better is produced.

John C. Kahl (Ky.)

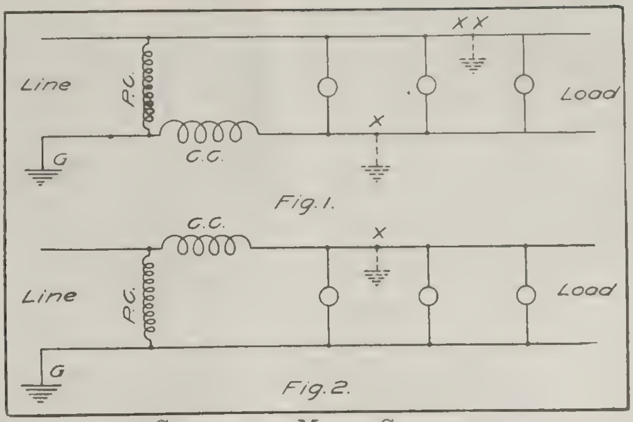
Meter Connections With Transformer Secondary Grounded. Ans. Ques. No. 404.

Editor Electrical Engineering:

In the diagrams of Figs. 1 and 2, 2-wire watthour meters with the current coil connected in the grounded and undergrounded sides, are shown. The notation *P C* is for the potential coil, *C C* the current or series coil, *G* the permanent ground at the transformer and *X* the partial ground or the ground inside the house.

In Fig. 1 two circuits are shown in multiple *i. e.*, "*G-CC-X*" and "G-earth X," therefore, part of the current will pass through *C C* and part through the ground, since when two circuits are connected in multiple, each will carry a part of the current. A ground on the other wire would not have any effect upon the meter, but there would be a loss of energy, as a partial ground at *X X* would be a partial short and would consume energy.

In Fig. 2 all of the current must pass through *C C*. If there is a partial ground as at *X* it will consume energy as it is a partial short, and this energy will be measured by the meter. The consumer is thus liable to complain



GROUNDS ON METER CIRCUIT.

about the size of the bill and that the meter is "creeping." This "creeping" would, however, cease as soon as the load wires were removed from the meter. A ground on the other wire would have no effect whatever upon the meter since there would be no difference of potential between this wire and the ground. G. J. Kilburz (Ill.)

Meter Connections With Transformer Secondary Grounded. Ans. Ques. No. 404.

Editor Electrical Engineering:

In answer to question 404 in the October issue, would state that the ungrounded wire should be connected to the series coils of the house-meter. If a ground occurs in the house circuit, it will register on the meter, which is correct. If the grounded wire is connected to the series coils and a ground should occur in the house circuit, it will not register on the meter. Also a consumer may use current from the outside wire to ground without paying for it.

Paul F. Quinlan, Jr. (Pa.)

Meter Connections With Transformer Secondary Grounded. Ans. Ques. No. 404.

Editor Electrical Engineering:

As stated in question No. 404, the current coil of the house meter should always be connected to the ungrounded side of the circuit when one side of the transformer secondary is grounded. When so connected slight grounds on the high side of the circuit will be indicated by the fact that the meter will continue to register when no energy is being used, for the leakage current must flow through the coil. Grounds on the low potential side will, of course, not affect the indications of the meter. If the series coil is connected to the grounded wire a ground on that wire on the house side of the meter will act as a shunt around the coil and the meter either will not operate or will indicate only a portion of the energy consumed by the installation. Grounds on the high side will, of course, not be indicated, because the leakage current does not flow through the current coil.

Fusing Capacity of Wire. Ans. Ques. No. 405.

In answer to question No. 405, I give below the formula for the fusing effects of electric currents given by W. H. Preece, in the March 15, 1888, Proceedings of the Royal Society of London, as $I = a\sqrt{d^3}$; where I is the current; (a) a constant which is different for different metals; and (d) the diameter of the wire. If (d) is measured in inches (a) = 10244 for copper, 7585 for aluminum; 3148 for iron; and 1379 for lead. A simpler way is to use a table such as that given on page 217 of Foster's Electrical Engineers' Pocket Book, from which the above information was taken.

F. E. Volk (Wis.)

Fusing Capacity of Wire. Ans. Ques. No. 405.

Editor Electrical Engineering:

It is probable that H. E. F., in his question in the October issue, desires to know the sizes of copper wire that can be used to replace fuses that may be blown when regular fuse wire or new fuses are not at hand. For this purpose I give here the fusing current for the sizes of wire that will be most often used:

Size Wire B & S	Fusing Amps.	Size Wire B & S	Fusing Amps.
10	330	22	40
12	240	24	30
14	160	26	20
16	120	28	15
18	80	30	10
20	60		

H. H. Williams (Ala.)

Fusing Current for Wire. Ans. Ques. No. 405.

Editor Electrical Engineering:

In the October issue, H. E. F. asks for a formula for calculating the fusing current of copper wire. The following formula was determined by W. H. Preece, and is found in all reliable handbooks:

$$I = A\sqrt{d^3}.$$

This formula is used in the calculation of fuses and the wire for rheostats used with forced cooling, such as coils of iron wire resistance submerged in running water for testing machines. In the formula, I is the current required to fuse the wire; d is the diameter of the wire and A constant, which for copper wire is 10,244, for iron wire 3,148, and for lead 1379.

As an example, take No. 12 copper wire, which has a diameter of 0.0808 inch. Then, $I = 10{,}244 \times \sqrt{(.0808)^3} = 10{,}244 \times .02298 = 235.4$ amperes. By substituting the constant for iron and lead, the amperage for wire of these materials is found. The following table gives values of fusing current for other sizes of copper wire found by use of this formula:

B & S Gauge	Diameter in Inches	$\sqrt{d^3}$	Fusing Current
20	.0320	.00571	58.5
18	.0403	.00809	82.8
16	.0508	.01145	117.3
14	.0641	.01622	166.1
12	.0808	.02298	235.4
10	.1020	.03254	333.3
8	.1280	.04620	473.2
4	.2040	.09240	946.5
2	.2580	.13060	1337.8
0	.3250	.18520	1897.1

R. L. Mossman (Ga.)

Fusing Current for Wire. Ans. Ques. No. 405.

Editor Electrical Engineering:

In answer to question No. 405 in regard to fusion of copper wire, will give a formula and some checks of same, conducted at the Carnegie School of Technology. This formula can be found on page 217 of the last edition of Foster's Electrical Engineers' Hand Book, and in various wire books published by wire manufacturers. It is $I = a\,(D)^n$ where a is a constant depending on the wire and n is 3/2. For copper wire, a is 10244, therefore the formula for copper wire will be, I or the fusing current equals 10244 times diameter to the 3/2 power.

The following data will illustrate this formula and show how to plot a curve of other values:

Number of Wire	28	24	20	18	16
Diam. in Mils	12.64	20.10	31.96	40.30	50.82
Fusing Current	15.5	26.0	50.0	71.5	102.5
Log of Current	1.190	1.415	1.699	1.854	2.012
Log of D (Mils)	1.1	1.3	1.5	1.6	1.7

$I = a\sqrt{D^3}$.

$\text{Log } I = \text{Log } a + 3/2 \text{ Log } D$.

From the above data, plot a curve and you will always find the log curve to be a straight line with a slope always 3/2.

J. C. Moore (Pa.)

Size of Wire for Motor Circuit. Ans. Ques. No. 406.

Editor Electrical Engineering;

In calculating the size of wire for a motor load, the determining factors are, amount of current to be transmitted, distance of transmission, and allowable drop in potential for that distance. This is for direct current work. For alternating current transmission, power factor, induction, etc., have to be considered. With the load, voltage and distance stated in the question, induction would be negligible.

The underwriters' rules say that no wire smaller than No. 8 shall be used outside on poles, and No. 14 the smallest for inside power work. Considering the example in the question, and assuming the circuit to be 3-phase, the 10-horsepower motors will take 25 amperes each, and the 5-horsepower 15 amperes, making a total of 65 amperes.

The formula: $(D\ 21\ I) \div v = $ C. M. can be used, where D = distance; I = current; 21 = a constant and v = voltage drop.

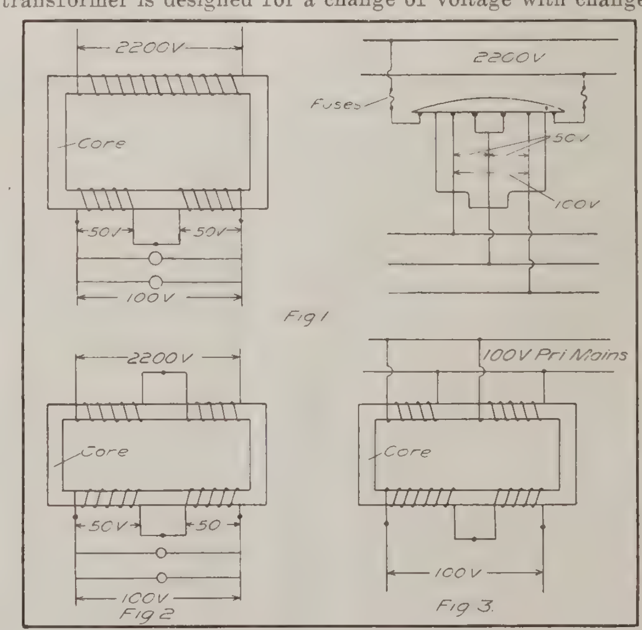
Allowing 5 volts drop and substituting the values, we have: $(200 \times 21 \times 65) \div 5 = 54{,}600$ C. M. Thus, No. 2 wire of 66,370 C. M. is the choice.

G. I. Morgan (Mass.)

Transformer Connections for Different Voltages. Ans. Ques. No. 408.

Editor Electrical Engineering:

In reply to H. A. D. in the October issue, unless a transformer is designed for a change of voltage with change



Figs. 1, 2, and 3. Connections of Transformers for Different Voltages.

of connections, this cannot be done. Some transformers are built as shown in Fig. 1, and the voltages indicated can be secured from same as shown. I have taken 2,200 volts for the sake of simplicity, but a transformer like this one can be bought for almost any voltage. Some transformers are built with both primary and secondary in two sections so they may be connected in series for high voltage and in parallel for low voltage, as shown in Figs. 2 and 3.

Single-phase can be secured from three-phase (three wire) by taking a tap off any two of the wires, but two-phase can be secured from three-phase and vice versa, only by the use of a special arrangement of transformers de-

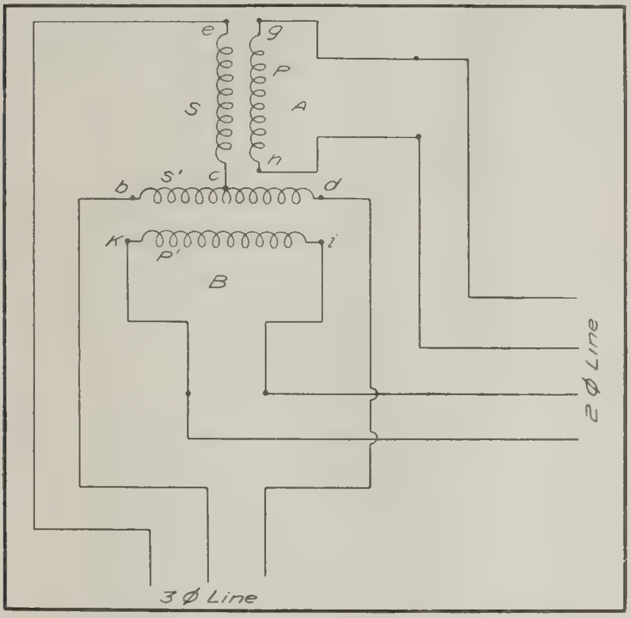


FIG. 4. THREE-PHASE TO TWO-PHASE CONNECTIONS.

vised by Mr. C. F. Scott. Fig. 4 shows the connections necessary. Two transformers *A* and *B* have their primary coils *P* and *P'* connected to the two-phase mains as shown. The secondary *S* of transformer *A* has 87 times as many turns as the secondary *S'* of transformer *B*. One end of *S* is connected to the middle point c of *S'* and the three-phase lines attached to the terminals *e. b. d.* If three-phase lines were connected to *e. b. d.*, the current would be converted and delivered as two-phase to the lines *g. h.* and *i. k.*

Theodore W. Bisland (Miss.)

Transformer Connections for Different Voltages. Ans. Ques. No. 408.

Editor Electrical Engineering:

In answer to this question we will assume particular cases and give the connections for the different voltages secured. Suppose it is desired to transform 2,080 volts, two-phase to 230 volts, three-phase, for operating a 10-horsepower, 3-phase, 230-volt motor. This can be done by

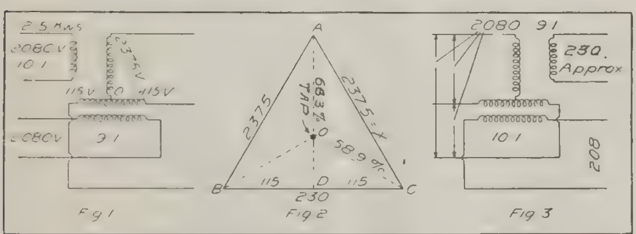
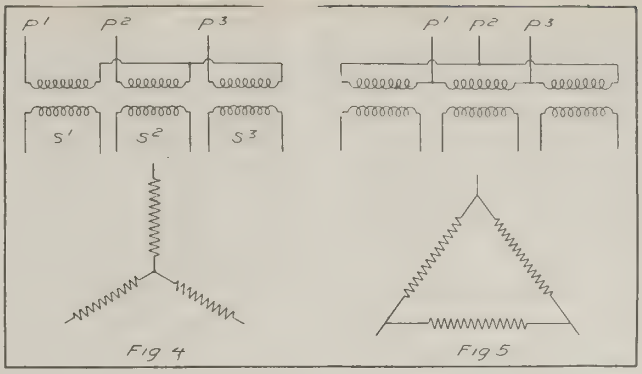


FIG. 1. CONNECTIONS FOR 2-PHASE TO 3-PHASE TRANSFORMATION. FIG. 2. VOLTAGE RELATIONS. FIG. 3. CONNECTIONS FOR 3-PHASE TO 2-PHASE TRANSFORMATION.



FIGS. 4 AND 5. STAR AND DELTA CONNECTIONS.

using two standard transformers of different ratios as 10 to 1.0 and 9 to 1.0 with the connections as shown in Fig. 1. It will be noted, as shown in Fig. 2, that the 3-phase voltages are not exactly equal, due to the fact that to accomplish this, ratios of 10 to 1.0 and 8.66 to 1.0 should be used. The arrangement using a transformer of 9 to 1.0, instead of 8.66 to 1.0, works satisfactorily for motor operation. The location of the neutral point for the 3-phase side of this connection is shown in Fig. 2, and arrived at as follows:

$OC = AD - OD$ and also $OC = \sqrt{[(DC)^2 + (OD)^2}$ or $(AD - OD)^2 = (DC)^2 + (OD)^2$ and $(AD)^2 - 2\ AD \times OD + (OD)^2 = (DC)^2 + (OD)^2$ or $(AD)^2 - 2\ AD \times OD = (DC)^2$.

Substituting percentage values of AD and DC as follows: $AD = 285 \div 237.5 = 87.5$ per cent, and $DC = 115 \div 230 = 50$ per cent, we have the following:

$7656 - 175 \times OD = 2500$ or $OD = 29.5$ per cent. Then, $OC = \sqrt{[(OD)^2 + (DC)^2} = \sqrt{[(29.5)^2 + (50)^2} = 58$ per cent. Thus the location of the point *O* on the winding AD is found thus: $87.5 : 29.5 = 100 : X$ or $X = 33.7$ or 66.3 per cent tap on the winding AD. For the neutral point with a transformer of 8.66 to 1.0 ratio instead of 9 to 1.0, the neutral tap is provided at a 57.8 per cent point.

The load carried by each transformer is found as follows: The capacity of 2—5 Kw. transformers on the 3-phase side is represented by $\sqrt{3}$ EI, that is, 10,000 watts $= \sqrt{3}$ EI. Since $E = 237.5$ volts, then the line amperage or

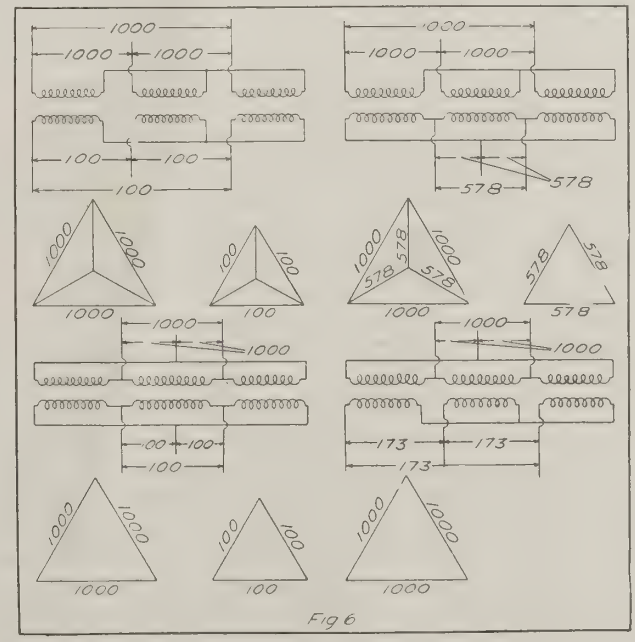


FIG. 6. VARIATIONS OF STAR AND DELTA CONNECTIONS.

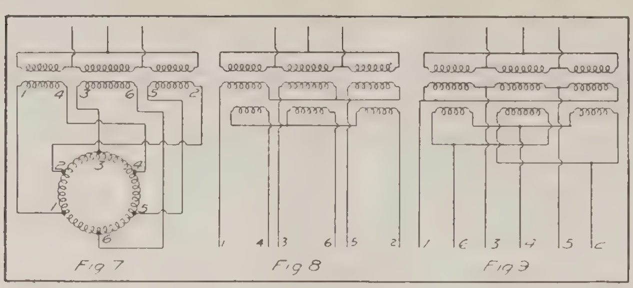


Fig. 7. Six-Phase Diametrical Connections.

I is equal to 10,000 ÷ $\sqrt{3} \times 237.5 = I = 24.4$ amperes. For the transformer with 10 to 1 ratio the rating would be $208 \times 24.4 = 5075$ volt-amperes, and for the transformer of 9 to 1.0 ratio, $230 \times 237.5 = 5475$ volt-amperes.

Transformers for 3-phase work are usually connected in two ways where three transformers are used, namely, in *Y* or star or in delta. In the *Y* connection one terminal of each primary is brought out to a common point and the other terminals connected to the line as shown in Fig. 4. In the delta connection, the three primaries are connected in series and the line wires connected to the corners of the triangle, as shown in Fig. 5. In these arrangements the secondaries may be connected in *Y* the same as the primaries or in delta and *vice versa,* as the voltages required may demand, the voltage relations being shown in Fig. 6.

Six-phase connections are obtained from three-phases for use with rotary converters by the use of transformers having two secondary windings and connected as shown in Figs. 8 and 9. These connections can also be secured by bringing out both ends of secondary windings of three ordinary transformers and connecting to opposite points on the rotary converter winding, as shown in Fig. 7. These are known as diametrical connections.

W. J. Taylor (Mich.)

Electrolysis of Water Lines at Trenton, New Jersey.

Editor Electrical Engineering:

The rapid deterioration and destruction of underground water lines and service pipes in streets traversed by traction lines at Trenton, has resulted in a series of recent investigations by the water department to accurately locate the cause and seat of trouble. These tests were made under the direction of Professor Albert F. Ganz, M. E., of Stevens Institute, primarily on North Clinton avenue and Perry street, where marked evidences of erosion have been noted. The tests were conducted for continuous twenty-four hour periods, measurements being taken of the potential difference between the water lines and rails at intermediate points along the thoroughfares. Measuring the current on the former during such period, it has been found that such was not noticeable during the early hours of the morning when cars were not in operation, conclusively showing that the issue rests with the traction lines.

The Trenton traction system comprises the general overhead feed line to the car, the circuit to the power station being completed through the running tracks, occasionally supplemented by return feeders. Such system, Professor Ganz states, would not bring about a condition of electrolysis on neighboring underground metallic lines if the tracks were laid on wooden ties above ground with broken stone ballast, similarly as employed by steam railroads and many interurban lines. In this case, however, the rails are necessarily laid in direct contact with the soil for extended areas, thus tending towards the usual effect of the electric energy in the return through the rails shunting to the surrounding soil, with a later return to the rails in the vicinity of the power station.

Professor Ganz in his report says, in part: "Since every electric circuit must be completely closed, all current escaping through the ground must again leave ground to return to the dynamo so as to complete the electric circuit. Where underground metallic structures, such as gas or water pipes, lie in the ground in the path of these stray currents, and where these pipes have electrically conducting joints, such as lead-calked joints or screw-coupling joints, current will flow from ground to such pipes, and flow largely on the pipes in a direction towards the power plant.

"If the negative terminal of the generator is connected to the rails at other points than at the power station, by means of negative return feeders, then at such connection points the rails will be rendered negative in potential to ground, and currents will tend to flow from underground pipes through ground to return to the rails in the neighborhood of these connections. Stray railway currents on pipes will, therefore, tend to leave these pipes to return to the rails in all regions where these rails are connected to return feeders.

"The leaking of current from the rails of electric railways, producing stray currents through ground and on underground piping, does not constitute a source of loss to the railway company, as for instance would be the case with leakage of gas or water. On the contrary, by allowing the current to return by ground or underground pipes as well as by the rails, the total conductivity of the return current is increased, and the voltage loss in return of this current is decreased, so that there is an actual saving of power for the railway company.

"Where stray currents flow on underground pipes they do no harm except wehere they leave the pipes to flow to the surrounding soil. At such points corrosion of the iron from electrolysis will take place, and theoretically there will be a loss of twenty pounds of iron per year for every ampere of electric current leaving the iron. The corrosion actually produced is at least equal to, and frequently greater, than the theoretical amount."

Referring to the situation at Trenton, Professor Ganz notes that it will be impossible to entirely eliminate electrolysis of the underground lines in question, but by the addition of a sufficient number of copper wires to take the current from the rails back to the power house, it can be reduced to a minimum. With such system properly worked out, the corrosion from electrolysis should not be faster than the ordinary corrosion from natural causes, making it negligible.

L. R. W. A. (N. J.)

Success.

Success depends on yourself, and nothing will influence your personal action, your individual effort, more than that of your associates, the men who surround you.

Success is contagious, and you cannot contract success unless you are where it is.

Keep pushing, driving, forcing your way to the front. Keep away from the unsuccessful, the indifferent.

Mix with men who think and act. Listen to leaders, step out of the crowd, and get in the atmosphere of result-getters.

New Apparatus and Appliances

The Draeger Pulmotor.

Remarkable success has accompanied the use of the pulmotor in cases of electric shock, drowning and asphyxiation. Numbers of central station companies are using this pulmotor with the result that the record of lives saved from electric shock is increasing daily. The nature and operation of the device is described in what follows.

The assembled device is shown in Fig. 1, arranged to be easily carried in a suitable case, as shown in Fig. 1, it is being reversed by hand which is necessary only when the automatic operation fails for any reason. This case contains two separate pieces of apparatus, an oxygen inhalation appartus for ordinary oxygen inhalation mounted on

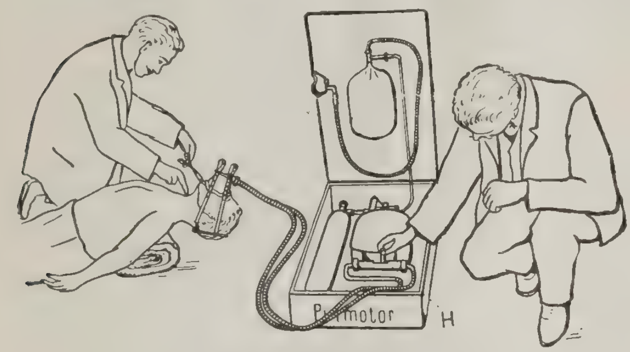


FIG. 1. THE PULMOTOR IN OPERATION.

the lid and a special apparatus for artificial respiration in the case itself. The two apparatus have in common an oxygen cylinder *C*, shown in Fig. 2, and a pressure reducing valve *D*, and either can be operated singly through use of a suitable lever at *U*. The oxygen passes from the reducing valve to an injector *S*, which draws in a large volume of air and propels this air through the flexible tube in front of the injector. This suction and delivery injector acts as a motor, alternately filling the lungs by pressure and emptying them by suction without injury to the lung tissue. With a full cylinder of oxygen the pulmotor for artificial respiration will continue in operation for 40 minutes in succession.

The apparatus reverses from suction and delivery, and vice versa, automatically through the action of the bellows at *M*. The respiratory rythm of the apparatus adopts itself automatically to the capacity of the lungs in every case, being slower when the lungs are capacious and faster when of smaller dimensions. The pulmotor is manufactured by the Draeger Oxygen Apparatus Company, 422 First avenue, Pittsburgh, Pa.

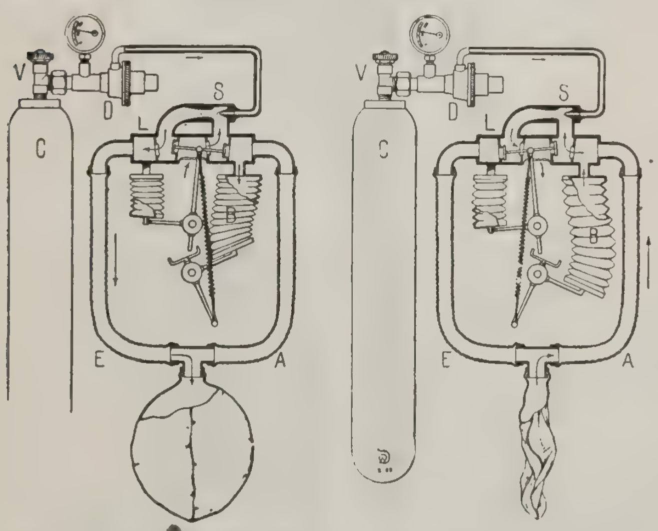
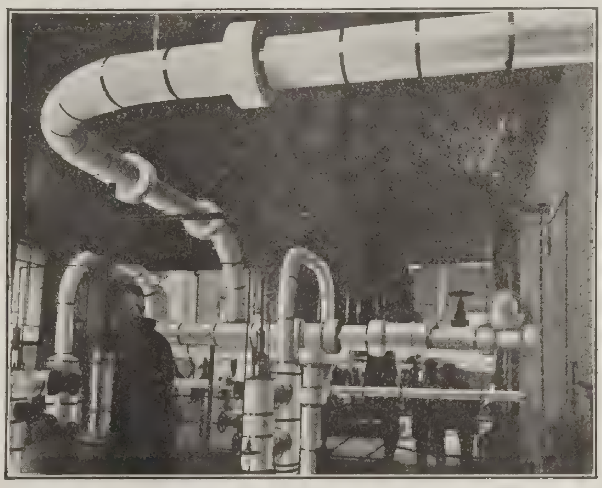


FIG. 2. DIAGRAMS SHOWING THE ACTION OF THE PULMOTOR.

Tests on Asbesto Sponge Felted Pipe Covering.

A series of tests on pipe covering and insulating material conducted by Mr. John Lloyd, of Middletown, Ohio, extending over a period of several months, has resulted in the selection of "Asbesto-Sponge Felted" pipe and boiler covering. By use of this material the condensation was reduced 76 pounds per hour. The efficiency of this pipe covering is accounted for by the millions of "dead air" cells it contains. Recent tests made by Prof. C. L. Norton, of the Massachusetts Institute of Technology, show that the yearly cost of maintaining 100 square feet of pipe at 100 pounds gage pressure is, for bare pipes, $225; for 1-inch moulded insulation, $35.90; and for 1-inch "Asbesto-Sponge," $25.40.



STEAM PIPES OF MIDDLETOWN, OHIO, WATERWORKS.

This covering is made of many layers of thin felt composed of pure asbestos fiber and finely ground sponge. It is tough and flexible so that vibration, moisture, heat or rough usage will not cause it to break, crack, crumble or lose its insulating efficiency. It is also fireproof and can be removed and replaced an indefinite number of times without deterioration. This pipe covering is manufactured by H. W. Johns-Manville Company, New York City.

Six More Electric Locomotives for the New York Central Terminal.

The New York Central & Hudson River Railroad Company has recently ordered six additional General Electric passenger, electric locomotives, for terminal service out of New York City. Early in the year ten electric locomotives of the most powerful type ever built were ordered from this company for the same service. These engines weigh 100 tons each. While the new machines are of the same type and construction, they are somewhat heavier, weighing 110 tons, and due to recent advancement in locomotive design, have materially increased capacity for continuous service.

The ten 100-ton electric locomotives ordered during the early part of this year are each equipped with eight bipolar, gearless motors, all the weight of the machine being carried on motor-driven axles. These engines are designed for pulling the heavy limited trains and will exert sufficient tractive effort to operate 800-ton trains in continual service between the New York Central terminal station and Harmon. They are capable of operating a 1,000-ton train in emergency service or a train of the same gross weight on level tangent track continuously, at 60 miles per hour, or an 800-ton train at 65 miles per hour.

In point of design and construction the new machines will be of identically the same type as the former ten engines, having an articulated frame with bogie guiding trucks at each end. The cab containing the engineer's compartment and that for the operating mechanism is swung between the two parts of the frame on center pins. Each section is equipped with two-axle trucks having a driving motor mounted on each axle. All the axles are, therefore, driving axles; and the eight motors, of the bipolar gearless type, are of the same general design as the motors on all the previous 57 locomotives, and are provided with ample forced air ventilation. The motors are electrically connected permanently in parallel in pairs, and the pairs can be connected in three combinations: *viz.*, series, series-parallel and parallel. They are insulated for 1,200 volts, so that if at any future time it should be desired to operate the locomotive on this voltage, the pairs of motors could be changed from parallel to series connections and the same speeds and control combinations obtained as on 600 volts. A description of the ten locomotives mentioned as already furnished the New York Central & Hudson River Railroad Company, was published in the June, 1913, issue of *Electrical Engineering*.

A New Voltmeter.

In the high voltage testing of wires and cables, made usually on open circuit, there appears to be considerable misconception of the fact that it is the peak of the wave which tends to break down insulation, rather than the "average" reading of the ordinary voltmeter. A new type of voltmeter has been developed by the Simplex Wire & Cable Company, for use in making tests of wires and cables.

When the voltage wave is distorted, the ordinary voltmeter still reads only the square root of the mean square, it gives very little indication of what is actually happening as regards a breakdown test. The peak of the wave is what counts so far as the breaking down of insulation is concerned. It follows, therefore, that the strain may actually be much larger than shown by the voltmeter if the wave is distorted into a high peak, or the strain may be less than indicated, if the wave has become flattened. An oscillograph shows the maximum, but an oscillograph is a delicate and cumbersome instrument for factory use where a large number of tests are made every day. It was conceived, however, that an instrument might be made on the principle of the oscillograph where, if the vibration could be confined to a straight line, this straight line would show the limits of oscillation, and its end indicate the peak of the wave. Further, it would be extremely simple to callibrate the instrument at any time by applying direct current of known voltage.

This proposition was laid before Prof. F. A. Laws, of the Massachusetts Institute of Technology, and Mr. Chester L. Dawes, of Harvard University. They built an instrument which, although somewhat crude, achieved the desired result and demonstrated the feasibility of the scheme by a test of three months' use under factory conditions. Now the Leeds & Northrop Company is at work perfecting a commercial and usable instrument, which it is expected can be put on the market at a reasonable price in the near future.

This voltmeter was developed by the Simplex Wire & Cable Company, wholly because of its need in the high voltage testing of wires and cables, and because no instrument fulfilling that need could be found in the market. It appears, however, that such an instrument should have varied uses, for many engineers must be interested not only in the voltage as shown by the ordinary meter, but also in the actual maximum voltage present in generators, transformers, meters or transmission lines.

Outdoor Transformers.

Considerable favorable interest has of late centered in the design of transformers for outdoor use, as a part of outdoor sub-stations serving small towns and plants along the line of high voltage transmission lines. On this account highly satisfactory weatherproof protective devices have been perfected, terminal outlet bushings having insulation strength equal to the insulators have been designed, so that it has been practically demonstrated that the outdoor sub-station has come to stay, and htat for all but the larger insallations is much the best.

The Kuhlman Electric Company, of Elkhart, Indiana, has perfected a design of outdoor transformer for this service. The construction of these transformers makes use

Fig. 1. Kuhlman Outdoor Transformer Complete.

of a method of insulating high and low voltage windings by supporting the high voltage coils from their outside diameter and securing them in their proper relation to the secondary windings with oil as an insulation wall.

The secondary is wound directly on the cores, with an oil channel between windings and core on one side. These windings are securely insulated against the core by means

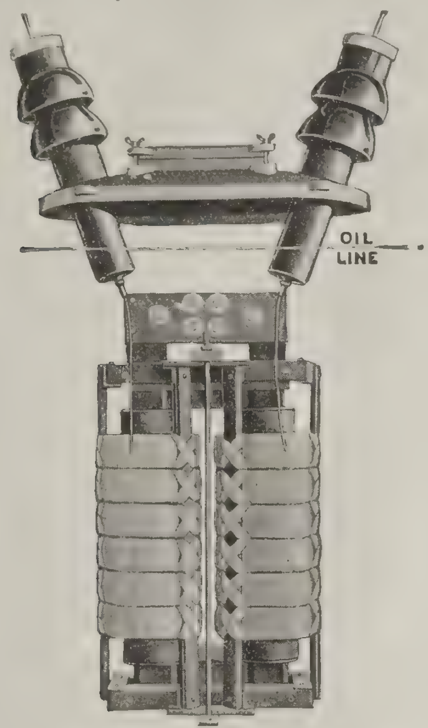


Fig. 2. Transformer With Case Removed.

of mica, etc., reinforced with vulcanized fiber for mechanical strength. After secondary windings are completed, an insulation shield consisting of mica reinforced with rope paper one-eighth inch thick, extending from two to four inches beyond windings (depending on voltage conditions), is securely taped in position. This tape is applied evenly and given a coat of oil-proof finishing varnish, so that the secondary windings present a perfectly smooth surface to the oil. The primary windings are sub-divided into a number of coils, the number depending on voltage and size of transformer. These coils are form wound, and each leg is provided with a special terminal coil, consisting of comparatively few turns specially spaced and insulated. These coils are then taped into a crib, consisting of three kiln-

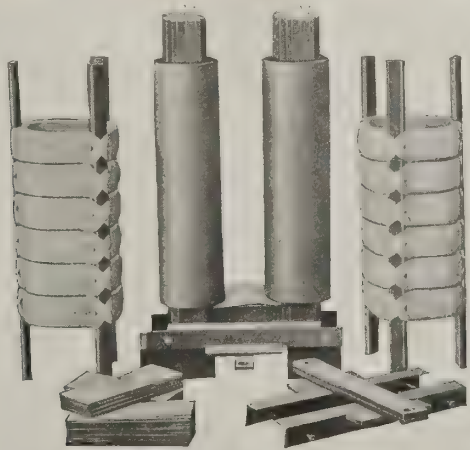


Fig. 3. Transformer Core, Showing Low Voltage Coils in Place and High Voltage Coils Secured to Cribbing Before Being Placed in Position, as Shown in Fig. 2.

dried sticks, having recesses cut crosswise to fit the coils, spaced about one-fourth inch apart. This holds the coils for each leg permanently in proper relation to each other, and the two sets, after being placed over the secondary, are secured in proper relation to secondary windings and core by bolting the cribbing sticks to angle iron clamps at top and bottom. After the transformers are completely assembled and all tests made, the whole unit is treated by the vacuum drying and impregnating process, whereby all atmospheric moisture is removed from the insulation, wood cribbing sticks, etc., and thoroughly impregnated with a high-class insulating compound having a dropping point of not less than 90 degrees C., and which is not affected by the oil at all ordinary temperatures.

Pole Type Feeder Voltage Regulator.

With the large electrical distribution systems of the present day, the outlying feeders usually extend far beyond the point where it is practicable to maintain constant voltage by apparatus in the central station or by feeder voltage regulators in the substations, resulting in unsatisfactory service to the consumers residing in such localities. Up to the present time, the apparatus for voltage regulation has been limited to the indoor type, the installation of which at remote points would necessitate building substations, this in many cases making the expense of installation prohibitive. The General Electric Company has just placed on the market an automatic regulator for outdoor service, and which is so designed that it can be installed on a pole or in any convenient place. This regulator is designed for single phase, 60 cycle circuits to give 10 per cent boost or lower where the power of the feeder to be regulated does not exceed 25 Kva.

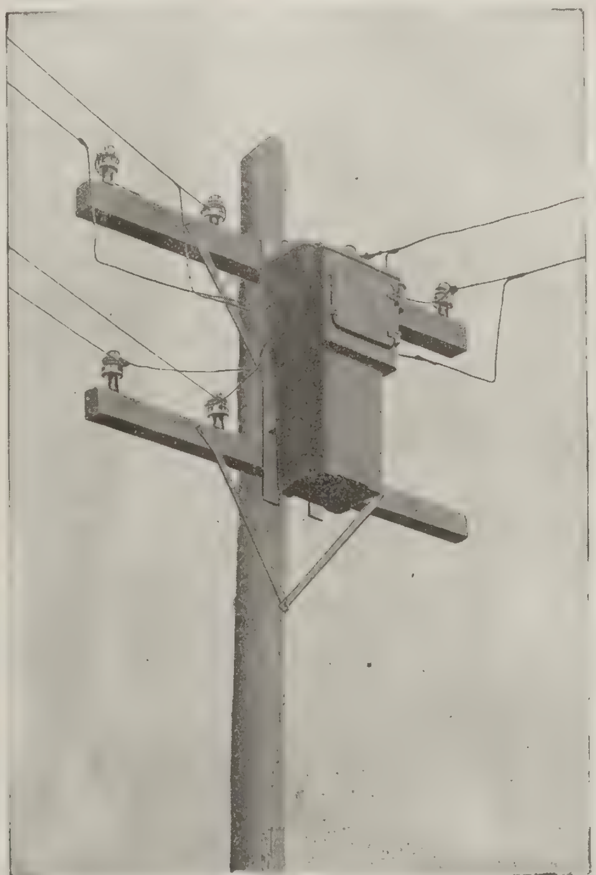


Fig. 1. Pole Type Voltage Regulator.

The regulator is of the well-known induction type, and has two windings arranged on separate iron cores, one, the primary or shunt winding, being connected directly across the circuit, while the other, or the secondary winding, is connected in series with the line. The primary core with its winding is so constructed that it can be rotated within the core of the secondary or stationary coil, so that the effect of its flux upon the secondary coil may be varied, causing the voltage of the feeder to be increased or decreased. The

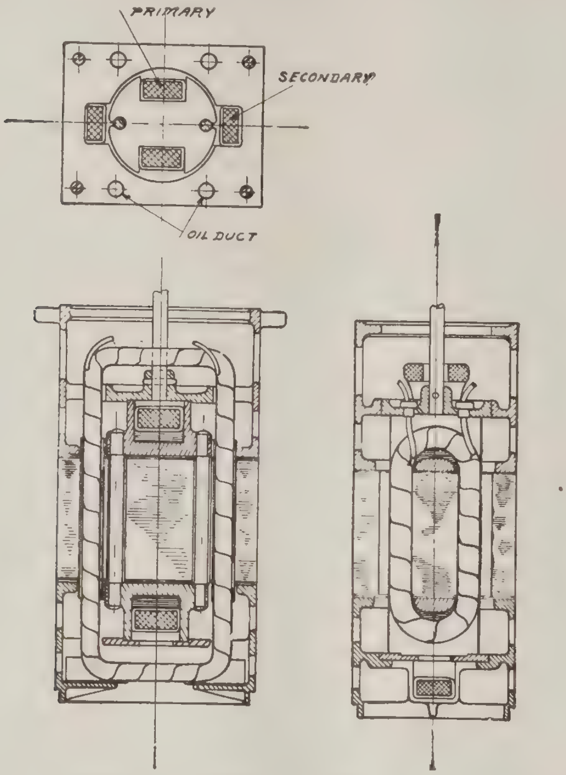


Fig. 2. Section of Regulator Winding and Core.

regulator is of 2 pole design, and the rotor is therefore arranged to be turned through a range of 180 degrees.. The movement of the rotor is obtained by means of a small single phase motor, which is kept running continuously.

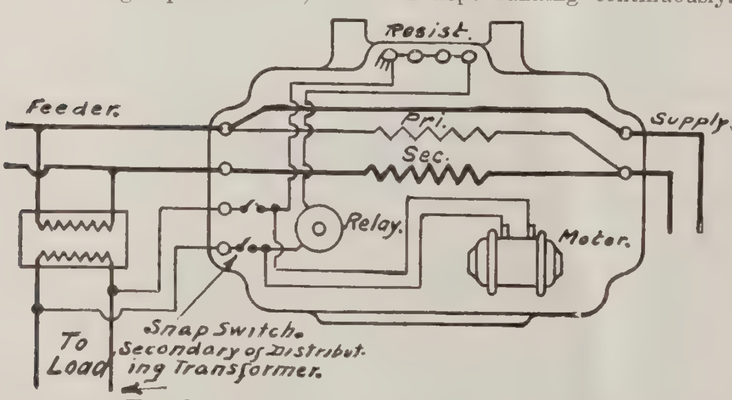


Fig. 3. Diagram of Connections for Regulator.

This motor is normally mechnically disconnected from the rotor, the connection herewith being controlled by a voltage relay, the winding of which is energized from the regulated side of the feeder.

Greenwood Electrically Lighted Shadow Picture.

A new method of producing shadow portraits and pictures in various styles and shapes has been devised by the Greenwood Advertising Company, of Knoxville, Tenn. The illustration, in Fig. 1, shows a portrait of Secretary of State, Hon. W. J. Bryan, as produced and displayed at

Fig. 1. Electrically Lighted Shadow Portrait of Hon. W. J. Bryan.

the National Conservation Exposition at Knoxville early in October of this year. The other illustration is a design for a theatre in Cincinnati, Ohio. This design is made for a constantly changing expression of the mouth and six eye changes, operated by a flasher.

The features of any portrait are ingeniously made lifelike by channeling the lower reflecting surface and the proper use of color-caps on the tips of lamps. Mr. Bryan was pleased with the likeness, and was presented with the design by Albert Greenwood, president of the Greenwood Advertising Company.

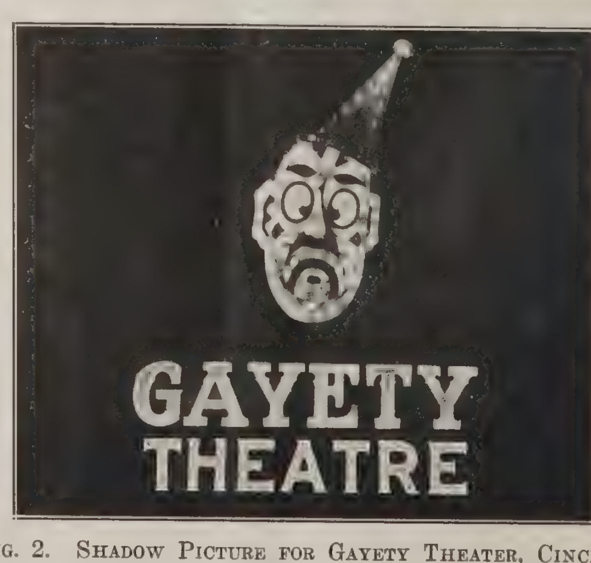


Fig. 2. Shadow Picture for Gayety Theater, Cincinnati, Ohio.

FIG. 3. MAN IN THE MOON SHADOW PICTURE SIGN AT KEY WEST, FLA.

The sign shown in Fig. 3 is one installed by N. A. Sherman, sales agent of the Key West Electric Company, Key West, Fla. This sign burns steadily with the exception of three changes of the man in the moon face. It is operated by a moving picture show.

Moloney Transformers.

A complete line of out-door, pole and pedestal type transformers in all commercial voltages up to 44,000, and standard frequencies, for single phase, two phase and three-phase distribution is now announced by the Moloney Electric Company, of St. Louis, Mo. For three-phase service the company is prepared to furnish either two or three single-phase transformers or one three-phase unit. In the three-phase units the advantages found are greater compactness of materials with lighter weights, and less space needed for installing so that moderately large sizes may be mounted on poles in the usual way. Special insulators are used to secure continuous operation under severe weather conditions such as driving rain and sleet, and piling of soft snow.

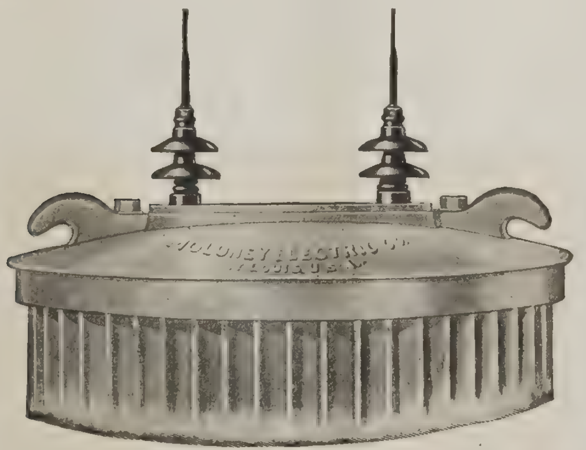


FIG. 1. TOP OF CASE SHOWING OUT-DOOR TYPE BUSHINGS.

The Moloney Electric Company are exclusive manufacturers of transformers and during their seventeen years of existence have built up a substantial business. The factories at Windsor, Canada, and St. Louis, Mo., are geographically located with rail and water routes to serve with dispatch and reasonable cost of delivery, a wide territory. Local stocks are carried in all the principal distributing cities in the United States and Canada, and the company's export business is looked after by a special export representative in New York City.

FIG. 2. THREE-PHASE SINGLE UNIT TRANSFORMER.

Electrical Construction News

This department is maintained for the contractor, dealer, manufacturer and consulting engineer.

ALABAMA.

HUNTSVILLE. According to reports, the Alabama Power Co. will build a steam plant at Huntsville. This plant will cost about $1,250,000.

HURTSBORO. The city has contracted with J. B. McCrary Co., of Atlanta, Ga., to construct an electric lighting system.

FLORIDA.

PUNTA GORDA. An election is to be held December 2nd for the purpose of issuing $75,000 bonds for extensions of electric, water and sewer systems.

SHIPLEY. Plans are under way for the equipment of a 10 ton ice plant to be operated in connection with the electric plant tf the Shipley Light & Power Co. E. H. Hale is general manager.

GEORGIA.

COLUMBUS. Reports state that the Muscogee Light & Power Co., has been incorporated with a capital stock of $50,000 by Edward W. Twist, J. P. Illges, J. P. Kyle, C. J. Swift and others.

FORT GAINES. A bond issue of $8,000 has been voted for the installation of an electric light plant.

MARSHALLVILLE. The construction of a municipal electric light plant is under way of about 50 Kva capacity, with three miles of transmission lines.

MACON. The A. B. Leach & Co., of New York Cty, scal agents for the Central Georgia Power Co., and the Macon Railway & Light Co., has purchased control of the Georgia Public Service Corporation owned by W. J. Massee. The steam plant of the latter company will be operated in connection with the Central Georgia Hydro-Electric Plant at Jackson, Ga., and the transmission system of this company.

KENTUCKY.

OWENTOWN. A contract has been made with James Clark, Jr., Electric Co., of Louisville, Ky., to construct a street lighting system to cost approximately $4,000. The plant will be located at a flour mill, and it is understood that a producer gas engine will be installed.

MISSISSIPPI.

BOONEVILLE. The Booneville Water Works Co. is planning the construction of a series lighting system and the purchase of a 50 Kw three-phase 60 cycle generator with meters and transformers.

GLOSTER. The Woodmere Springs Light & Water Co. proposes to construct a hydro-electric plant.

NORTH CAROLINA.

WENDELL. The city will vote on January 5th on $15,000 in bonds to build an electric light plant.

WINSTON-SALEM. The North Carolina Service Co. has been incorporated with a capital of $50,000 by T. W. Barbee, A. F. Moses and Thermis Demetralis.

SOUTH CAROLINA.

MOUNT PLEASANT. Work will begin on a new substation at Mount Pleasant, January 1st, 1914. The substation will be built by the Isle of Palms Improvement Co., and be equipped with two 300 Kw. rotary converters, 6,600 volts, primary 60 cycle. Two miles of arial three phase line will be constructed, one and one quarter miles of which will be submarine cable, connecting the substation in Mount Pleasant with the power station in Charleston. W. W. Fuller, of Charleston, is in charge.

YORKVILLE. It is understood that the city is to erect a power house and install the necessary equipment.

TENNESSEE.

JEFFERSON CITY. The Jefferson City Milling & Electric Co., plans to construct a five mile transmission line and install a 75 Kw, three phase, 6,600 volt generator in their plant.

WEST VIRGINIA.

BEAVER HOLE. The West Virginia Development Co. is planning to construct a hydro-electric plant at Beaver Hole on the Cheet River, 13 miles from the Pennsylvania state line. It is understood that a dam is to be constructed 1200 feet long and 100 feet high, and a power house to develop 52,000 Hp. F. W. Scheidenheim is chief engineer at 503 Savings Bank Bldg., Pittsburgh, Pa.

Book Reviews.

ELECTRIC LIGHT AND MOTOR WIRING, by George J. Kirchgasser. Published by the Electroforce Publishing Co., Stroh Bldg., Milwaukee, Wis. Vest pocket size. Price $1.00.

This small book discusses in a practical manner the various systems of wiring including the open knob, moulding, metal moulding, knob and tube, flexible and rigid conduit and armored conductor systems. It does not simply develop the National Electric Code but tells how the installations are made and what the restrictions are for light and motor equipments. Calculation of wire sizes, very complete motor and controller connections, tables, etc., are included in this work. For the electrical worker, contractor, electrical engineer, steam engineer, architect, central station man, student, etc., this book should be of considerable value. It is one of the few books that tell how to do wiring. Equipped with a copy and a copy of the national electric code telling what not to do, many puzzling wiring problems can be properly handled.

TELEPHONE CABLES, by J. C. Slippy, 428 Oliver Bldg., Pittsburg, Pa. For sale by author. Price, $2.50.

This is a decidedly practical handbook on the design, construction and maintenance of the telephone cable plant. It contains some 180 pages with 97 illustrations and 31 tables, many of the illustrations being working drawings to which the text refers with details and explanations. This is not a big book but a useful book and one that will at once appeal to the engineer connected with the small telephone system and the medium-sized one. The headings of the six chapters of the work indicate the nature of the subject matter. 1. Cable Specifications. 2. Cable Plans. 3. Cable Construction. 4. Cable Records. 5. Cable for Long-Distance Work. 6. Cable Inspection.

PART II. Vol. 20 PROCEEDINGS OF SOCIETY FOR PROMOTION OF ENGINEERING EDUCATION. Published by Society. H. H. Norris, Secretary, Ithaca, N. Y. Price, $1.25.

This volume contains especially the papers and discussions relating to engineering laboratories in all divisions of engineering, and papers giving details of engineering courses. The articles by Professor W. T. Magruder, giving the results of a tour of investigation of laboratories; by Dr. R. R. Heuter, giving in great detail a description of the Charlottenburg laboratories; by Professors Franklin and McNutt, on the Teaching of Elementary Physics, and by Professor Horace Judd, describing the equipment of the new Robinson laboratory at the Ohio State University, are especially interesting. In addition to this material, the volume also contains, in the preliminary section, statistics of the Society. It is sold to non-members at $1.25 per copy, this being one-half of the price of the bound volumes of Proceedings for the year.

THE ELECTRIC VEHICLE HAND-BOOK by Cushing and Smith. Published by H. C. Cushing, Jr., 53 Park Row, New York City. 362 pages, pocket size. Price $2.00.

This work is a compilation of information and data on the operation, care and maintenance of all classes of electric vehicles, discussing in addition, storage batteries, motors, controllers, tires and accessories used therewith. The subject is largely descriptive yet presented in a very comprehensive and instructive manner.

THE ELECTRIC COMMERCIAL VEHICLE and THE STORY of the PLEASURE VEHICLE. Published by the Electric Vehicle Association of America, 124 West 42nd street, New York City.

The above titles are those of two very instructive and interesting publications prepared in such a way as to present a review of the electric vehicle situation and give data on electric vehicle operation of value to users and prospective buyers. The information has been compiled by the electrical vehicle association being results of special research work and on this account is authoritative. The booklet devoted to commercial vehicles contains 36 pages with operating and maintenance data for different sizes and types of vehicles compared with horse drawn vehicles, the information being drawn from the experience of different large and small users of trucks in different lines of business. The booklet on the pleasure vehicle is largely descriptive of various types of electrics, giving cost of maintainance and operation, battery life, etc, for particular cases, in various parts of the country. Both these booklets are furnished without charge to central stations upon request and arrangement can be made to secure quantities at small cost for distribution among possible purchasers of electric vehicles in the field of any station.

ELECTRICAL AND MAGNETIC CALCULATIONS, by A. A. Atkinson. Fourth Edition—revised. Published by D. Van Nostrand Co., New York City. Pages 299. Price $1.50.

This work is the outgrowth of a course in electrical engineering conducted by Prof. Atkinson at Ohio University, and while primarily intended as a text book, the treatment of the subject is such that it will be found decidedly useful by those who desire a complete reference on electrical matters and at the same time a guide in the application of rules and formulae in electrical problems. Numbers of examples are presented with their solutions covering practical problems in circuits and electrical machines. The following headings of chapters explain the nature treatment: Explanation of units; Relation of quantities; General laws of resistance; Electrical energy; Wiring for Light and Power; Batteries; Magnetism; Relation of magnetic quantities; Emf of Dynamos and Motors; Calculations of Fields; Elements of Dynamo Design; Alternating Currents; and Alternating Current Distribution.

TRANSFORMER PRACTICE, by William T. Taylor. Second Edition rewritten and enlarged. Published by McGraw-Hill Book Company, New York City. Pages, 271. Price, $2.50.

The first edition of this work appeared in 1908 and was then one of a very few taking up practical information connection, installation and operation of transformers. The second edition contains much new matter and data of especial interest to those operating and constructing plants. The theoretical features of transformer operation are not taken, the material being decidedly practical and therefore of interest to every electrical man in a plant large or small. Considerable space is given to possible connections, both wrong and right connections being discussed. Installation and operation comes in for considerable discussion, the information on switching for transformer protection being especially good for the engineer in charge of inter-connected systems. Chapters one to twelve are devoted to stationary light and power transformers, the remaining four chapters discussing series transformers, regulators and compensators, transformer testing and transformer specifications.

Personals.

PHILIP S. DODD, who for the past 12 years has been identified with the electrical industry, as manager of the Electrical Review, director of publicity of the National Electric Lamp Association, past secretary of the commercial section of the National Electric Light Association, one of the early organizers and recently secretary and treasurer of the Society for Electrical Development, has allied himself with The Tucker Agency, Inc., of New York City. The Tucker Agency is headed by W. Gaylord Tucker, Jr., and is well known in the national advertising field, and especially in electrical circles, as advertising agents for The New York Edison Company, the N. Y. Electric Vehicle Association, the United Electric Light and Power Company, and a number of other large clients in electrical and mechanical fields.

Mr. Dodd will undertake for this agency the organization of a special department for central station advertising service. The company has already prepared three series of advertising campaigns, any of which can be efficiently used by large or small central stations in newspaper advertising at a very low cost; one series being general, another a direct special campaign to promote the sale of electrical appliances and the third what might be called a "public policy" campaign intended to promote the establishment of better relations between the public and the central stations. The department is also equipped for the preparation of special central station advertising to include not only newspaper advertising copy and sales ideas generally, but also the preparation of booklets, folders, etc. It is also contemplating the publication of a monthly magazine for central station use among customers. Mr. Dodd's wide range of experience, combined with the experience of other men in the Tucker organization, should make it especially well equipped for handling this work, and we wish Mr. Dodd all success in his new line of endeavor.

MR. A. J. REED, recently connected with the Dayton office of The Westinghouse Electric & Mfg. Co., has severed his connections with that company to assume duties with the Robbins & Myers Co. in the capacity of manager of a branch office recently opened in Cleveland, Ohio.

Industrial Items.

THE ADAPTI MFG. CO., of Cleveland, Ohio, has recently issued a booklet of 48 pages taking up different types and styles of "Adapti boxes." The Adapti box is a conduit fitting designed to give a large number of combinations with few parts. It is made up of five parts as follows: The base, four side plates and cover. The side plates are made in seven interchangeable types, a blank side plate, an insulating side plate, a side plate containing lug for rigid conduit, a side plate containing lug for flexible conduit, an angle lug, an elbow lug and a threadless lug. On account of these features the boxes are of interest to contractors as with a small selected stock a large number of requirements of any job are at once met.

THE BRISTOL COMPANY, Waterbury, Conn., has taken over the business of the Goodwin Hollow Set Screw Company and have made arrangements for the exclusive manufacture of the Goodwin Patent Hollow Safety Set Screws with the dove-tailed slots. Better facilities for manufacturing these set screws will be provided and shipments are already being made from the main factory of the Bristol Company.

THE CENTRAL ELECTRIC COMPANY of 320-326 South Fifth Ave., Chicago, Ill., has just issued catalogue No. 29 devoted to Christmas gift suggestions. It contained 80 pages and described and illustrates all kinds of electrical devices, considerable space being given to table lamps, heating devices and electrical toys. The catalogue has a very attractive cover design suggesting an electrical Christmas in the home. The arrangement of material described and displayed in the pages shows skill in catalogue making to present the details of a large stock of goods in few pages. A copy of the catalogue will be sent upon request made to the company at the above address.

THE SANGANIO ELECTRIC CO., Springfield, Ohio, has issued bulletin No. 36 under date of October, 1913, taking up the general use of ampere-hour meters. These meters are of the mercury flotation type, a description of which is given in detail These meters are built in different styles for different service, including storage battery service for central stations, train lighting batteries, electric vehicles, electroplating, etc.

THE BELL ELECTRIC MOTOR CO., Garwood, N. J., has issued bulletin No. 150 on direct current motors of inter-pole design and bulletin No. 160 on a compensated type of polyphase motor. Each bulletin takes up in detail features of design and construction. It is claimed for the compensated type of motor that it starts under full load with about twice full load current and no starter; that it has a high power-factor and efficiency; that added torque can be secured by using short-circuiting taps on commutator and that they are made for all voltages and frequency, both 2 and 3 phase.

THE UNIVERSAL CABLE GRIP CO., 207 East Jefferson St., Syracuse, N. Y., is manufacturing a cable grip designed for handling all types of aerial and underground cables. The grip is made up of a tubular net such that it is slipped over the cable and grips it when pulled, each strand of the net taking a part of the strain but in no way exerting a crushing strain on the cable sheath. The grip can be used for end pulling or pulling slack and may be applied at any point without cutting cable by simply lacing the grip on the cable at the desired point.

H. W. JOHNS-MANVILLE CO. has secured new quarters for the Baltimore office in a modern six-story building with floors measuring 47 x 187 feet, located at 207-13 E. Saratoga St., which is within two blocks of the post office and right in the heart of the business section. It will include an attractive store and up-to-date offices, in addition to large warehouse accommodations. To facilitate the handling of incoming and outgoing shipments there will be a railroad switch running into the building.

THE AMERICAN CARBON & BATTERY CO., on October 1, moved the St. Louis offices to the factory at East St. Louis, Ill. On this date Mr. D. E. Ford took charge as sales manager. Mr. Ford comes from the Wesco Supply Co., of St. Louis, where for esveral years he has had charge of telephone and specialty sales.

Trade Literature.

THE FORT WAYNE ELECTRIC WORKS, Fort Wayne, Ind., has issued booklet 5027, giving detailed information on the Compensarc and other electric current savers for moving picture theaters. The Compensarc is a transformer device built in types for a.c. and d.c. circuits, reducing the voltage and giving different adjustments of current. It is a device that takes the place of rheostats for moving picture machines and effects considerable economy. They are also built in types for changing alternating current to direct, consisting in the main of an a.c. motor and d.c. generator of suitable design.

THE HART & HEGEMAN MFG. CO., 342 Capitol Ave., Hartford, Conn., has issued catalogue K, devoted to switches and accessories. This company has for 21 years specialized in the manufacture of electric snap switches, and this catalogue presents the latest developments, giving illustrations and specification data.

RECORDING INSTRUMENTS. To those who desire to keep a file of catalogues for reference, The Bristol Company, of Waterbury, Conn., is sending a complete set of current issues of catalogues and bulletins neatly bound in loose-leaf binder. The bulletin numbers are as follows: Nos. 1000, 179, 142, 143, 173, 1100, 167, 1200, 128, 1300, 168, 177, 131, 132, 133, 134, 138, 166, 139, 149, 147A, 106, 169, 103, 108, 170, 152, 157, 701, 703. They are arranged under the following headings with appropriate index notations: Pressure and vacuum; liquid level; differential pressure; temperature; electricity; motion; speed; flow; humidity, and miscellaneous. 35 bulletins make up the set which indeed to those interested is one containing valuable data and information.

THOMPSON LEVERING COMPANY, of Philadelphia, Pa., has recently issued bulletin G, devoted to portable testing sets, cable testing apparatus and standard electrical instruments. Illustrations and detailed descriptions of the different types of devices are given as well as best prices. The bulletin contains 24 pages and is well printed and attractively made up.

STORAGE BATTERIES. The U. S. Light and Heating Company, Niagara Falls, N. Y., has issued bulletin No. 111, devoted to storage batteries for automobile electric lighting and engine ignition. A description of the batteries is given with illustrations and data and information for determining proper size of battery for any use.

LIGHTING GLASSWARE. The Lighting Studios Company of Madison Ave., corner 31st St., New York City, has issued a handbook of their creations in lighting glassware. The types displayed and described are suitable for all classes of lighting where either direct or indirect systems are used. Types of pendant units are also shown of an attractive and scientific design known under the trade name of "Doric."

PIPE COVERING. Among the many large contracts placed for building material in connection with the new general Hospital, Cincinnati, O., was one for 50,000 feet of J-M pipe covering for the heating system of that structure. This contract was awarded to the Cincinnati branch of the H. W. Johns-Manville Co. The many types of pipe covering manufactured by this firm are fully described in their new booklet, a copy of which may be obtained by writing their Cleveland branch.

GROUND WIRE CLAMP. W. E. Belcher, Bloomfield, N. J., has issued a folder descriptive of the Belcher groundwire clamp for use on transmission systems. This device is manufactured by Hubbard and Company, Pittsburgh, Pa., and used on a number of systems.

ELECTRIC VEHICLE MOTORS. Issue No. 17 of "Small Motors," a magazine published monthly by the Industrial & Power Department of the Westinghouse Electric & Mfg. Company is devoted to the exceedingly popular subject of electric vehicles. Vehicle equipments are described very thoroughly, the different points of construction being brought out in detail.

BUS BAR SUPPORTS. The Delta-Star Electric Company, Chicago, have issued a bulletin devoted to high tension bus-bar and wiring supports. With the standard units listed, over 7,000 combinations are possible, thus greatly simplifying high tension stations and switchboard wiring.

WESTINGHOUSE PUBLICATIONS. Westinghouse A. C. watthour meters are fully described and illustrated in a little folder (4241) just issued by the Westinghouse Electric & Mfg. Company. Load curves of the different types of meters are also shown.

"Electrically-Driven Pickers" is the subject of the latest issue of Westinghouse Textile Quarterly issued at frequent intervals by the Westinghouse Electric & Mfg. Company on the subject of Motor Drive in Texile Mills.

"Motor-Driven Refrigerating and Ice Making Machinery" is the title of another publication (Section 3133) just issued by the Westinghouse Industrial & Power Department. This little pamphlet gives in a concise manner some exceedingly interesting information on this subject including specific data on motor applications together with actual kilowatt hours consumption for different plants.

STAGE LIGHTING. Catalogue by the Universal Electric Stage Lighting Company of 240 West 50th St., New York, Kliegl Bros., proprietors, takes up electric stage lighting apparatus, electromechanical effects, electrical spectacular productions, electric signs and illuminations. The catalogue is filled with illustrations of types of this apparatus, together with descriptions, price lists and ordering data. It is a most complete catalogue of its kind and should interest all electricians and contractors.

STREET RAILWAY LAMPS. The Engineering Department of the National Electric Lamp Association has just distributed Bulletin 18-A, entitled "Mazda Street Railway Lamps." The bulletin bears the note "Technical Data Compiled Especially for Street Railway Engnieers," but this should not be interpreted to mean that the bulletin is not of interest to those engaged in the lamp industry in general. It gives the latest information concerning the lighting of street railway cars by means of high efficiency Mazda lamps. It contains illustrations of the lamp used in this class of illumination as well as of a car in which the latest car lighting scheme is applied. Considerable technical data on the lamps and their performance is given. Cost tables are also presented and performance curves are shown. The bulletin contains paragraphs pointing out the adaptability of Mazda lamps to the lighting of street cars and car barns, a discussion of the candle-power regulation of Mazda street railway lamps and their candle-power life performance, also some information on the latest illumination system used in street car lighting.

GENERATORS. Steam turbine driven generators is the subject of bulletin No. 152, recently issued by Crocker Wheeler Company, of Ampere, N. J. This bulletin takes up design and presents illustrations of parts.

COUNTERS. Bulletin No. 169 by the Bristol Company, Waterbury, Conn., takes up types of counters that automatically count and register revolutions or strokes, accurately measure production of machines, and save waste of time spent in counting by hand or by weight.

METERS. A catalogue has recently been issued by Holcomb & Hoke Manufacturing Company, Indianapolis, Ind., describing H and H meters. The catalogue presents details of construction and many illustrations showing the essential feature of design. A brief description of these meters appears in the New Apparatus and Appliance Section of this issue.

SUB-STATION DATA SHEET. The Delta-Star Electric Company, of Chicago, are distributing a data sheet showing the cost per Kw of substation equipment for commercial voltages from 13,200 to 33,000 volts. This data sheet will be of service to those managers called upon to make quick costs and estimates.

CHICAGO STREET LIGHTING. A second contract for 30 250 Kw. 12,000-volt 60-cycle station type Pittsburgh transformers has been awarded the Delta-Star Electric Company of Chicago by the Sanitary District. This will make a total installation of 58 transformers of this type for use in the new street lighting plans of Chicago.

CONDUIT SUPPLIES. Conduit Catalogue No. 439, issued by the Sprague Electric Works of General Electric Company, covers the entire field of conduit products. The trade is made cognizant of some special features new in this line, such as Greenfielduct—a high-class galvanized rigid unlined conduit, treated with molten zinc by means of a patented hot galvanized process on both interior and exterior surfaces for rust preventative purposes. An attractive and complete list of boxes and covers including new adjustable and non-adjustable and adjustable gang floor boxes. Especial attention is called to the complete line of standard Greenfield flexible steel conduit, flexible steel armored conductors, BX cable and armored cord. Also of considerable convenience will be found the carefully compiled tables and information relative to the adaptability of "Fittings" of other manufacturers to Sprague boxes and covers. The electrical contractor and jobber will find this catalogue, which contains 100 pages, of value.

ELECTRICAL SPECIALTIES. The Chelten Electric Company, of Philadelphia, has recently issued a new catalogue giving information and illustrations of house-wiring specialties. These include switches of various types, combination plates, receptacles, wall cases, conduit boxes, etc.

DOSSERT CONNECTORS. Dossert & Company, H. B. Logan, president, 242 West 41st Street, New York City, has issued a new catalogue of 62 pages giving price lists, code words, dimensions and useful information on Dossert Solderless Connectors for Solid and Stranded Wires. The different types and the uses for which each connector is intended is fully described and dimensions of all standard connectors are given.

OUTDOOR CABLE TERMINALS, is the title of Bulletin No. 700-1, recently issued by the Standard Underground Cable Company, Pittsburg, Pa. This volume is 6 x 9 inches in size and contains 28 pages of condensed descriptive matter, illustrations and tables of dimensions, voltages, weights, etc., together with instructions for ordering and installing outdoor cable terminals. The company states that this bulletin is the first of a forthcoming series which supplements its other literature and is designed to supply its customers and prospective customers with such information as can be conveniently filed for reference. For this reason the text is confined closely to such information as will be valuable for filing purposes. The bulletins are punched so that they can be inserted in a suitable loose leaf binder. Copies of this bulletin will be sent to those interested in this class of material upon request.

KYLE ARC LAMP HANGER. A patented arc lamp hanger is made by the Line Material Company, South Milwaukee, Wis., and consists of a supporting insulator. By the small division of a transverse 3/8 inch rivet, passing under the malleable iron yoke, formed by two vertical bolts, and a connection washer, the possibility of dropping the lamp in case of breaking of the insulator is eliminated. The rivet which forms part of the single piece malleable iron top, blocks the fall of the yoke to which the pig-tail lamp hook is secured. The high insulation resists a pressure of 20,000 volts, and the pig-tail hook allows the lamp to be easily hung with one hand. This patented supporting insulator can be used with a variety of arc lamp hanger brackets.

GRAPHITE PRODUCTS. The largest and most complete catalog ever issued by the Joseph Dixon Crucible Company, Jersey City, N. J., is now being mailed to those interested in graphite, crucibles, paint, lubricants, pencils and the other productions of the Dixon Company. Though over one hundred pages of type and illustrations are used, this catalog does not attempt to carry a full description of the entire Dixon line, and only a few of the many hundreds of Dixon's American graphite pencils are listed. The Dixon Company attach a peculiar value to their production catalog inasmuch as it serves to acquaint those who are already users of one form of grphite with its many other forms and uses. If you are particularly interested in graphite products, you should send for a copy of this catalog.