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With Which is Combined The Electrical Age.

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CONTENTS.

The Electrical Age.

With this issue there is combined with SOUTHERN ELECTRICIAN, THE ELECTRICAL AGE published for more than a quarter century in New York City. All subscribers to THE ELECTRICAL AGE will hereafter receive SOUTHERN ELECTRICIAN to the end of the period to which their subscriptions have been paid. With this, the January 1911 issue, THE ELECTRICAL AGE would have started its 42nd volume. Since SOUTHERN ELECTRICIAN in absorbing it constitutes a continuation, the January 1911 issue is numbered volume 42, number one.

Southern Power Engineering.

In looking back upon recent developments of the electrical industry, striking features come to notice, which will go down in electrical history dated 1910. Many of these developments are modifications or special applications of already existing apparatus, while not a few are newly born ideas worked into definite form and applied to a definite purpose heretofore unknown commercially.

In other sections of this issue, the new things which are successful products of the past year are taken up and their relation to the various fields of electrical activity discussed. While the material presented, bears especially upon the engineering development of Southern States, such developments are not far different from those which may be accomplished in other sections presenting similar conditions. The South has only recently reached the stage where its engineering achievements form valuable contributions to the progress of the country.

Due to the splendid water powers of the South, hydroelectric installations are particularly important features in the generation of power. The types of engineering construction required for the development of any power site makes each such development an interesting problem. In the sections of the South where water powers are not available, the selection of prime movers seem to favor the steam turbine and gas units. In those cases where the water power development has little storage and the run off uncertain a part of the year, a combination of hydroelectric and turbo-electric installations is good practice.

The general tendency in power generation is decidedly toward alternating current, generating at a medium high voltage, stepping up to high voltage for transmission of from 66,000 to $100,000 volts and transforming for distributing networks requiring low voltage, and obtaining direct current by the rotary converter. A development in the Southern industrial fields is the tendency toward the use of low and mixed pressure turbines in connection with already existing reciprocating steam engines using the exhaust steam. Since a large percentage of Southern plants, now established, are using steam equipments and finding it necessary to expand rapidly, it is expected that the near future will bring about interesting applications of electrical energy in Southern industries.

A Review of Southern Central Station Developments.

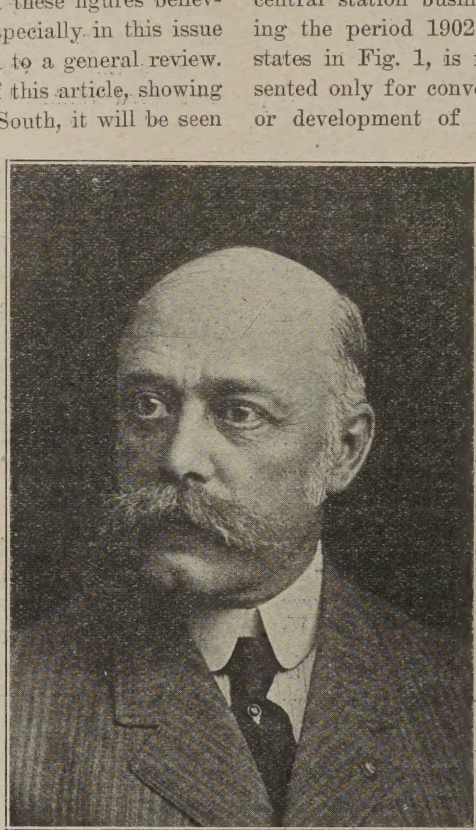
(Contributed Exclusively to SOUTHERN ELECTRICIAN.)

BY THOMAS COMMERFORD MARTIN, SECRETARY N. E. L. A.

ANY study of available statistics soon reveals that the South has witnessed in recent years a very remarkable development in central station work. The writer has endeavored to throw together a few of these figures believing they will be of general interest, especially in this issue of the SOUTHERN ELECTRICIAN devoted to a general review. From the table presented at the end of this article, showing the number of central stations in the South, it will be seen that in the two recognized Southern divisions the increase in the number of stations from April 1908, to October 1910, has been 202, or from 1106 to 1308. Some authorities might be inclined to include the figures of Missouri and New Mexico, but they are given separately. As the gain in number of stations in the whole country was 654 it will be seen that the Southern gain of 202 was one-third of the whole—a very striking and satisfactory exhibit.

It is not, of course, possible to bring detail figures down to so recent a date as October 1910, but on looking into the data bearing upon April, 1908, it will be seen that the stations of that period, as compared with those of five years previously were in an unusually active condition. The figures available are those of the U. S. Census office, which were issued recently and which went through the hands of the writer as special expert of the Census on electrical matters. They compare 1902 and 1907, that is, they come down to the beginning of 1908. It is shown that in 1902 there were 655 stations in the sixteen States and District of Columbia. Whereas 1069 were scheduled five years later, or a few less than are actually included in the table referred to above. The discrepancy is due probably to slightly different methods of enumeration, one company or "Station" composing sometimes several sub-companies or plants.

In order to obtain a mental picture of the distribution of central station in the United States and to give a general idea of the distribution in the South, curves have been plotted and presented herewith as based on the data of commercial and municipal central stations reported in 1907. Further than showing a distribution of central stations, the entire set of curves is intended to present the data for ready comparison of the various lines of central station business and development by sections during the period 1902 to 1907. Although the grouping of states in Fig. 1, is rather unusual, such grouping is presented only for convenience in showing up the overlapping or development of certain sections. From the curve in Fig. 1, showing the number of stations for 1910, it will be noticed that there has been a particularly active section for the establishment of central stations, in what is known as the Piedmont section of the South including Tennessee, Kentucky, West Virginia, Virginia, North Carolina, South Carolina, Georgia and Alabama. This percentage of increase in the number of plants is particularly interesting since it is taken from data showing the increase since 1907. It serves to confirm the tendencies set forth by data at that time as to the sections from which further increases in central station development could be expected. Other interesting features observed from this curve of per cent. increase in number of stations are, the large percentages of increase in the Western States and the development of those sections which at the 1907 enumeration possessed a small number of plants.



THOMAS COMMERFORD MARTIN, SECRETARY, N. E. L. A., AND EXPERT SPECIAL AGENT, BUREAU OF CENSUS.

The curve of gross income from central stations in 1907 is plotted so as to be directly comparable with the number of stations in 1910 and the percentage of increase in this number since 1907. It will be noted that the percentage of gross income from 1902 to 1907 presents a curve which is decidedly similar to the percentage of increase in number of stations since 1907. It would be natural to expect that the regions showing central station activity would be those in which the income from plants and the possibilities of future business could be expected to be greatest, and it is gratifying to note that this has in general been the case. Although there is no information from which to draw definite conclusions as to what shape the curve of increase in gross income since 1907 would take, it is believed that a comparison of the two sets of curves above referred to will reveal that no strikingly fertile new central station field has developed since 1907 and that the tendency is towards the intensive working of the present fields which are well established.

From the information presented in Fig. 2 striking comparisons can be made in regard to the variation of the central station load throughout the Southern States. South Carolina shows up in a striking manner, its horsepower in motors, a large percentage of which is distributed among the numerous cotton mills and turning over four million spindles, nearly 35 per cent. of the total number in the South. Fig. 3 presents interesting information in regard to the average output for a customer in the South and the intensity to which the field is worked at the present time. If it can be assumed that the output is in direct proportion to the number of stations, it can and would be expected that the hollow shown by the curve in West Virginia, Virginia and North Carolina would be filled at the present time to a considerable extent on account of the characteristic increase shown in Fig. 1 by the per cent. of in-

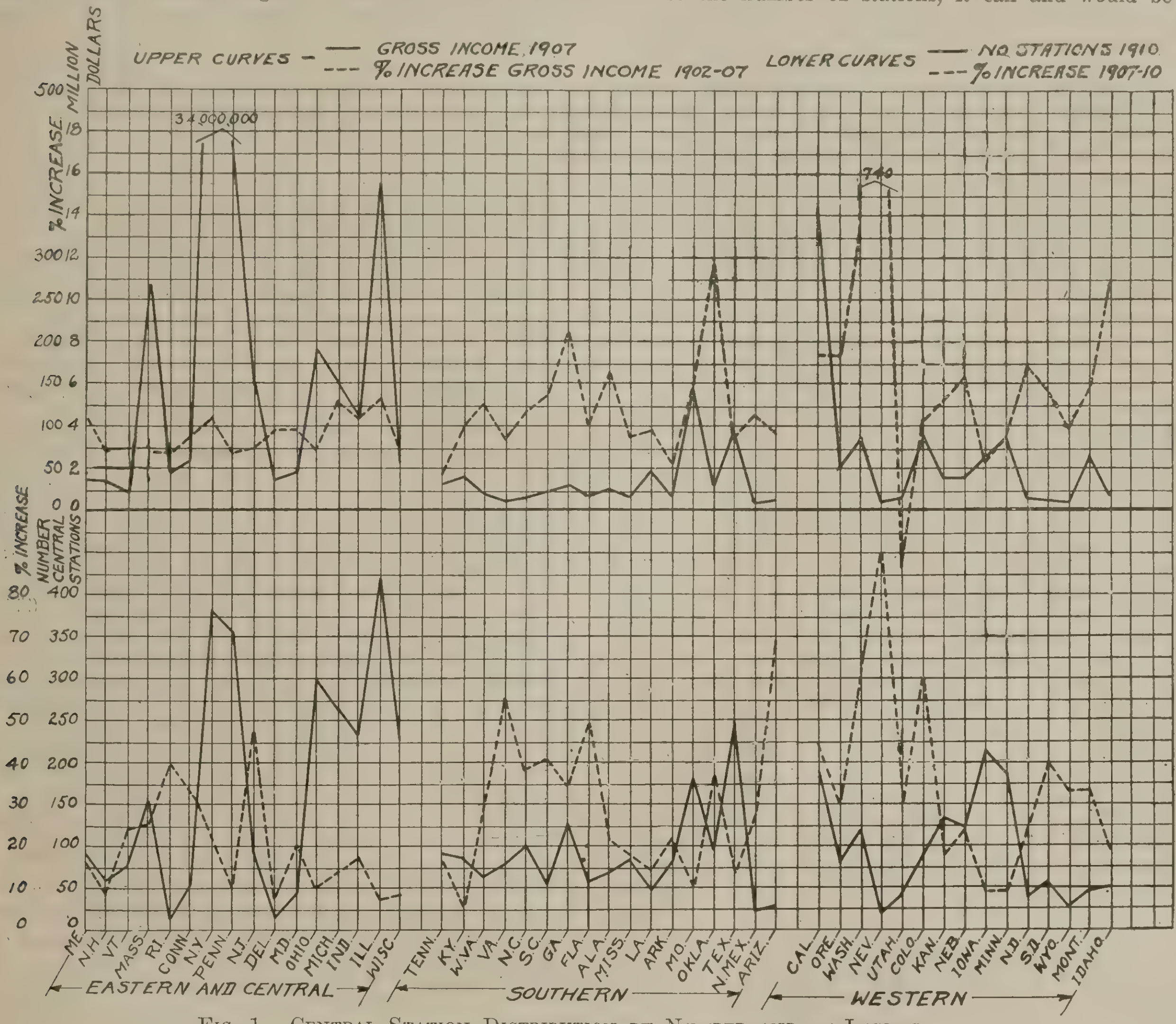


FIG. 1. CENTRAL STATION DISTRIBUTION BY NUMBER AND BY INCOME.

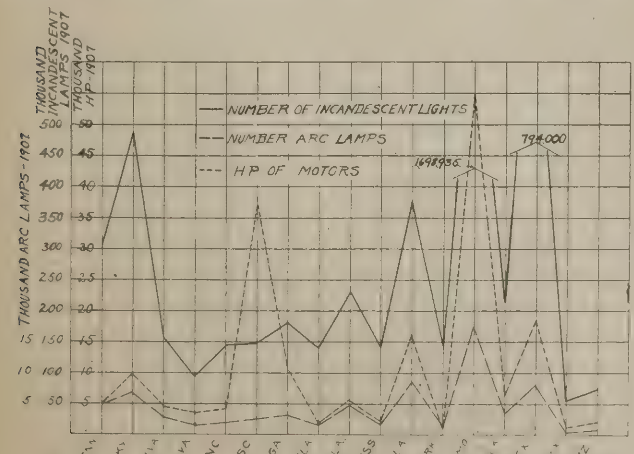


FIG. 2. FACTORS OF SOUTHERN STATION LOADS.

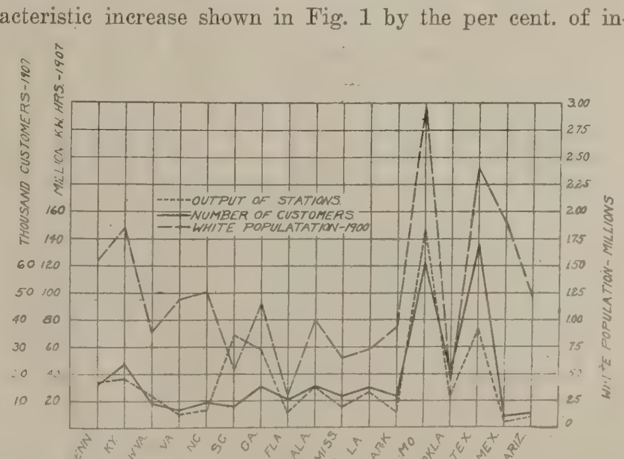


FIG. 3. DISTRIBUTION OF OUTPUT OF SOUTHERN STATIONS.

crease in the number of stations during the past three years.

The information presented in Fig. 4 is interesting, due to the fact that there is a decided increase in the motor load revealing that this feature of central station output bears a favorable relation to the lighting output and therefore tending to bring about a load factor agreeable to the satisfactory working of the central station. Fig. 5 is presented to definitely picture the hydro-electric development of the South in what is known as the Piedmont section. While this chart shows a thoroughly well developed growth of power from natural resources, it is estimated that the water power of the South has only been utilized to a small extent, there being available according to best authorities based on geological surveys, approximately 9,000,000 horsepower, only 10 per cent. of which has been used.

	NO. OF STATIONS APRIL 1908.	NO. OF STATIONS OCT. 1910.
SOUTH ATLANTIC STATES:		
Maryland, Delaware & Dist. Col.	50	61
Florida	41	55
Georgia	100	125
South Carolina	49	55
North Carolina	82	98
Virginia	62	79
West Virginia	53	61
SOUTH CENTRAL STATES:		
Kentucky	83	87
Tennessee	74	90
Alabama	53	67
Mississippi	73	80
Louisiana	39	48
Arkansas	63	76
Oklahoma	63	80
Texas	221	246
	1106	1308
Missouri	158	179
New Mexico	15	19
Total in South	1297	1506
Total in U. S. A.	5015	5669

The following data may be regarded as thoroughly inclusive, dealing with equipment and output:

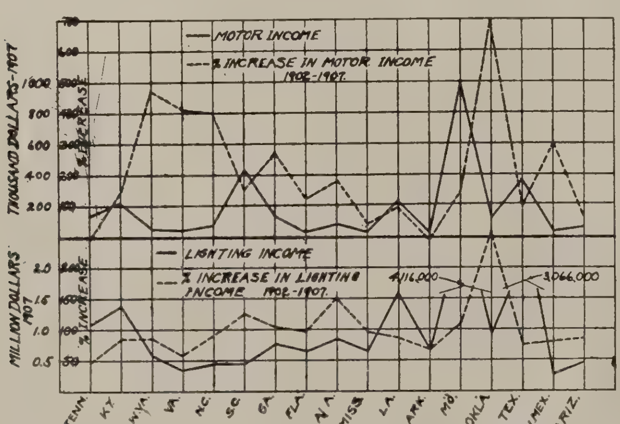


FIG. 4. DISTRIBUTION OF SOUTHERN STATION, MOTOR AND LIGHTING LOADS.

NO. OF STATIONS:	1902	1907
South Atlantic	251	390
South Central	404	679
Total	655	1,069
KILOWATT CAPACITY OF DYNAMOS:		
South Atlantic	62,301	195,309
South Central	82,259	165,969
Total	144,560	361,278
HORSEPOWER ENGINES AND WATER WHEELS:	1902	1907
South Atlantic	92,641	295,265
South Central	117,192	244,422
Total	209,833	539,687
K. W. OUTPUT:		
South Atlantic	102,990,575	266,437,175
South Central	153,905,350	257,387,610
Total	256,895,925	523,824,785
ARC LAMPS:	1902	1907
South Atlantic	17,183	27,103
South Central	29,320	39,794
	46,503	66,897
INCANDESCENT LAMPS:		
South Atlantic	611,001	1,915,725
South Central	1,022,298	2,697,115
	1,633,299	4,612,840

The "Capitalization" is not particularly revelatory of real conditions in such matters, but it is worthy of note that the actual cost of the total equipment here represented in plant and line rose from $41,791,207 in 1902 to no less than $117,879,725 at the beginning of 1908. In five years therefore seventy millions were invested in the central station industry in the South.

These are surely impressive figures, and no reason exists for any belief that the rate of growth has slackened. The statistics of increase in number of central stations is direct evidence to the contrary. Moreover since 1907-8 there has been a rapid development in power companies and power

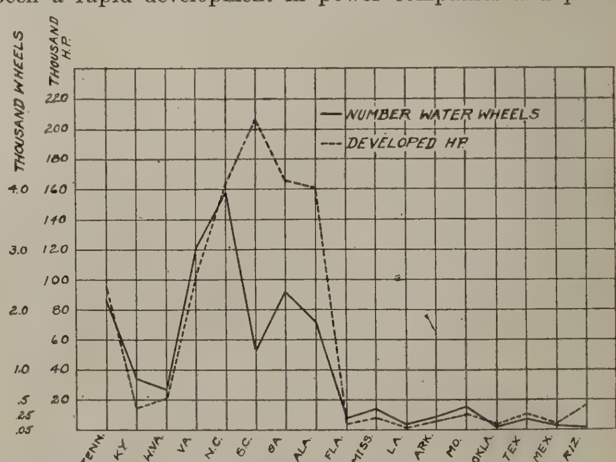


FIG. 5. DISTRIBUTION OF SOUTHERN DEVELOPED WATER-POWERS.

transmission lines, all of which will cause tremendous jumps in the next figures obtainable in 1912.

One of the most significant features of Southern development is the existence of power circuits ramifying over whole States. A visitor to the South, from Washington to Atlanta for example cannot but note, with surprise and enthusiasm, that from early morning until late evening, as the train proceeds, power lines one after the other loom into sight, paralleling, crossing and looping the railroad and reaching out to hundreds of new mills and factories and serving as nerve ganglia for scores of prosperous communities. In such work as well as in the swift adoption of all the new electrical ideas and developments, the South is distinctively a leader and example for the whole country. The general electrical rate of increase for the country as a whole is from 15 to 20 per cent. per annum, and some sections and cities of the South are doing much better than this, in practically all departments.

The Water Powers of Alabama.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

BY EUGENE ALLEN SMITH, STATE GEOLOGIST OF ALABAMA.

While there are five principal drainage areas in Alabama, viz.: the Apalachicola, the Choctawhatchee, the Pensacola, the Mobile, and the Tennessee, the water powers are mainly on the two last named basins, which embraces most of the area of the State, except a small territory in the Southeastern part.

In general the large water powers are above the fall line of the main streams, the fall line being where the older and more consolidated rock formations pass under the younger rocks of the Coastal plain. In the Coastal plain, which embraces about three-fifths of the area of the State, the streams are practically graded, and thus devoid of any very decided falls. Above the fall line the streams flow in general through narrow channels and have swift currents and numerous falls or shoals, affording most suitable localities for the development of water powers.

Roughly speaking the fall line extends from Columbus, Ga., on the Chattahoochee river Westward to Tallassee on the Tallapoosa, Wetumpka on the Coosa, Centerville on the Cahaba, Tuscaloosa on the Warrior and thence to the Northwestern corner of the State. While small water powers up to 50 and exceptionally up to 150 horsepower have been utilized mostly for grist mills in practically every county in the State, the really important water powers have been developed in comparatively few places, at Tallassee on the Tallapoosa river by the Tallassee Mills Company, and a few miles above at the power plant of the Montgomery Power Company.

CHATTAHOOCHEE RIVER AND TRIBUTARIES.

From West Point in Georgia Southward the boundary of Alabama is on the West bank of the Chattahoochee river, which leaves all the water power of the main river in Georgia territory. There are many creeks flowing into the river from the Alabama side, some of which have considerable fall as they come from a high plateau. Some of these which have been examined show from 7 to 11 horse power per foot of fall and might well be utilized. These are Big Uchee, Hatchechubbee, Cowikee, Yattayabba, and Omussee Creeks.

TALLAPOOSA RIVER AND TRIBUTARIES.

At Tallassee Falls on this river the Factory Company utilizes a fall of 64 feet, with the development of 8,900 horse power at minimum low water. A few miles further up the river, the Montgomery Power Company has a 40 feet dam by means of which they realize at the wheels 5,572 net horse power. At the Double Bridges Ferry, still further up this river, a dam 35 to 40 feet high would develop a net horse power in proportion to the head the same as that developed at the Montgomery Power Company's dam.

From the mouth of Big Sandy Creek to a place one mile above Griffin's Ferry, a distance of 32 miles, the fall of the Tallapoosa river is 176.5 feet. Nearly all of this fall can be utilized for power by developments similar to those which have been referred to above.

COOSA RIVER AND TRIBUTARIES.

The Coosa River has its beginning at the confluence of the Etowah and Oostanaula at Rome, Ga., a short distance West of the Alabama line. The lower end of the Coosa is at its junction with the Tallapoosa a few miles below Wetumpka, where the two form the Alabama River. From Rome down to Greensport, Ala., a distance of about 108 miles by the river, the stream is navigable by steamboats, the total fall being only about 55 feet. This part of the river will therefore not be considered as having any water power value. Below Greensport, Ala., down to Wetumpka, a distance of 142 miles, there is a fall of about 340 feet. This section of the river it is proposed to make navigable by the construction of locks and dams in connection with which many fine water powers can be developed without interfering with navigation. Plans have been made by the government engineers for the location and construction of 31 locks varying in lift from 5.83 feet to 15 feet and capable of developing from 1,308 net horse power to 4,505 net horse power, according to the lift of each. Only the three uppermost of these locks have been completed. The 4th lock below Greensport and the 31st at Wetumpka are under construction. Details of the available water power at each of the proposed locks will be found in the publications of the Alabama and National Geological Surveys above cited.

The tributaries of the Coosa River from Wetumpka up, according to estimates made by the Alabama Geological Survey, are capable of affording an aggregate of 195 horse power per foot of fall. On these tributaries there are many important water powers, very few of which have been surveyed. A few details where the falls have been measured may not be out of place, Talladega Creek, in the vicinity of Taylor's Mill, has a fall of 73 feet in one mile, where it emerges from the Crystalline rocks. Taking the flow at Nottingham, we may say that during the low water of 1900 and 1901 this 73 feet of fall would have produced 438 net horse power without storage. This 73 feet is probably the most precipitous shoal on the larger creek, but above it for 4 or 5 miles the creek has a number of rapids and shoals that will admit of good development. The head waters of this stream in the neighborhood of Pyriton in Clay county have high falls on them.

Choccolocco Creek is a very large and constant stream, and has many rapids where good powers could be developed by dams. During a season such as low water of 1900 or 1901 a 10-foot dam near Jenifer would develop 86 net horse power. A 10-foot dam at any point near the mouth of the creek would develop 140 net horse power during the given season. Big Wills Creek, at the old Wesson Mill, two miles North of Attalla, has a good site for a 25-foot dam. The flow at this point on October 16, 1901, was 107 second-feet, which with a fall of 25 feet, will give 242 net horse power. The fall on other tributaries named has not been ascertained.

BLACK WARRIOR RIVER AND TRIBUTARIES.

The Black Warrior River is formed by the confluence of the Locust and Mulberry forks and runs in a Southwesterly direction by Tuscaloosa to Demopolis, Alabama, at which point it enters the Tombigbee. The Mulberry fork receives an important tributary known as the Sipsey at old Warrior Town in Walker county. In the 92 miles from Old Warrior Town to Tuscaloosa there is a fall of 158 feet. The distribution of this fall is shown by the table in the water power bulletins quoted above. There are gage stations both at Tuscaloosa and Cordova, Alabama, where systematic discharge measurements have been made for a number of years. Measurements at these two stations at the same stage of low water, November, 1901, show a discharge of 825 second-feet at Tuscaloosa, and 285 second-feet at Cordova. At minimum stage of driest years the water gets considerably lower, but the figures named are safe for low season in all ordinary years, and will be used below for determining the power available at different sites along the river. Locks 10 to 15 are completed, and locks 16 and 17 are under construction at Squaw Shoals. No. 10, formerly No. 1, is the first lock above the bridge at Tuscaloosa. Estimates have been made of available horse power at the lock sites originally proposed, but subsequently the number of locks above Tuscaloosa and the heights at the dams have been very materially changed by reducing the number and increasing the lift.

The best power on the river is at Squaw Shoals, 26 miles above Tuscaloosa, covered by locks Nos. 7, 8 and 9, each having a lift of 14 feet, and making a total fall on Squaw Shoals of 42 feet. This can be developed to best advantage by constructing a canal from the top of proposed dam at lock No. 9, along the river bank, two miles in length, to a point opposite the foot of Squaw Shoals, below lock No. 7. This canal, taking the river water not needed for lockage, and allowing two feet for grade and storage, will utilize a net head of 40 feet, and produce 2,400 net horse power continuously, or 4,800 net horse power for a 12-hour run per day, storing the water above lock. No. 9 during the 12 idle hours.

CAHABA RIVER.

This river rises near Birmingham, Ala., and flows in a Southerly direction, enters the Alabama River at a point just below Selma. From published notes of a survey made by the Corps of Engineers U. S. A., a profile has been constructed beginning at the Southwestern boundary of Shelby county and running down the river a distance of 110 miles to its mouth, in which distance there is a fall of 227 feet.

Measurements and observations have been made at Centervile and at Sydenton but have not extended over sufficient length of time to give accurate measurements of discharge at all seasons. From measurements made on the same day at Centerville and at Harrell near the mouth of the river, it is estimated that the flow at Centerville is about one-third of that at the mouth of the river. The closest estimate that can at this time be made of the river discharge for ordinary low stage of water at Centerville, is 344 second-feet, and from this the following estimates have been made: Power No. 1. This can be developed either by building a dam 34 feet high at mouth of Dry Creek or by building a low dam near the head of half-mile rapids and a canal from it to a point opposite the mouth of Dry Creek. Such a development would give about 500 net horse power with an 80 per cent. turbine at very low season. This power would be near Blocton, Ala. Power No. 2. By building 15-foot dam at the head of Bailey Reach Rapids near the mouth of Big Ugly Creek and constructing from this point a canal along the river bank about 4 miles long to the mouth of Little Cahaba River, a practical head of 54 feet can be developed which would produce about 800 net horse power. The same power could be developed by building a high dam lower down the river, having a short canal, or the power could be divided into two separate powers. This power site is between River Bend and Cadle in Bibb county. Power No. 3. This power could probably best be developed by erecting a dam at Centerville 23.6 feet high. This would produce 732 horse power without storage. A plant running only 12 hours a day and storing water at night could utilize 1440 net horse power. Power No. 4. This power could be developed by a 16-foot dam about 17 miles below Centerville and would produce 670 horse power without storage, or 1,340 feet with storage. Power No. 5. A 15-foot dam at Blocks Cut-off would produce 750 continuous or 1,500 12-hour horsepower. Power No. 6. A 14-foot dam at the foot of Shoal No. 24, or a 5-foot dam at its head and a short canal would produce 720 continuous or 1,400 12 hour horse power. Power No. 7. A 20-foot dam at Fikes Ferry near Marion would develop 1,100 continuous or 3,200 12 hour horse power.

TENNESSEE RIVER AND TRIBUTARIES.

In the Tennessee river in the vicinity of Florence, Ala., are several shoals capable of development of power in large quantity. The shoals are a succession of cascades amidst numerous islands, in a river bed varying in width from half a mile to three miles. The numerous channels thus formed are very irregular in fall and direction. The difference between high and low water is only 5 or 6 feet, corresponding to a difference of 50 feet at Chattanooga.

Beginning at Brown's Ferry, 12 miles below Decatur, the river has the following falls: Brown's Ferry to mouth of Elk River, Elk River Shoals, fall 26 feet, minimum net horse power in average years, 30,550; Big Muscle Shoals, fall 85 feet, minimum net horse power in average years, 99,875; Little Muscle Shoals, fall 23 feet, horse power as above 27,025; Colbert Shoals, fall 21 feet, net horse power as above, 24,675.

WATER POWERS OF THE COASTAL PLAIN.

While the most important water powers are in the region of the older and more consolidated formations where the streams are still in the early stages of their development, yet many useful powers have been developed in the territory of the younger formations of the Coastal plain. Very few measurements have been made in this part of the State.

The Industrial Use of Power in the Piedmont Section of the South.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

BY L. S. RANDOLPH, M. E.

THE financial depression which ravaged the Piedmont section of Virginia some twenty years ago, left that section of the country in an entirely helpless state, from an industrial point of view, as it did the whole of the United States. Certain it was, that the industrial possibilities were recognized, but if such possibilities were only recognized as future actualities through the expenditure of brains, brawn and capital, such information was not generally announced.

The recent industrial development in this region has been along entirely different lines from that of former times. Instead of trying to create a demand for a supply, the effort is now being made to supply a demand and in consequence the industries are on a healthy basis. The most remarkable industrial growth has been in the distribution and growth of power by means of electricity. The Piedmont section, while having but few streams of large flow, has a large number of small streams. While their flow may be small, they have a rapid fall, and in consequence advantage can be taken of that well-known law in the development of hydraulic power, viz., that for a given amount of power, the higher the head the less the cost of installation, other things being equal.

L. S. RANDOLPH, M. E., MEMBER OF A. S. C. E., A. I. E. E. AND A. S. M. E. PROFESSOR OF ENGINEERING VIRGINIA POLYTECHNIC INSTITUTE.

One is constantly surprised at the number of small power plants, sometimes of only one or two hundred horse power, which have been built within recent years. In fact a number of small private plants have been installed where the available power amounts to only fifteen or twenty horse power; electricity being used for the various power requirements of the farm or mill during the day and for illumination at night. The following important advantages have been developed in the use of electric motors on the farm, namely, simplicity, ease of starting, portability and general convenience. Farm machinery as a rule, runs at a high speed to which the speed of the electric motor closely approximates, making unnecessary the long belts and counter-shafts which give so much trouble with the steam and gasoline engines. Many of the small hydraulic plants of the Piedmont section cost but little more than a steam or gasoline engine, with much lower repair and depreciation accounts, much greater freedom from danger from fire losses and no fuel bills to be paid. Scarcely a stream of any size on the headwaters of the James, the Shenandoah, the New River or the Dan but has one or more of these small power plants. In nearly every case their capitalization is small and within the reach of local financiers, by whom they are owned and operated.

An interesting outcome of the development of these small plants is an increasing demand from the farming element, close to our cities and towns with their central power plants, for electrical facilities, small grist mills formerly run by steam or gasoline engines are also run in this way. Several attempts have been made to supply this demand, but so far with rather indifferent success. It is evident that the farming element has not sufficiently awakened to the advantages of electrically delivered power on the farm, and has not sufficiently patronized these country lines. An investigation of a proposed country line to supply a neighboring village some five miles away, with which the writer is familiar, developed the fact that there were twenty-two farms within easy reach of the line, only four however were willing at the present time to take the current. That it will not be very long however before ten to twelve will take the current and in sufficient amounts to make the line remunerative, goes without saying.

The upper Piedmont section with its relatively small drainage areas has not developed any large hydro-electric power plant, very few indeed where they supply all of the current, a steam plant making up any deficiency and being kept running nearly all of the time. There is an increasing probability that some large plants will be shortly erected thus developing some of the larger hydraulic power possibilities. The New River with a capacity of one hundred horse power per foot fall is being investigated by interests associated with the Virginia Iron, Coal and Coke Co. with a view to its development. Numerous power sites on other parts of the river have been purchased, and one large plant has been in operation for several years at Freeze.

The conditions in the Southern portion of the Piedmont section are quite different from those described above as far as hydro-electric installments are concerned. The lofty mountain ranges which form the foundation for Mt. Mitchell, the Great Smoky and the Cumberland mountains give much steeper stream beds than other parts of the Appalachian range. It is here that the moisture laden winds from the tropic seas, the Carribean and the Gulf of Mexico, first begin to pour out their generous store of rain.

The minimum daily run off per square mile of drainage area of the Tusgasegee, Etowah, Watauga, Nottely, and Nolichucky, which lie in the triangle formed by Mt. Mitchell, the Great Smoky and Cumberland Mountains, is for the driest year recorded as 0.36 cubic feet per second. For the Tombigbee, Alabama, Flint, and Cape Fear rivers of the plain, the same figure is 0.125 cubic feet per second. For the head waters of the James, the Roanoke, the New River the minimum dry year run off is 0.161 cubic feet per second.

In the Northern portion of the Piedmont section where we would have plants of from 200 to 1,000 horse power, in similar situations of the Southern portion would be found plants with a capacity of from 2,000 to 10,000 horse power. With a rate of fall of double and a minimum flow increasing in similar proportions, the value of the water power would increase in much greater ratio than the product of these two.

In the Southern portion of the Piedmont section, there are few fertile valleys so that agriculture is a secondary matter, although fruits and similar products are coming to the front very rapidly. These sites where power can be developed cheaply however the region is peopled to an extent almost incomprehensibly. Nestled away in some mountain gorge with towering peaks all around it, close to the railroad that brings in its raw material and takes away its finished product, or close to some thriving city to which it adds its quota of enterprise, will be found some large cotton mill or other industry.

When the cotton manufacturing industry was first developed in New England it was necessary to place the mill on the banks of the stream, in order to have the power delivered without a loss in transportation which would be impossible to stand. The question of proximity to market or source of supply of labor and material was a secondary consideration. With electrical transmission, the proximity of the source of power becomes a secondary consideration and the factory sight may be chosen with a view to the most economic sources of supply, of land, labor, material, and transportation facilities.

There is found in the Southern Piedmont section the cheapest power anywhere east of the Rocky Mountains, the only place comparable to it being at the fall line separating the coastal plain from the plain of the foot hills. This, with cheap cost of living for operatives, and the isolation which admits of ready control and cheap land, leaves only the selection of a site, with a view to satisfactory transportation facilities, in order to obtain the conditions for the lowest prime cost. These conditions have brought many of the cotton and textile mills to this region, as a rule to the Eastern and Southern portion in the closest proximity to the cotton fields, Western North and South Carolina with North Georgia and Alabama having the majority of them, Eastern Tennessee and Kentucky having a much larger proportion of other manufactories particularly those requiring coal in large amounts.

Where steam driven central stations exist, they are almost without exception, auxiliaries to the hydro-electric stations, only operated during periods of low water. An interesting tendency is noticeable in the Piedmont section, namely, the linking together of several water plants forming a network, at one of which convenient to a coal supply, an auxiliary steam plant is located.

Two lines of future development for this region stand prominently forward, the lumber industry and the mining of the metals, of which this country has so varied a store. So far, few lumber plants have used electrically driven machinery to any extent, as comparatively few are close enough to transmission lines and but few permanent mills have been erected. Some, however, are attacking the problem of lumbering on broad and comprehensive lines, and such plants are treating the entire proposition as a factory. The land is but a machine to make trees and the mill is another machine to convert these trees into a marketable product. Several such plants are in operation and are now cutting the second growth trees from their land. Such plants can afford to have motor driven machinery without a belt or a fire on the premises, it not being difficult to find a use for the wastage.

The Piedmont region has now the largest supply of hard wood lumber in the country. So far however but little furniture is manufactured although the conditions are ideal. Cheap power and an abundance of raw material need but the magic touch of brains and capital to turn the region into the center of the furniture industry of the country. To convince one that this prophecy will some day come true, needs but a moments' consideration of the well known economic law, "That manufacturers follow the raw material."

The most fascination and probably the most important prospect for the future, is that along the matallurgical lines. The electric furnace is in its infancy and we are just beginning to realize the possibilities of electrolysis, both with aqueous and fused electrolytes. It is confidently predicted, and indeed experiments seem to prove, that the electric furnace can compete successfully with the blast furnace. Just as we are beginning to realize that there may be a limit to the world's supply of iron ore, our metallurgists are discovering that there are other things to take its place. There are already electrolytic plants for the manufacture of an alloy of chromium iron so much used in the manufacture of high grade steels. Chromium, Manganese, Tungsten and numerous other alloys are coming into greater use in the arts, particularly in the steel industry.

When we come to a consideration of the other products of the electric furnace and of electrolytic action one must frankly admit the impossibility of doing more than touching the surface of the subject. The calcium carbide from which acetyline gas is made is only a mixture of finely ground coke and lime which has passed through the electric furnace; all of these materials are in close proximity. Carborundum, which has supplemented emery as an abrasive, is another product of the electric furnace.

When one considers that aluminum, which was but a few years ago a scientific toy, is now supplementing tin, copper and some of the other metals, and to this add the fact that cheap electricity is one of the most important elements in its manufacture, its importance can be readily comprehended. Such a discussion could be prolonged indefinitely, the enormous salt fields West and North of the Piedmont section could be mentioned, and the enormous coal fields to North and West.

Undeveloped Resources of Southern States

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

BY S. W. MCCALLIE, STATE GEOLOGIST OF GEORGIA.

CHIEF among the undeveloped resources of the Southern States are her water powers. This most valuable asset has only recently attracted the attention of capitalists, and its development has scarcely begun. According to Mr. M. O. Leighton, Chief Hydrographer of the U. S. Geological Survey, the estimated maximum water power of the Southern states is approximately 9,000,000 horse power. Of this estimated horse power, only about 900,000 horse power, or one-tenth of the available power is now actually in use. Still more important than the water powers are the enormous, only partially developed, mineral resources of the South, the most important of which are the deposits of coal, iron, gas, clay and phosphates.

The coal area of the Southern States, embracing Virginia, Maryland, Kentucky, Alabama, Tennessee, and Georgia, has been estimated by government experts at 70,866 square miles. Coal mining developed slowly in the South. In 1880 the annual production was but little more than 6,000,000 tons. In 1907, however, the output had increased to 100,000,000 tons. At the present rate of increase, it is estimated that by the year 1930 the coal output will be 400,000,000 tons which was practically the coal output of the entire United States in 1908. Despite this enormous output, estimated for 1930, the coal supply of the South is ample to last for more than a thousand years.

The iron ores of the South, now available, are estimated at 777,940,000 tons, and those not now available by reason of the low iron content, but will become available in the future, is estimated at 1,820,500,000 tons. Iron ore mining in the Southern States developed much more slowly than coal mining. The output of the mines in 1881 was approximately 1,000,000 tons. In 1900 it had increased to four and one-half million tons and in 1907 it was approximately 6 and one-fourth millions. At the present rate of mining the iron supply of the South will last for more than 400 years.

Oil and natural gas, which are always intimately associated, are both sources, at present, of large revenue to the Southern states. The South has 1,560 square miles of oil lands which have produced 335,549,797 barrels of oil. At present, there are 27,239,057 barrels produced annually. At this rate of production, the South will have sufficient oil to last for 25 years, when the duration of supply will doubtless be lengthened by the discovery of new oil fields. Natural gas is found in West Virginia, Kentucky, Tennessee, Alabama, Texas, and Louisiana. Dr. David T. Day, of the U. S. Geological Survey, has valued the natural gas output of the South, up to the close of 1907, at $77,085,717, and for the year 1907 at 17,229,714.

Phosphates were first mined in the South in South Carolina in 1867. Florida, Tennessee, and Arkansas are also producers. The mining of phosphates has marked a new era in the history of agriculture in the South, increasing as they do the products of the soil very nearly half. The total production of phosphates up to the year 1907 was 29,168,680 tons and for that year, 2,265,343 tons. Owing to the great abundance of phosphates and phosphatic marls in the South, the supply will last for a long period of years.

Clay of superior quality for high grade china, paper, and other purposes, in a large measure undeveloped, is found in many of the Southern states. Georgia, Florida, and South Carolina have especially valuable clays for these purposes. The deposits are among the most extensive and valuable in the United States, and a large percentage of high grade domestic clays used in this country are obtained from these three states. The Southern states have, in addition to these high grade clays a practically inexhaustible supply of clays suitable for the manufacture of brick, tiles, etc.

The most important building stones of the South are marbles, granites, limestones, and sandstones. They occur in great variety and are widely distributed. The marbles of Georgia, Tennessee, and Alabama are especially noted and are extensively used throughout the United States for building and monumental purposes. The marbles of Georgia are very popular, and have been used in the construction of many of the handsomest buildings in this country. Scarcely less noted are the granites, limestones, and sandstones of the South, and so abundant is the supply of these stones that they may be said to be practically inexhaustible. The value of the stone products for 1907 in the South was $9,811,492. This output can be increased almost indefinitely if necessity should demand it.

The cement industries, both natural and Portland together with the lime industry, are destined to play an important part in the South's economic development. While the manufacture of Portland cement in the South is only in its infancy, yet the output at present is greater than the output of the entire United States 12 years ago. The raw materials for the manufacture of this cement are practically inexhaustible, and as they are widely distributed they offer excellent opportunities for development.

Gold is found in economic deposits in six of the Southern states and while it has never been productive of fabulous wealth, yet it has proved a steady source of revenue and still continues to yield a considerable output. Prior to 1849, all the gold used in this country came from the South. The total production of gold in the South has been variously estimated at from 50 to 75 millions of dollars.

Copper is found in several of the Southern states, but the most valuable deposits are in the Ducktown district of Tennessee. Indeed, to Tennessee belongs the honor of establishing the largest sulphuric acid plant in the world, which renders the destructive fumes of these ores harmless to vegetation and renders them a valuable bi-product of copper, used for the manufacture of commercial fertilizers.

Bauxite and manganese are found in valuable extensive deposits in the South, as are also asbestos, pyrite, sulphur, talc, soapstone, mica, graphite and fuller's earth. The various minerals above mentioned, as well as other minerals of the Southern states, offer excellent opportunities for the investment of capital.

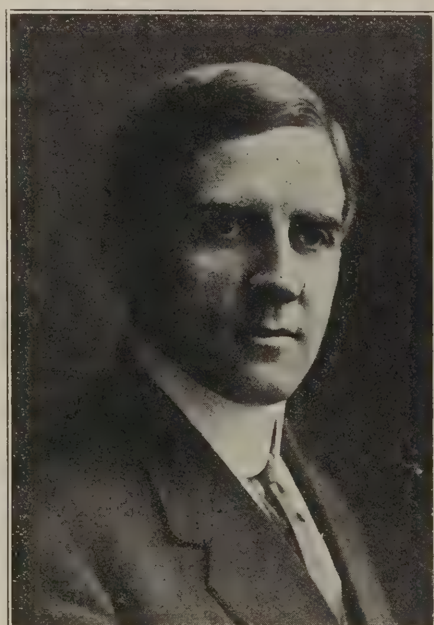
Production of Hydro-Electric Power and its Utilization in the South.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

BY WILLIAM C. SPIKER, C. E. ASSOCIATE MEMBER, A. S. C. E.

THE convenience in using electric power and the development of long distance transmission has made water power valuable. It has been only fifteen or twenty years since water power was first developed to be used at a considerable distance from the water wheels, yet during this period great improvements have been made in the methods of procuring electrical power from the power of falling water.

It can be demonstrated that water power is cheaper than power produced from coal. This fact is strongly indicated if not practically proved by the fact that so many water powers are now being developed. That electric power is convenient and efficient is indicated by the fact that not only is water power utilized through the electric motor, but also, steam power is often transformed into electric current and through the motor back into power. Since it is often advantageous to generate electricity from steam power and then use the power a short distance from the steam plant it is apparent that electrical power secured from an hydro-electrical plant is comparatively ideal. Especially is this true when one considers that power can be produced by this method at thirty to ninety per cent. of the cost of power taken direct from a steam engine.



WILLIAM C. SPIKER, C. E. ASSOCIATE MEMBER OF A. S. C. E. AND CONSULTING HYDRO-ELECTRIC ENGINEER.

Electrically driven mills well lighted and ventilated are coming to stay; not because of laws passed to compel it, but because they will pay dividends. In mills where electric motors are used to drive the machinery, there is practically always an increased production and the quality of the product is usually better. Leading cotton manufacturers have said that not under any circumstances would they use in a cotton mill any other known power.

In a cotton mill uniform speed is essential to a high grade of product. In any electrically driven mill, the machines can be located independent of drives and therefore so as to be relatively in the best possible position to secure maximum efficiency in operation. There is less noise and dirt and the mill can be maintained in a more sanitary condition. On account of the mills being more sanitary and a more cheerful place in which to work the operatives work at a higher degree of efficiency. Therefore, simply on account of a mill being driven by motors instead of ropes or belts, the mill turns out more product and at the same time a better product.

The advantage in driving by electric motors is now known to be so great that there are cotton mills being built a short distance from water power sites when they could be built at the site and be driven directly from the water wheel shaft. All of this indicates a long step since the time when water power was utilized only by the little grist mills through the now old-fashioned but familiar overshot, undershot, or breastwheel.

Modern turbines are only a few years old. Their development has taken place rapidly because the perfecting of electric transmission resulted in the demand. Only thirty-three years ago the first plant was put in at Niagara Falls. The available head was then as now 210 feet, but only 25 feet of this head was utilized because there was then no one in this country who could design or build a wheel to work under a greater head. Only four years later a wheel was installed to utilize the full available head. There are now plants utilizing heads up to several thousand feet and also plants utilizing heads as low as two feet and lower.

TYPES OF DAMS.

The power of falling water is made useful by compelling the water to turn a wheel. This result is accomplished by passing the water through, over or around a natural or artificial dam. Most developments require an artificial dam, and these may be earth, wood, stone, steel, concrete or a combination of these materials. Dams are either gravity dams, arch dams, pressure dams on a combination of these principles. Their failure may be sliding, overturning or rupturing and caused by water leaking under the dam, through the dam, by a very exceptional floodwater going over the dam or on account of the dam being too light to carry its ordinary load. Earth dams are most likely to fail on account of leakage. Wood dams decay. Steel dams rust. Masonry and mass concrete dams are most likely to fail by sliding. Reinforced concrete dams can fail only by rupturing; which in turn can result only if the dam is designed too light.

The greatest danger to solid masonry dams is that the water may get under the dam and tend to raise it and perhaps at the same time a flood higher than reckoned upon may go over the dam and create a vacuum on the downstream side of the dam thus causing it to slide as was the case with the famous dam at Austin, Texas. On account of a reinforced concrete dam being hollow, it can be built economically with the upstream face on such a slope that the pressure of the water tends to hold the dam down and thus prevent both overturning and sliding. The same principle is made use of in timber dams and if they could be kept always wet so that they would not decay, they would be economical.

There are many types of movable dams and movable crests for dams built for the purpose of raising the headwater when occasion requires. These dams are lowered in case of a high flood or are washed away and replaced as is often done where the ordinary type of flushboard is used. The approximate probable cost of a dam on rock foundation can be estimated roughly in dollars per lineal foot of dam by squaring the height of the dam and dividing by ten. Multiply this result by the length of the dam in feet. If the dam must be built on earth the cost may increase 50 per cent. to 100 per cent.

In making at first very rough calculation of the probable power available at a site, it may be interesting to remember that in most sections of the South, except in the mountains, the horsepower which could possibly be developed would be approximately equal to the drainage area in square miles multiplied by the height of fall in feet divided by seven. This will usually require that there be at least a small storage and regulating reservoir.

FLUMES AND PENSTOCKS.

Power houses are built as a part of the dam; or inside of the dam; or at any distance from immediately below the dam to a number of miles from the dam. When the power house is at a distance from the dam or reservoir the water is carried by a canal, flume, tunnel or penstock; or a combination of these, as best suits conditions.

Flumes are usually made of timber, some have been made of masonry. Reinforced concrete will no doubt be much used for building flumes in future. The velocity of the water in a flume should ordinarily be six to eight feet per second. In case a canal is used, the water must flow at a velocity which will not erode the banks. This velocity will vary from one foot per second for a canal in sandy soil, to ten feet or more for a canal in rock. Since a canal carrying water at a slow velocity in most sections of the South will deposit sediment or silt at such a rate as to soon reduce the flow of water in the canal, canals in this section should ordinarily be built to carry water at a comparatively high velocity. This will usually require that the canal be lined either with wood or concrete. To secure a high velocity in a canal or flume the slope must be increased, but for canals and flumes of ordinary length this will not appreciably reduce the working head on the water wheels.

Where a tunnel has been used it has usually been a non-pressure tunnel, in which case it is practically a canal dug through a hill or mountain. A pressure tunnel is one built to flow full of water under pressure, which practically makes a penstock of the tunnel. Penstocks are usually made of riveted steel plate. Sometimes under high heads welded joints are used to reduce friction in the penstock. In the West, wood stave pipes are often used, while Cypress penstocks have been considered for use in the South.

To control the flow in the canal or flume, headgates are provided. These gates should be set at a sharp angle with the current in the river where possible, so that in case of high water driftwood will be carried past the gates. In comparatively small developments these gates will always be made of wood, will lift vertically and be operated by hand. Except where the turbines are set directly in the headwater as in Fig. 1 a penstock is used to conduct the water to the wheels. The wheels are then set inside the enlarged end of the penstock, which enlarged end is called the wheel case, as indicated in Figs. 2 and 3. In the case of an impulse or pelton wheel the wheel or wheels are set just outside of the end of the penstock and the wheels are driven by jets from nozzles attached to the penstock. In practically all developments where the working head is over about 35 feet a penstock is used. The penstock may be a few feet long as in Fig. 3 or it may be as much as several miles.

TYPES OF HYDRO-ELECTRIC DEVELOPMENTS.

A power house built inside of a hollow reinforced concrete dam, is indicated in Fig. 3. A plant of this type is in operation on the Patapsco River near Ellicott City, Maryland. Another has recently been built at Marble Falls on the Colorado River in Texas. A similar plant is being built near Athens, Ga., and others are projected. A notable feature of the Marble Falls dam is that it is full of sluice gates which can be operated from the inside of the dam. In case of a flood all gates are opened. This allows the flood to pass through the dam reducing the strain on the dam and carrying the silt out of the pondage reservoir.

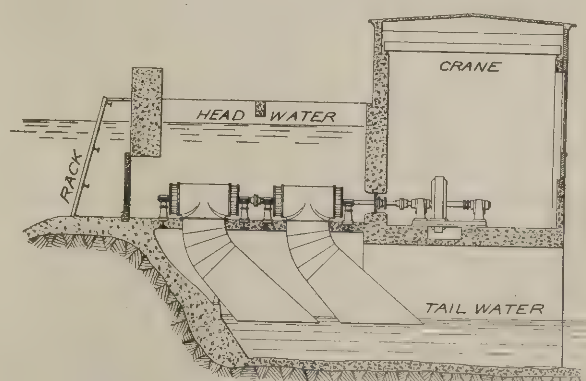


FIG. 1. TYPE OF LOW HEAD DEVELOPMENT, HORIZONTAL TURBINE, DIRECT GENERATED.

A type of construction of which many have been built is indicated in Fig. 2. The general arrangement and details vary considerably. For instance the penstocks have usually passed through the dam instead of being built in the dam and the switches are located in different places. Often the turbines are set on a vertical instead of on a horizontal shaft. The general scheme, however, is the same in each case. Where this type of development is used the head is usually 35 to 125 feet. A large new plant of this type is the one recently completed on the Ocmulgee River near Jackson, Ga. The large plants at Rocky Creek and at Great Falls, S. C., are of this type. The plants at Columbus, Ga., are of this general type.

The type of development indicated by Fig. 1 is well suited for use where the working head is from about 15 feet to say 35 feet. Under proper conditions this arrangement is very efficient, especially under a head of 20 to 30 feet. There is a saving in the cost of a penstock and a saving on account of eliminating the friction that takes place in a penstock and wheel case. From a thirty foot head up to possibly a hundred foot head the most economical and efficient development for most conditions especially in a narrow gorge is the type indicated in Fig. 3. It will be noted that in this type of development the penstock is very short and that no additional room is required for the power house.

In any scheme of development, the turbine wheels and generators may be set on either a vertical or horizontal shaft. For very low heads and small plants, it is some-

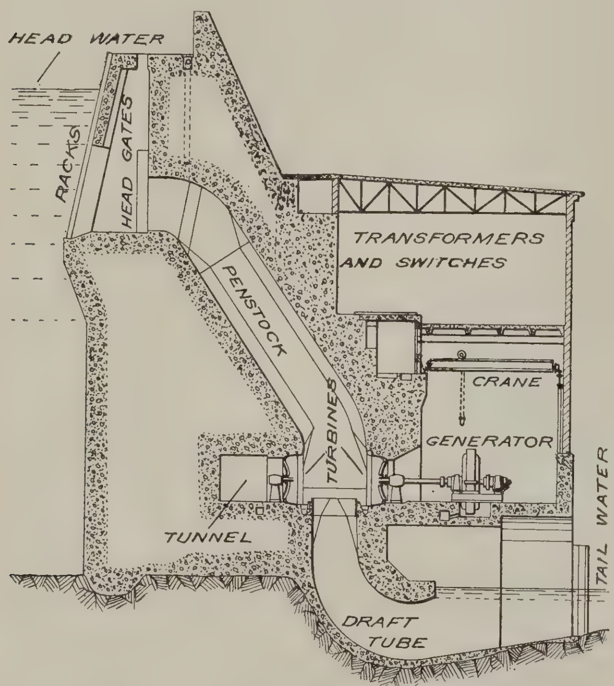


FIG. 2. TYPICAL MEDIUM HEAD DEVELOPMENT.

times better to set the wheels vertically and gear them by bevel gears to the generator shaft set horizontally. Sometimes the wheels are set horizontally and belted to the generator. Gearing or belting is necessary in case of very low heads because the speed of water wheels decreases with the working head. The speed of the wheels increases as the size decreases and therefore in planning a medium low head development there are a great many combinations and arrangements possible.

TYPES AND APPLICATIONS OF TURBINES.

The old-fashioned overshot and similar water wheels are no longer used. Not because of their inefficiency but because of their comparatively great cost. The small modern turbine does the work equally well. Turbines are of two general classes known as impulse turbines and reaction turbines. Impulse wheels or turbines are driven by a jet or jets of water playing on the circumference of a wheel. This kind of wheel is usually called a pelton wheel in America. Reaction turbines are submerged in the water and are driven by the water pressing simultaneously on all of the blades vanes or buckets of the wheel. Reaction turbines are divided into four types in accordance with the direction the water takes in passing through the wheel as follows: Radial outward flow as in the Fourneyron wheel; axial downward flow as in the Jonval wheel; radial inward flow as in the Frances type; and mixed flow which is known as the American type. Turbines are further classified by the kinds of gates through which the water passes to the wheels. These are cylinder gates, register gates, and wicket gates. Again turbines are classified as setting on a vertical or on a horizontal shaft.

Pelton wheels are used only under high heads, 200 feet and over and are therefore not likely to be used much if any in the South. Within the last few years many Frances turbines have been designed to work under high and medium high heads. Special designs are necessary for high head wheels, and for medium heads. Taking cost and efficiency into consideration, it will often be economical to install a special design rather than a "stock wheel."

The speed of turbines is regulated by varying the flow of water. This is done automatically by governors. Impulse wheels are regulated by varying the size of the water jet or by deflecting it. In reaction wheels the gates are opened and closed as required. Turbines are designed to carry their ordinary load with the gates about three-quarters to seven-eighths open. Governors are of three or four different makes and are in America either hydraulic governors or mechanical governors. They should be selected which act either quickly or slowly as will best serve the purpose in a specific case.

HYDRO-ELECTRIC CONSIDERATIONS IN THE SOUTH.

The first consideration in connection with a possible hydro-electric opportunity is the amount of water available, the uniformity of its flow and the available head under which it can be made to work. To determine these questions requires much studying of government reports, studying of the topography and vegetation of the watershed, stream gauging, surveying and computing. In developing an hydro-electric opportunity the object is to deliver a maximum of the most suitable kind of electric current to the best market for a minimum first cost, maintenance and operating cost. To this end under the specific conditions there will be a best type of generator, a best voltage, best number of generator units, best exciters, best governors, most suitable turbines, best number of turbines, best relative arrangement and best setting of all apparatus, best and cheapest housing of apparatus, best and cheapest dam and headworks, and best and cheapest transmission line.

Power to be valuable must be constant and since the source of hydro-electric power is rainwater it is important that rainfall be evenly distributed throughout the year or

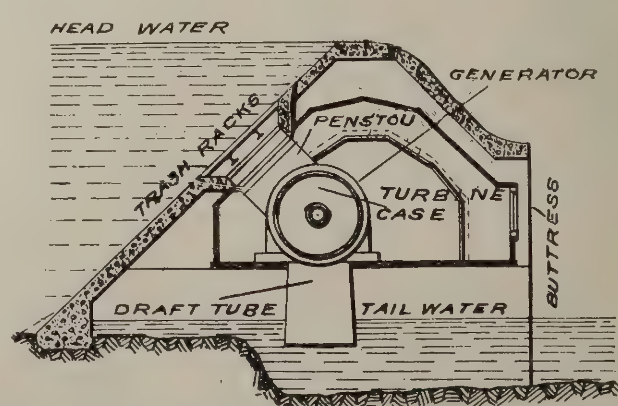


FIG. 3. POWER HOUSE INSIDE OF REINFORCED CONCRETE DAM.

throughout a large part of the year. The mean annual rainfall in the Southern States is forty to seventy inches. And the rainfall in the six summer months is forty to seventy per cent. of the total. The mean average rainfall in the United States is 29.4 inches, so there is no other section in the United States nearly as large as the South and in which the rainfall is as great as it is in the South and at the same time as evenly distributed.

The South is also unusually favored by its topography. In the Appalachian region there are some of the finest medium head opportunities to be found anywhere. There are hundreds of low head opportunities all over the Piedmont Plain. This plain extends from the base of the Appalachian Mountains toward the Ocean and the Gulf a distance varying from a few miles in the north to some 300 miles in North Carolina and somewhat less in Alabama. All along the line, known as the "fall line," where the Piedmont Plain breaks over into the lower Coastal Plain, there are falls or rapids wherever there is a stream. This line can be roughly traced even now by noting the location of a number of the larger powers already developed.

The South has no lakes to act as natural river flowage regulators. It has, however, large tracts of forests located in the right place to serve the same purpose. Beside regulating stream flow to the advantage of power companies, forests and natural or artificial lakes regulate the flow to the advantage of navigation. Besides this they reduce the damage caused by floods to an extent which perhaps makes them more useful for this purpose than for any other.

It is therefore of great importance to the South that deep artificial lakes be constructed and of the greatest importance that a maximum of the forests in the Southern Appalachian region be maintained. To this end the proposed Appalachian Reserve Bill should at almost any cost be passed. Only six years ago the first plant of a now great southern hydro-electric power company was put in operation. This company is now operating a number of large plants and building others. Beside furnishing power for traction companies and for the lighting of many cities it already furnishes power for the driving of over 140 cotton mills. There are two or three other companies following this lead and many cotton mills have developed and are planning to develop their own hydro-electric power.

A most interesting possibility in connection with hydro-electric power and the development of extensive business interests in the South is contained in the fact that the National Government has begun to improve navigable rivers by building locks and dams high enough to create incidentally a valuable water power. A notable project of this kind in the South is the $3,000,000 improvement at present under construction on the Tennessee River. In this class of development the same dam serves three purposes and it has begun to look as if the power is to be more valuable even than the improved condition of the river for navigation. These same large dams create flood and flowage regulating reservoirs any one of which on any river is useful to all of the water powers and commercial interests below it.

SOUTHERN HYDRO-ELECTRIC POSSIBILITIES.

That there are vast possibilities for developing hydro-electric powers in the South, is shown by the following table of developed and undeveloped powers on the principal rivers in the South. This table has been made up from the reports of the Interior Department of the United States. The undeveloped horsepower is the estimated maximum commercially available.

NAME OF RIVER SYSTEM.	HORSEPOWER DEVELOPED.	HORSEPOWER UNDEVELOPED.
James River	40,173	300,000
Chowan	3,528	10,100
Roanoke	36,066	343,000
Neuse	11,365	10,000
Cape Fear	27,539	80,000
Pedee (Yadkin)	58,299	334,000
Santee	205,736	590,000
Savannah	59,535	438,000
Ogeechee	1,965	10,700
Altamaha	44,531	94,000
Apalachicola	71,273	326,000
Tombigbee	6,290	100,000
Alabama	47,761	487,000
Brazos	448	20,900
Colorado (in Texas)	1,503	55,700
Guadalupe	6,447	43,400
Pecos	637	87,800
Tennessee	221,599	1,950,000
Cumberland	13,007	159,000
Green	3,774	28,500
Kentucky	*2,916	45,100
Big Sandy	1,505	57,600
Kanawha	22,612	1,020,000
Other smaller rivers	29,177	170,700
Totals	917,646	6,761,500

There are a great many powers in the South not included in this list because they are on streams the greater extent of which is in other sections or on boundary lines.

THE SOUTHERN MARKET FOR HYDRO-ELECTRIC POWER.

The South has therefore the opportunities to develop hydro-electric power. She also has the markets for the power. Aside from all the rapidly growing cities and towns needing light and small units of power, there are many electric railways needed which are not yet projected and many of the steam railroads will be running electric cars and trains on their tracks much sooner than most people expect. The South now raises $1,000,000,000 worth of cotton and cotton seed. She now manufactures more cotton goods than New England and much the larger part of this is done by steam power at present. There are something like 1,000 cotton seed oil mills in the South almost all driven by steam power which on account of the small size of most of the plants is exceptionally expensive. Since oil mills operate only in the colder months when the flowage in the rivers is above the average these oil mills could be operated by hydro-electric secondary power which otherwise would largely run to waste and which therefore could be supplied to oil mills at a small fraction of the present power cost.

Think of the amount of business which will be done in the South when even one-half of the undeveloped water powers are working. And consider the saving to the South if all the power which is being used even now were hydro-electric power working at an increased efficiency of only five per cent. and costing even as much as seventy-five per cent of what steam power is costing.

Reflections on Southern Industrial Progress During the Past Decade.

(*Written for* SOUTHERN ELECTRICIAN.)

BY D. H. BRAYMER.

THE results of the census enumeration for the year 1910 has been announced by the government both for states and for sections. The South taken to include the South Atlantic States, South Central States and Missouri, Oklahoma, Texas and New Mexico, shows an increase in population during the past decade of over 18 per cent. with striking increases in the population of various sections and in a number of Southern cities. This official increase in population of the South, confirms the general opinion which has been voiced of late that the condition of the South has been growing better year by year in every industry. Reports from all sections are full of encouragement for future development and the results which have already been accomplished indicate plainly that the South has regained its position of 30 years ago in regard to the industrial and manufacturing features of this country.

Thirty years ago when the South began anew its manufacturing and commercial pursuits, the largest city was Baltimore with an inhabitance of less than 350,000 people. The census of 1880 shows only thirteen cities in the South having a population greater than 25,000 with Baltimore and New Orleans reaching the highest mark of 100,000 persons each. At the present time the South has 41 cities with a population of over 25,000, twenty per cent. of the total number of cities in this classification throughout the United States. Among the 100,000 inhabitant class the South has nine cities also nearly twenty per cent. of the number in this class throughout the United States. From the recent statistics, the Southern cities showing large rates of increase are Oklahoma City, Okla., with 539 per cent. to its credit. Second to Oklahoma City, is Muskogee, Okla., with 494 per cent.; third, Birmingham, Ala., with 245 per cent.; fourth, Fort Worth, Texas, with 174 per cent., and fifth, Tampa, Fla., with 143 per cent. Among the eighteen cities showing an increase in population of over 90 per cent. out of the 156 cities reported at this writing, eight or nearly 40 per cent. were those from Southern States.

Throughout the entire South signs of progress and general prosperity are noticeable on every hand. Activity in construction work on large and small undertakings is reported more extensive month by month. This activity is not confined to any particular line, but includes new and modern office buildings, industrial plants, warehouses, dwelling houses, churches, schools, and public buildings, and serves as an indication of a general prosperity and the increasing wealth resulting from the fast going commercial, industrial, and financial conditions of the South.

Perhaps one of the most recent agencies showing up in a convincing way the actual resources of the South was that of the Ohio Valley Exposition in its exhibition held during last summer at Cincinnati. A portion of the exhibition space was given to the South and its material resources and there was exhibited the actual products from the various Southern States. Orange and lemon tree specimens were shown as grown in Texas, also rice, cotton and the cotton seed products. The woods of Arkansas, Mississippi, Tennessee, Virginia and Florida were represented by samples of the 150 million acres of hard wood and pines from these Southern States. The coal of Kentucky, West Virginia and Alabama and the many minerals generally unknown from Virginia, Kentucky, Alabama and Georgia were in abundance. South Carolina had its fishery exhibit, Louisiana and Mississippi their syrups, sulphur, salt, rice and other vegetables, North Carolina its brown stone, marble, sand stone, granite, quarts and surpentine, while fruits and vegetables of every known variety were features of the display.

Industrial activity is not a new thing to the South. This section has been held up in its progress and is simply now accomplishing what it would have done had it not been for the years of confusion following the civil war. The sentiment which has held the South handicapped with certain supposed conditions adverse to general progress dates back many years. Among these supposed adverse conditions that have been forwarded are, the sub-tropical climate, absence of natural forces and resources necessary to serve progress, the presence of the negro in large numbers, unhealthy conditions, and social and political intolerance. While in the minds of the masses not exactly familiar with general conditions, these features have always been connected with Southern activity, it may be said that no one of these conditions has been a handicap. Unquestionably the greatest hindrance to Southern progress was the one-third of a century of political disorder and impoverished conditions. This has all past and now manufacturing and commercial activity has revived to a degree equal to that of any section of the country.

SOUTHERN DISTRIBUTION OF POWER.

The distribution of power for manufacturing purposes, is an intensely interesting study for all sections of the United States. According to the United States census for 1905 the middle and central States are credited with the largest horsepower. It is stated, however, that for the first time in the history of the country, the horse power used in manufacturing in the Southern States exceeds that reported for the New England States. The South reported a total horse power for manufacturing in 1905 of over two and a half million, a figure which is larger by forty thousand horse power than the total horse power used for manufacturing in this country 35 years ago. While the whole country has developed and large increases have been made all this time, records show that the South has kept pace by developing about one-seventh of the total horse power of the United States over the period of 35 years. The motive power of Southern States is about 80 per cent. steam and 6 per cent. water power. The gains in steam power have been rapid, Alabama increasing over 72 per cent. in the five years from 1900 to 1905, Georgia, 65 per cent., Mississippi 69 per cent., North Carolina 49 per cent., and South Carolina 94 per cent. which is the larger single gain. The increase in the use of power in the South, is not confined to the States mentioned, it is altogether general. The principal large gains, however, occur in those regions which have undergone rapid developments in the textile, mineral and timber resources for manufacturing purposes.

The development of electrical power is comparatively new to the South, as it was only in 1890 that there was any data compiled for this source of power for any section of the country. During the short time which has intervened, the use of this type of power has undergone a rapid development and any data taken five years ago is now only an indication of the tendencies at that time. The electric motor has become generally adopted in nearly every line of manufacturing where a source of electrical energy is available. The evolution of the motor drive is not yet complete, however, it has reached such a stage and been applied to such a variety of uses that the actual data soon to be issued showing the extent to which the electric motor has been used, will bring out remarkable developments and results never dreamed of ten years ago.

The tendency in the South is to use power from central stations on account of the convenience and possibility of obtaining it for a large or small equipment. The possibility of connecting numerous small loads to the lines of a central station in any territory, has brought about the establishment of well designed transmission systems, transmitting energy at high voltages over long distances, and reaching out to the various plants about any section. On account of the numerous opportunities to utilize hydraulic power and generate electrical energy in the South, there has been a large development along this line materially reducing generating costs and enabling a small company to supply energy at such a rate as to be generally used. Information in regard to the development of this feature of the electrical industry is taken up in another section of this issue of Southern Electrician in detail and it will not be carried further here.

In view of the foregoing facts based upon the data furnished by the government in the last census of industrial developments, it can only be concluded that the period through which the South is now passing, is revealing the wealth of natural resources and the possibilities of development which have long been unknown on account of political, financial or engineering conditions. Since the South has regained its own place in the developments which are under way throughout the country, a goodly number of the new things which remained to be accomplished in engineering and industrial fields bid fair to be a part of her contribution to the future.

SOUTHERN INDUSTRIES.

According to the value of products, the most important industries of the South are agriculture, lumbering, and textiles. The importance in which these industries are found throughout the Southern States is for the most part in the order named. Agriculture from value of products stands first in six States and third in four. The lumber industry stands first in three States, second in eight States, and third in four States. The textile industry stands first in three States and third in two. The iron industry of Alabama and Tennessee, of course, holds a high position in the iron and steel industry, Louisiana in the rice industry, and South Carolina in the fertilizer industry.

Unquestionably the most important development in the textile industry has been the expansion of the cotton manufacturing end. While the largest number of establishments at the present time are in the New England States, those establishments which are turning out cotton products in large quantities are located in North Carolina, South Carolina, Georgia and Alabama. Situated at the center of the cotton growing field, these establishments, with exceptional power and transportation facilities, bid fair before long to handle practically the whole crop of the raw product. The increase in numbers of textile establishments reported in 1905 for the five years preceding, was 251, this increase being almost entirely confined to the South. With over 800 textile establishments and a capital invested of more than $250,000,000 an increase of approximately 90 per cent. for the South during the past decade, it will be readily seen that this industry, developing from the product which is the standby of the Southern farmer, is in a growing condition.

In 1905, the spindle capacity of North Carolina, Georgia, Alabama, and South Carolina exceeded that of New England, excepting Massachusetts, by more than one and one-fourth million. This growth is not stopped, for today the number of cotton spindles in the South has increased to eleven and one-half million since 1905, a growth of over 90 per cent. The long lead of Massachusetts in the old established mills, of over 20 per cent. of the number of Southern spindles in 1905 has been cut down year by year, until at the present time the spindle capacity of this State is approximately 300,000 less than for the South. The industry from natural causes is being transferred to the section which has long been known as the land of cotton.

The motive power represented by the textile industry, is at the present time a large percentage steam power. There has been during the past ten years a remarkable evolution in the application of power to mills and especially in the application of electric power. Statistics show that the increase in the use of the electric motor is large in all sections being about 200 per cent., or an increase for the whole country during the period of 1900 to 1905, of 37,500 electrical horsepower and 175,000 steam horsepower. This date which is five years old only indicated the general tendencies, for today it is safe to assume that the increase in electric power in cotton mills has at least doubled. Especially is it to be expected in the South, due to the rapid development of water power and the establishing of a large number of new mills either equipped with individual electric plants or using power from a commercial central station. The water power development at the present time in the cotton manufacturing States of North Carolina and South Carolina, Alabama, and Georgia, has reached an aggregate of over ten thousand wheels delivering over 690,000 horse power.

THE LUMBER INDUSTRY.

On account of the general distribution of timber in the United States and the manufacturing of lumber products generally in all sections, any increase in the production of these products by any section indicated two things. Either that the particular section is rich in a particular grade of wood used exclusively by certain industries, or that there is an extensive progress in the way of building and land development. The large increases in this industry in the South during the period from 1900 to 1905 points out the second condition. The lumber industry five years ago was first in importance in three States, second in eight, and third in four. Louisiana occupying ninth place in the industry in 1905, rose to first place in the South and to fourth in the country. Mississippi rose from 12th place to 8th, Alabama from 19th to 13th, and Tennessee from 10th to 9th. In 1905 saw logs constituted nearly nine-tenths of the total logging products, the South being active in this production; Louisiana advancing from 8th to second place in the country, Mississippi from 11th to 7th place, Alabama from 13th to 11th place, Texas from 10th to 9th. Further than these gains in output of the industry, there is accorded an equal advance in capital invested, Mississippi and Louisiana showing the largest increases. At the present time, judging from data whch is obtainable, the South furnishes half of the lumber in the country, increasing from an output of about 15 per cent. in 60 years.

In the past, the power for lumber mills and factories has been derived from steam and mechanical transmission. At the present time, however, this industry affords an excellent field for the isolated plant. The waste from the working up of timber furnishes fuel for generating steam, and with the directly connected electric unit transmitting energy to electric motors, a large percentage of the power is saved beside adding convenience of arrangement, much appreciated in factories handling timber products.

Modern practice seems to favor the application of the alternating current motor in factories, properly protected from dust. With the absence of sparking commutators, this type of motors serves very well the requirements in regard to insurance.

The value of agricultural products, as already stated, holds a high place in the South. Southern agricultural pursuits are so extremely varied and the success obtained by growing any individual product is such, that each is in itself an industry. Foremost among these pursuits is the raising of rice in Louisiana, Georgia and Texas. Over 60 per cent. of all the rice milled in the United States goes through mills in Louisiana, while Louisiana and Texas together mill 95 per cent. of the total crop. The cotton industry has already been commented upon, treated as a separate industry, yet it can be classed as an agricultural product up to the time it is delivered to the cotton mill when it becomes a textile product and is usually so classed. As a producer of wheat, the South, in 1905, ranked second as to value of product and third in capital invested. Among the thirty corn raising States producing more than one and one-half million bushels, are mentioned 10 Southern States, with Tennessee ranking sixth in number of bushels, Missouri eighth, Georgia eleventh, and Virginia twelfth. Oats, buckwheat, barley and rye are also raised in the South, oats being the most common and raised in the larger quantities than the other three grains. Vegetables and fruits are raised in the South equally as well as any other section of the United States and on account of the widely varying climatic conditions, this section of the country presents a field for extensive possibilities in this line.

In regard to the importance of industries by sections, the rice cleaning and polishing industry is credited principally to the South, the turpentine and rosin entirely, the by-products of cotton manufacturing almost entirely, over 50 per cent. of the manufactured fertilizer and wood preserving, 50 per cent. of the tobacco, 50 per cent. of the lumber products, over 45 per cent. of the cotton goods, 30 per cent. of the manufactured ice and over twelve per cent. of the blast furnace products of iron and steel.

INDUSTRIAL AND ENGINEERING EXPANSION BY SECTIONS.

In regard to the industrial and engineering expansion of the Southern States by sections, we have been fortunate in being able to present testimonials directly from those in the various sections who are thoroughly acquainted with the conditions and the results which have been accomplished during the past few years. We are indebted to the authors of the following letters for the information which is presented in them. The review of conditions told by this compilation of facts and history from the various sections of the South, will serve not only as interesting material in regard to Southern progress, but be of real value to every one interested in the industrial, engineering or commercial features as they may be found at the present time.

North Carolina, Charlotte, Progress in the Carolinas.

The recent United States Census presents figures which give to the City of Charlotte an increase of 88 per cent. in population. The growth which is thus indicated has arisen from a number of different causes, not the least of which is its geographical position. A careful inspection of the map reveals the interesting fact that Charlotte is the practical center of the two Carolinas and the logical point for distribution of merchandise and the products of factories. Its recognition as a strategic point commercially, has served to materially increase the number of factories and jobbing houses, and has attracted a large number of outside firms, who have placed men in the field to work this section with headquarters in Charlotte.

The prosperity which has of late years been prevalent all through this section is in evidence through the immense volume of building which has taken place together with a strong tendency to build nothing but the very best modern structures. The activities in the building line during the past five years in the City of Charlotte alone have included all classes of structures, and several millions of dollars have been invested in business houses, factories and residences.

The immense additions to the property of the railroads in Charlotte made necessary by the increasing volume of business, both in track facilities and in freight and passenger depot accommodations, has proved to be one of the most striking features of the growth and development here.

There are in operation at the present time 788 cotton mills in the entire South, of this number about two-thirds are located within 100 miles of the City of Charlotte, thus making it the center of the cotton milling industry of the South. Ten years ago the same territory contained less than 200 cotton mills. These figures present a most conclusive piece of evidence pertaining to the growth of this industry, which has been remarkable. Second only to the cotton milling industry is the manufacture of furniture, which has reached proportions sufficiently large to give the State of North Carolina a place of prominence in manufacturing circles as a furniture center.

The hydro-electric developments of the Southern Power Company, with headquarters in Charlotte, with its twelve millions of capital are creating a revolution in the industrial methods of the two Carolinas. This large concern owns waterpower sufficient to develop close to 300,000 electrical horse-power; of this vast volume of power four large dams are now generating 110,000 electrical horse-power. This wonderful energy is being distributed by means of transmission wires over a territory 300 miles in length, lighting cities, running street cars and turning the wheels of hundreds of factories and contributing in each case largely to the economy of operation. Plans are rapidly being matured by this large company for the building of an electric interurban freight and passenger railway, the main line of which will cover the territory from Greenville, S. C., to Charlotte, N. C., and from Charlotte to Durham, N. C., including all intervening points of importance. This road and its branches, when complete, will add much to the convenience of the people and will also prove a factor in reducing the cost of the transaction of business between local points.

The spirit of enterprise which is found to exist in live, hustling Charlotte, is to be found permeating the atmosphere of the entire Piedmont region, and it is this which augurs so strong for its future prosperity and growth. The wealth of resource possessed by the great State of North Carolina is almost untouched. The beginning has been well made and enterprises of various descriptions are being developed at a profit to the owners. The future is exceedingly bright for the commercial and industrial life of this commonwealth.

Such is the impetus and so great are the possibilities that those who are in close touch with the situation predict a far greater percentage of expansion during the next decade than has occurred in the past. Potentially there is no section of our country which offers so much for the future. The prosperity existing here has manifested itself in many different ways, by no means the least of which is the rapidly increasing demand for all kinds of goods by the inhabitants, not only a greater quantity but as well a greater variety and a much better quality.

The Greater Charlotte Club, an active commercial organization, advertising and pushing the development of the City of Charlotte by every legitimate means, calls the attention of the public through its invitation to "Watch Charlotte Grow." It would be equally fitting for every county in the State to issue the invitation to "Watch North Carolina Grow," for there is to be no cessation in the pace now being maintained, on the contrary, the speed will be accelerated rather than lessened.

W. T. Corwith, Secretary,
The Greater Charlotte Club.

Texas, Fort Worth.

The recent census returns given out by the census department, giving Texas a population of 3,896,542, a gain of 847,832, or twenty per cent., is an indication of the remarkable stride forward that is being made by this wonderful State. Fort Worth is one of the characteristic cities of this rapidly growing State, with remarkable educational and industrial achievements to its credit during the past year. A city of 73,312 people, with the phenomenal increase of 174.7 per cent., Fort Worth stands the embodiment of the faith and co-operation of capital and of her citizens.

During the past year this city has paved more streets than any city of her size in the United States. More than a month ago figures showed that the streets paved had already past the sixty mile mark for the year of 1910. This large scale of paving will be continued in 1911. Street car lines have been extended on all branches and several new lines have been surveyed and will be pushed to a speedy completion during the first part of the year.

Three hotels, representing two million dollars, have been completed during the past year. The Terminal, and the August Hotel, two magnificent hostelries, make most desirable additions to Fort Worth's list of superb hotels. The new Westbrook Hotel is as fine and convenient a hotel as will be found in the entire Southwest, and represents an expenditure of one million dollars. It is absolutely fireproof, and modern in every detail. A new Elks home representing an expenditure of $100,000, is rapidly nearing completion, and when finished will be the most modern Elk home in the Southwest, and one of the finest in the country. During the past year five theatres have been added to the number already located in the city. All of these houses will cater to the highest in vaudeville and legitimate art, and all are making most auspicious beginnings.

A high school building costing $400,000 will be added to the large list of public buildings already in Fort Worth. When completed, this building will be without a peer in the field of buildings of a public nature in the Southwest.

Several new factories have located in this city during the past year, among which might be mentioned the Fort Worth Pottery Co., the Fort Worth Glass Factory, and the Mutual Wagon Factory, all factories of no small size and industries, which will mean thousands of dollars annually to Fort Worth. Fort Worth, with her wealth of natural resources and accessability to the trade, is rapidly becoming the industrial center not only of Texas, but of the Southwest, as well.

During the past year, the Southwestern Baptist Seminary has been located in Fort Worth, and buildings aggregating a quarter of a million have been erected on the site chosen for their campus. The Catholic College known as "Our Lady of Victory College," has been located in Fort Worth, and buildings costing more than $200,000 have just been completed. The Texas Christian University, formerly of Waco, has been located in Fort Worth in temporary quarters, pending the building of the college buildings on their new campus at University Heights. Contracts have been let calling for more than a quarter of a million dollars expenditure at present, with a promise of several similar expenditures in the very near future.

Paul E. Palmer, Assistant Secretary,
Fort Worth Board of Trade.

Oklahoma, Oklahoma City.

Oklahoma is probably advancing more rapidly than any other State in the Union, which statement the 1910 Census will substantiate. The increase in population during the past ten years has been approximately 127 per cent., which, we think, exceeds any other one of the States. It is believed that this phenomenal increase is due first, to a greater variety of natural resources in Oklahoma than any other State in the Union together with the fact that all the crops of both the North and South do equally well in this climate. Oklahoma stands first in broom corn, 7th in cotton, 9th in winter wheat, 5th in alfalfa, 10th in corn, 15th in oats, 7th in cattle, 9th in horses, 9th in mules, 12th in hogs, 1st in gas, 1st in gypsum, 1st in glass sand, 2nd in lead and zinc, 3rd in salt, 5th in building stone, 1st in oil, 1st in asphaltum, 1st in cement materials, 3rd in coal, 4th in granite, 5th in clay and shale, 7th in marble.

Furthermore, where the influx of people is so great as it has been in Oklahoma, it creates a demand for jobbing and manufacturing which has resulted in these lines advancing more rapidly here than in older States. During the past year the Morris & Company and Swarzschild & Sons packing companies have expended in the neighborhood of seven million dollars in Oklahoma City installing immense packing plants and all branches necessary to conduct this industry, together with stock exchange buildings, horse and mule barns, stock yards, belt line railroads, etc., which is without doubt the largest single manufacturing industry in the State.

The value of stock handled by these two plants when in operation will amount to approximately 50 million dollars annually. This, of course, will be a great benefit to the farming interests of the State and will lend an impetus to the raising of live stock which can but redound to the benefit of the State as a whole and the farming element particularly.

The question of Good Roads is being discussed all over the State at the present time and a great many of the counties are voting bonds with which to carry on the work of building public highways, while our State laws makes the employment of convict labor optional for this purpose. This feature will also do much to build up the rural districts and make for better conditions among the farmers whose prosperity will naturally reflect itself in the advancement of the entire State.

Taking it all and all, the State of Oklahoma is, we think, on the eve of a greater advancement during the next decade than ever before.

J. H. JOHNSTON, Manager,
Oklahoma City Chamber of Commerce.

Louisiana, Shreveport.

Shreveport is a city of 28,015 people, according to the last census, which is an increase of 75 per cent. It has 45 miles of paved streets and 27 miles of trolley line. We have within our immediate neighborhood one of the greatest, if not the greatest gas and oil fields in the world which supplies our city with both heat, light and power. We are particularly well situated for all lines of manufacturing, having such a desirable medium as natural gas which can be easily converted into electric energy. This alone should be an incentive for investment of capial utilizing gas in internal combustion engines. Shreveport is well drained and located on the bluffs of Red River.

L. C. BUCKLEY, Secretary,
Chamber of Commerce.

Arkansas, Fort Smith.

Fort Smith, Arkansas, is one of the Southern cities for which the 1910 census shows more than 100 per cent. increase in population over 1900, at which time the records showed 11,500. This growth has largely been made within the last five years and is due almost altogether to the industrial expansion which has been taking place. This year's report shows 112 manufacturing establishments actively engaged in business and 66 jobbing houses, giving employment to approximately 4,500 workers.

Probably the most marked improvement in civic conditions has taken place within the last 12 months. The contract for 71 miles of brick pavement, which was let at one time, has been progressing steadily and is now nearly half completed. The school board, which is incorporated and has control of a fund for school purposes of approximately $1,000,000, has spent more than $150,000 the present year in building a new manual training building and making improvements to the numerous ward buildings.

The Goldman Hotel, which was erected and furnished at a cost of $400,000 by our citizens, was opened to business February 1, and has made it possible to hold many large trade and fraternal conventions here during the year. The First National Bank completed and occupied its eight-story building on February 1. The Elks Club built and furnished at a cost of approximately $100,000, was occupied early in the year. The wholesale building built for the Speer Hardware Co., at a cost of $150,000, was occupied in April. The Arkansas Valley Trust Co. completed and occupied its new six-story building costing $80,000 on Sept. 1. Numerous other buildings of a minor character have also been erected.

The Fort Smith Wagon Co., having the largest plant in the city, completed an addition which will increase its output one-third. The Fort Smith Couch & Bedding Co. erected an entirely new building more than doubling its former capacity. The Southern Broom Company and the Champion Broom Co. have both doubled their output the past year and are now employing 40 to 60 people respectively. The Fort Smith Rim & Bow Co. has increased its capacity 40 per cent. The Ketcham Iron Co. has erected new buildings and more than doubled its former capacity. Other factories have increased their business from 10 to 20 per cent. and for several months past more than a score have been working from 12 to 13 hours a day.

New industries established during the year include the Fort Smith Stove Co., which is now employing about 60 hands, the Arkansas Coffin Co., employing 25 hands, the Arkansas-Oklahoma Table Co., the H. P. Finks Mfg. Co., the Fort Smith Paint & Color Co., and the Texas Company, warehouses. Probably this record will be even surpassed during 1911. Large public contracts totaling more than $1,000,000 have been let and are now in process of execution. Work was begun in November on the free iron bridge over the Arkansas River to connect Fort Smith with Van Buren, and costing $563,000. The sale of the municipal water plant, a Maine corporation, has been confirmed by the court and will be taken possession of by the city very soon, several miles of extension are now being put in by order of the court.

The Kansas City Southern has cleared ground and has begun work on a $50,000 passenger station. The Fort Smith & Van Buren Railroad Company, running along the river front to Van Buren, was granted a franchise some weeks ago and work is now beginning on the right of way. Conditions are very favorable for the entrance of the Santa Fe and possibly the Rock Island or Katy Railroad during the year which will give Fort Smith ten separate railroad systems with fifteen outlets.

The most perfect barometer of business conditions is found by an investigation of the banking figures of Fort

Smith's three national banks and three trust companies. The combined deposits on January 1 approximated $4,500,-000. From the time the statement was made to the comptroller on Sept. 1 to Nov. 10, the three national banks made more than $2,000,000 gain in bank deposits and the first of the year will see the total resources of the banks more than double the figure of one year ago.

These favorable conditions have been brought about by a combination of circumstances, one of the greatest of which has been the general attention Arkansas has been attracting throughout the country the past year and the turning of the tide of immigration from the far Southwest to this section. This has been accelerated by the most wonderful crops the section has ever produced, the fruit crop alone in Western Arkansas having totaled several million dollars. The corn and cotton crops were also far above the average and the price of the former exceptionally good. This improvement in the crops of Arkansas has been no accident or freak of nature, having been brought about almost entirely through the adoption of improved cultural methods. Nearly every county provides a farm expert to work among the farmers and teach the best methods of cropping. Arkansas today spends more money this way than any State in the Union and it is proving to be the best money ever invested in any educational work. Confidence is the key note to the greater part of the success which has visited Arkansas this year, the people here have confidence in the country and thus being able to instill confidence into others have been helped by making integrity a cardinal principle and avoiding in every way the inflation of values.

H. G. SPAULDING, Manager,
Fort Smith Commercial League.

Alabama, Demopolis.

While there has been no great increase in the population of the City of Demopolis within the past ten years, there has been a decided improvement in industrial conditions. Marengo county is one of the few Black Belt counties of Alabama that the last census shows a decided growth for. I attribute this largely to the very wise diversification of crops. Much of our cotton land has been turned into alfalfa, and this section has been shown to be one of the best adapted sections of the United States for the successful and profitable growth of this wonderful crop. The production of corn has been largely increased per acre and the acreage increased. The raising of cattle, fine horses and hogs has been greatly increased and encouraged by its success.

The City of Demopolis is situated on two rivers and the Southern Railway and a new railroad from Demopolis to Pascagoula, Miss., is practically assured. The prospects of this road have stimulated business. Many well-to-do Western farmers have recently bought large farms near here and have moved their families here to live. They are all well pleased and are trying to induce their friends to move here also.

Within the past year a handle factory, spoke factory and stave factory have been established here and we have immediate prospects of several large manufacturing establishments. I would say the great advantage of river transportation, being situated on two rivers navigable all the year, together with the high price of cotton and other farm products, has given Demopolis the advantages in the industrial world that she enjoys. The completion of the proposed Demopolis-Pascagoula Railroad will add ten thousand bales of cotton to our receipts, bring many manufacturing establishments here, and make Demopolis decidedly the best small city in Alabama.

JESSE B. HEARIN, Secretary,
Demopolis Business League.

Mississippi, Jackson.

In the center of the circle with all four points of the compass looking toward her, is the position Jackson now occupies in the industrial and commercial affairs of Mississippi. Little more than an old time sleepy town ten years ago, she has since that time sprung forward with leaps and bounds until today she is the bustling, wide-awake metropolis of the State. With only about 8,000 population ten years ago, she now numbers about 25,000 people, including the suburbs, whose people come and go each day as other citizens in their various avocations.

As an educational center Jackson is superbly equipped, having two commercial colleges, four literary colleges, and six magnificent graded schools. As a manufacturing center she also takes high rank, having about seventy manufacturing and industrial plants in active operation, and more planned for the near future. Her annual pay roll from the above sources is approximately two million dollars. Jackson railroad facilities are unsurpassed. The railroads operating into Jackson pay salaries in Jackson amounting to over two hundred thousand dollars annually. As a distributing center for all kinds of merchandise and manufactured products Jackson occupies a position of unusual advantage.

In civic pride and improvement she is thoroughly abreast of the times, being now actively engaged in adding many miles to her paved streets. These streets are being paved in four different kinds of paving—vitrified brick, creosoted wood blocks, granitoid and bitulithic. In addition, many miles of the lighter travelled residential streets are being treated with pyrites, which makes magnificent driving thoroughfares. A new and complete artesian well water works system is being installed.

In the past ten years Jackson has expended in municipal improvements alone one million and seven hundred thousand dollars. She has eleven banks with a combined capital and surplus of two and one-half million dollars with deposits amounting to nearly ten million dollars. Our jobbers do a business of more than ten million dollars annually, and show a steady increase in the volume of business. Jackson's magnificent location is bound to make her grow very rapidly in the next few years, and it is only a question of a little while when she will rank among the best commercial centers of the country. The vast timber resources surrounding her naturally make her a lumber center for both manufacturing and distribution.

A. C. CROWDER, Mayor.

Oklahoma and Red Rock.

The statement is sometimes made that if it were possible to build a wall around Oklahoma, so that nothing could either come in or go out, the people of the State would not be seriously inconvenienced. Oklahoma produces within her borders practically every necessity for the maintenance and comfort of her people.

The State is rapidly taking front rank in the matter of textiles. Oklahoma's cotton is already in great demand in the markets of the world, and more cotton is being raised every year. Sheep thrive well, and wool is destined to become an important source of income. Flax has been successfully raised. Oklahoma can easily produce material for the manufacture of clothing for many times the number of people she now has.

Oklahoma also produces practically everything needed by civilized man in the way of food supply. Wheat and corn, hogs and cattle, which are her great staples, are raised in all parts of the State. Fruit and vegetables flourish everywhere. Her soil and climate are peculiarly adapted to the cultivation of a very large number of food plants, perhaps a larger number than any other part of the country.

In the matter of minerals, also, Oklahoma takes front rank, for the statement is made that no State in the Union possesses so many kinds of mineral or so many minerals of a kind as does Oklahoma. She has coal and asphalt, salt and gypsum, oil and gas, clay and stone, glass sand and Portland cement rock, iron, copper, lead, zinc and other valuable minerals, most of them so far as we know, are inexhaustible. Unfortunately, however, the greater part of these minerals are undeveloped. And Oklahoma imports from other States such products as salt, pressed brick, building stone, stucco, clay products, lime and even a good part of her coal supply, altho she has great deposits of these products utilized.

As soon as the mines and quarries are opened and plants and factories established and these products lying dormant are developed, Oklahoma will cease paying tribute to other States. When this has been done the food product of Oklahoma will be sold at home, prices will naturally be enhanced, and be rendered even more prosperous than she is now.

Oklahoma should not be dependent upon other States for either her fuel, building material, clothing or food supply. She has an abundance of raw material, and all that is needed is the utilization of the products now at hand. Until this is done, the State cannot hope to come to her full development.

Red Rock, Oklahoma, is situated on the main line of the Sante Fe Railroad from Chicago to Galveston. It is nineteen miles South of Ponca City, nineteen miles North of Perry, and twenty-one miles from any town half as large. It is situated upon a hill gently sloping eastward toward the railroad, and you have a commanding view of the surrounding country, overlooking Red Rock and Pettet creeks, which are fringed with trees as far as the eye can see creating one of nature's most beautiful pictures.

While Red Rock is only five years old, it has 400 inhabitants, two elevators, $5,000 brick school building. It is a township high school. We have one lumber yard, three blacksmith and woodwork shops, one livery stable, one wagon yard, one flour and feed store, one drug store, four general stores, two grocery stores, one jewelry store, one hardware that carries a complete line of implements and buggies, two hardware stores that also carry a large line of furniture, one pool hall, two banks, two meat markets, one hotel, two restaurants, one bakery, one barber shop, two doctors, one photograph gallery, one telephone office where you can talk all over the United States, as well as a city exchange, one good weekly newspaper.

C. L. WOOLVERTON, Secretary,
Commercial Club.

Florida, Tampa.

The city of Tampa is famous throughout the world as the center of the clear Havana cigar industry. Tampa manufactures more clear Havana cigars than the city of Havana, Cuba. There are, however, many other important interests and industries in Tampa. It is the headquarters of the Florida Citrus Exchange, being located at the center of the citrus fruit producing country. Tampa is also a very important point for the shipment of phosphate and naval stores. A matter which should be of special interest and benefit to the readers of your journal, is the fact that Tampa has one of the finest, and also one of the most profitable electric railway systems in the country. I believe that the last several reports of the Stone & Webster Company show that Tampa ranks 9th in the United States in the percentage of profits. It is a splendidly equipped and ably managed system and its prosperity is a very safe indication of the prosperity and progressiveness of the city of Tampa.

Tampa expects to benefit greatly by the opening of the Panama Canal. This city is the logical route for traffic and travel to and from the canal, and we are making, with the aid of the National Government, preparations for the handling of this business. We are building what will be one of the best and most commodious harbors on the South Atlantic or Gulf coasts. The National Government by formal resolutions has recognized Tampa's advantageous location with relation to the business that will be handled through the Panama Canal, pronouncing this the nearest city to the canal with first-class railway facilities.

The population of Tampa is very cosmopolitan, people being assembled here from all parts of the world. It is, however, very homogeneous, and aside from occasional disturbances which come to all wide-awake cities, its people are unified and all imbued with the common purpose to make this the greatest and richest city on the South Gulf Coast.

This information was transmitted to SOUTHERN ELECTRICIAN by

D. B. McKAY,
Mayor of Tampa.

Mississippi, Jackson and Vicinity.

The city of Jackson, Miss., is one of the best located cities on the map. It is situated in the very heart of one of the finest agricultural sections of this Union, where good lands may be had at reasonable prices that are suited to the growth of cotton, nearly all kinds of grains, nearly all kinds of fruits and vegetables, and as fine for grazing and stock raising purposes as any part of the West or Southwest. It has a mild and genial latitude that is alike free from the severe winters of the former and the blighting winds and droughts of the latter section. Both man and beast can live in health and comfort the year round, and at a minimum of expense by reason of our unrivaled average evenness and mildness of climate especially fitting it as a most desirable place of location.

Jackson's railroad facilites are not surpassed by those of any city of its size in the South. The railroads radiating out from Jackson, as the "Hub" form the spokes of almost a perfect wheel. Only one spoke is lacking, with the building of a road up through the hardwood belt that lies between Jackson and Columbus, Miss., however, and there making connection with Birmingham and other important points, the building of which road is practically a certainty in the near future; the wheel will then be complete and perfect.

As a manufacturing center, embracing many and varied kinds of finished products, Jackson has made rapid strides in the past few years, and the near future will find her making even more rapid strides in manufactories. Jackson is superbly located for all kinds of wood-working factories, as the native timber of various kinds is at its very door.

It is also well located for flour, grist and feed mills, and will very likely embark upon these lines in the near future. It is likewise well located for peanut oil mills, and this industry is now one of absorbing interest. The same may be said of meat packeries, as our people are now busily engaged in making extensive preparations for stock raising, such as cows, hogs, sheep, etc. Indeed, the magnificent exhibits of fine live stock at the State Fair last October proved a revelation alike to our own people and to visitors from the North and West. This section is also beginning to raise its own horses and mules, as they can be raised here as well, and even more cheaply, than in Kentucky and Missouri.

The boll weevil has proven, and will continue to prove, one of the greatest educators of this age. His advent seems to have roused our people from their age-long slumber in so far as our sole dependence upon cotton is concerned. Being roused, and emancipated from old dogmas, our section is now preparing for the greatest revolutionary progress known to the generation now living. "General Diversification" has become the slogan of our people. Not that they intend to forsake cotton, for cotton can be grown very profitably under boll weevil conditions if the farmers will follow out the instructions of the Agricultural Department at Washington. They are now preparing to plant those kinds of grains for which their particular land has been scientifically demonstrated to be best adapted. More grains, of course, mean more live stock of all kinds, and unlimited food stuffs for both man and beast. This change in our agricultural system will mean that each farmer will make his own living at home, so that at the end of the harvest season he will own his cotton, the world's great cash staple, instead of owing it, as, unfortunately, has for so long been the custom.

The next five years will witness such a remarkable transformation in the material well being and progress of Mississippi that it will almost tax the imagination to comprehend it. Jackson, being in the very center of the tremendous development that the next three to five years will witness, is certain to become a great manufacturing and commercial metropolis. If I were to designate any particular field in manufacturing in which it is destined to excel, I would say that it is in all kinds of wood-working.

JAS. B. LUCK,
Secretary Jackson Board of Trade.

Oklahoma, Enid.

The Progressive Spirit of Enid, Oklahoma, is in evidence from the fact that more improvements in the way of beautifying the city is in progress than in other cities of the State.

Within the past year 15 miles of asphalt pavement has been laid; 10 miles of sewers have been constructed; a septic tank installed, in fact everything is being done to make this a first-class city. Building operations have been active, there now being in course of construction a Government Building to cost $250,000; a High School to cost $200,000: a State Institution costing $50,000, and a number of smaller institutions. Enid has the people who do things at the right time.

J. J. COUGH, Secretary,
Chamber of Commerce.

Mississippi, Vicksburg.

In Vicksburg, Mississippi, during the past twelve months, there has been complete building and general construction work aggregating more than $1,500,000 in value. This work has been well distributed between the municipality and the citizens. The city has built a sewerage system, costing $225,000, and has laid paving, costing $150,000. The two principal hotels of the city have been remodelled at a cost of $110,000; the Vicksburg Sanitarium, a private institution, has had additions made to it at a cost of $55,000.00; and new business houses have been constructed at a cost of $150,000. Residences, costing more than $250,000 have been built, and some of these are among the handsomest in the city.

Several new manufacturing plants have been built and others have been enlarged. The Vicksburg Ice Co., has largely increased its capacity; contracts have recently been let for a new ice plant, capitalized at $100,000. Christian & Brough's wagon factory has been constructed at a cost of $25,000; and the B. J. Robinson Co.'s machine shops are to be rebuilt at a cost of $18,000, replacing the present plant.

In the Vicksburg National Military Park, which almost encircles the city, expenditures for State and national memorials and road and general construction work have aggregated $300,000. The principal developments in the park have been the completion of Wisconsin's $100,000 memorial, the building of two steel and concrete obervation towers and the work done on the $175,000.00 Sailors' Monument, by the United States. Building and general construction projects for 1911 already indicate that there will be more than half a million dollars expended in such work in Vicksburg for the first six months of the year.

FRANK H. ANDREWS,
Secretary Board of Trade.

Kentucky, Lexington.

Lexington, Kentucky, the center of the Blue Glass region, is the hub of a splendid interurban railway system connecting six county seats with the county seat of Fayette county. The entire system embraces approximately seventy miles and is considered by commercial Lexington one of the largest, if not the largest asset in the City's business. During the year a half a million dollars has been expended by this system in completing another spoke of the wheel. This line is twelve miles in length and while the topography of this section of the State is heavily rolling, the line was constructed upon a steam grade and is considered to be one of the finest to be found anywhere. There are two other spokes to be constructed in the future which will complete the wheel.

There has been considerable talk for over a year past concerning a through interurban connection from Lexington to Louisville, but for some little time past this has quieted down. The local company is contemplating extensive improvements in their entire system. With reference to other lines of industry in and about Lexington, the past year has seen a substantial increase in all branches of business throughout this section. Within the past year new companies with capital aggregating more than three million dollars have located in Lexington alone.

This short sketch cannot be closed without a word with reference to the wonderful development of the Eastern section of this State which is now in progress by an extension of the Lexington & Eastern Railroad recently purchased by the Louisville & Nashville Railroad Company. This extension will be made through perhaps the richest undeveloped coal area in the entire South. The Chesapeake & Ohio Railroad is also doing extensive work to reach these coal deposits. A number of large coal companies control great bodies of land in this section; among them the Northern Coal & Coke Company, capitalized at fifty million dollars, and the Consolidation Coal Company of Baltimore, Md. A number of large timber companies are fast developing large bodies of timber lands in this same section; one in particular has, since the first of October last, begun an expenditure of one million dollars to develop their properties. Coming out of this section, which is now receiving such marked attention upon the part of capital, the first competitive point reached by the railroads is Lexington and the people of this community are fast awakening to the benefits to be gathered by this city as a result of the opening of this new country.

S. H. CLAY, Secretary,
Lexington Commercial Club.

Principles of Illuminating Engineering.

(*Continued From December.*)

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

BY A. G. RAKESTRAW.

Continuing the subject of last issue, the formulae that are used in the computation of the intensity of illumination from a given light source will be considered. Referring to Fig. 1, if A be a source of light, and CD, C_2D_2, C_3D_3, etc., be plane surfaces at distances of one, two and three feet from the light, it will be observed that as the beam of light enlarges, the size of the surface illuminated by the beam increases as the square of the distance from the source. If therefore, A be a light of one standard candle, these surfaces will be lighted with an intensity of one, one-fourth and one-ninth foot candles respectively. The intensity therefore equals candle power divided by x^2, where x is the distance of the surface from the light. In the case of a plane EF which is not at right angles to the light rays, but makes an angle O therewith, the intensity will be less. The formula in this case is $I =$ candle power $\cos O / x^2$.

If, therefore, a light is considered, say an incandescent lamp, illuminating a plane surface AB, as in Fig. 2, in order to calculate the intensity at various points, the distribution curve of the unit must be provided with or without its reflector as the case may be, laid off to scale. The curve shown in the figure is typical of a bare tantalum lamp. Then draw the line AB to scale representing the plane of illumination, a certain distance y, below the lamp, and lay off points one, two, three feet, or other convenient distances, from a point directly beneath the lamp. At any desired point, Z, find the candle power in that direction from the curve. Then the illumination at that point will be $I =$ (candle power $\cos O$) / $(x^2 + y^2)$. Continuing this computation for other points a curve as shown is obtained. In most cases occurring in practice, a point will receive light from more than one source and often from many sources. In these cases this computation must be performed for each source and the results added. Fig. 3, shows the intensity of the light produced at different points by two lamps with reflectors, placed in proper relation to each other. Curve C shows the results when using a reflector that concentrates the light, and curve D when using one that distributes the light over a wider angle.

This method of calculation is called the step by step method, and is not often used as it requires laborious calculation and further is liable to be inaccurate as it takes no account of reflection from ceiling and walls. The most satisfactory method is to make tests on the lamps as actually installed, either in a room fitted up for experimental purposes, or in their permanent location. Stations are chosen at numerous intervals, and the actual intensity of the light measured at these points. These values were formerly determined by some sort of visual test, such as the ability to read certain sizes of type. This method gave irregular and rather inaccurate results. There has lately been placed upon the market a portable photometer by means of which the value of the actual illumination at any

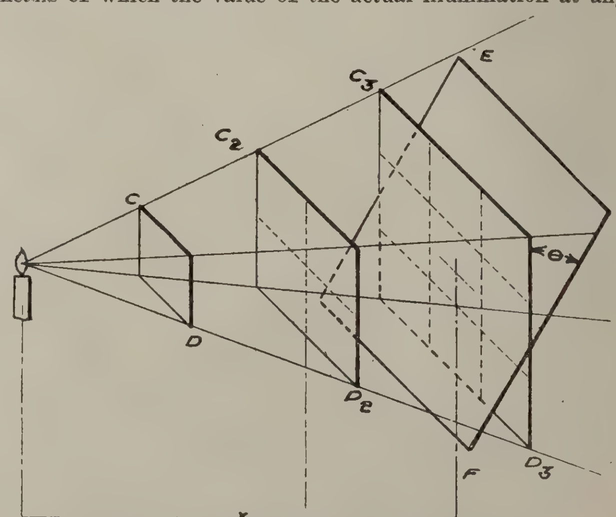


FIG. 1. INTENSITY OF ILLUMINATION.

point may be determined quickly and accurately. This instrument has already proven indispensable in securing satisfactory data on this subject. A good way of showing these results is by means of isolux lines, which are lines passing through points of equal light intensity. A typical appearance of the isolux lines in a room lighted with four units is shown in Fig. 4.

The distribution of light depends on the size and number of the lighting units, the height at which suspended, the shape of the distribution curve of each unit, and the character of the reflecting surfaces. In connection with distribution, the aim should be to secure efficiency and uniformity. By efficiency is meant that the light should be thrown where it is desired, and not in useless directions. For this reason in any lighting installation where the least regard is shown for efficiency, some kind of reflector is used to throw the light downward, instead of on the walls and ceiling where it is for the most part wasted. Of course it is not desirable to leave the ceilings in total darkness and in some cases a certain amount of light is needed to bring out architectural features.

In most installations there are two requirements to be met, as regards intensity. In the first place, it is necessary to have enough general illumination to enable objects to be seen distinctly. This is called general illumination. If however, no more than this is provided, it will not be sufficient for the detail work such as is carried on at machines, desks, and other places. For this reason it is usually reinforced by local illumination, consisting of small lamps and reflectors at the points needed. In fact the earlier installations of electric light consisted almost entirely of these local lights, each operator working in a narrow illuminated area, the balance of the room being comparatively dark. This gave the interior a peculiar spotted appearance and the room was usually too dark and gloomy for comfort. Besides this, the direct reflection from books, papers, or pieces of metal was ruinous to the eyes of those using the light. This led to the placing of larger units overhead, sufficient to give a good general illumination, and there is a growing tendency to provide enough general lighting that individual lamps will be no longer needed. This takes somewhat more energy for any given space, but the results secured appear to justify the expense. Besides being efficient, the distribution should be uniform instead of showing light and dark spots which is offensive to the eye. Absolute uniformity is impossible but in well designed installations the variation from maximum to minimum, on the plane of illumination should not exceed 15 to 20 per cent.

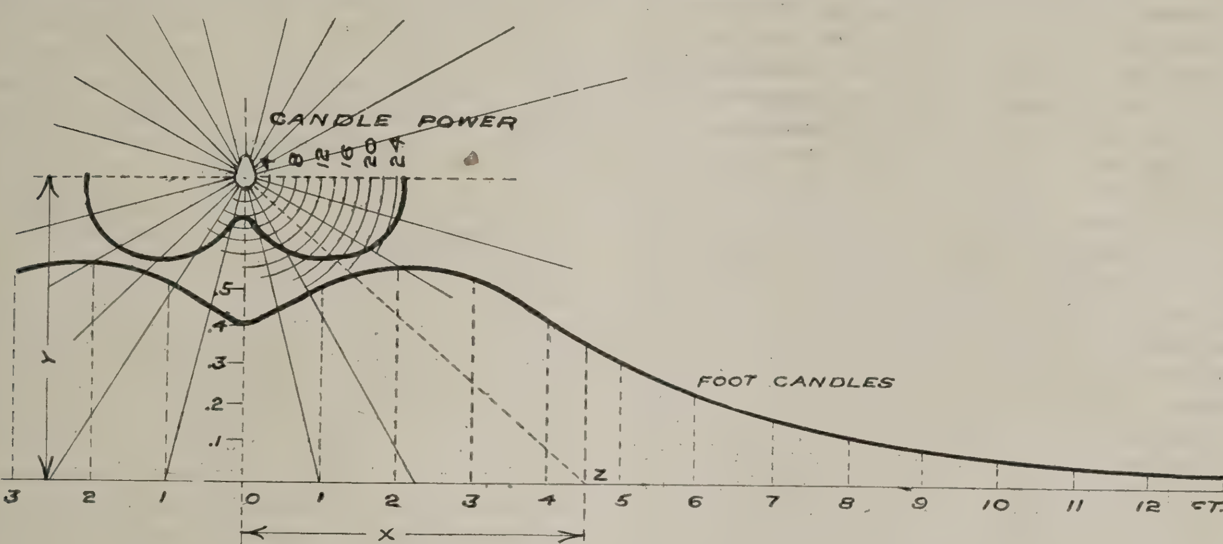


FIG. 2. DISTRIBUTION CURVE OF A BARE TANTALUM LAMP.

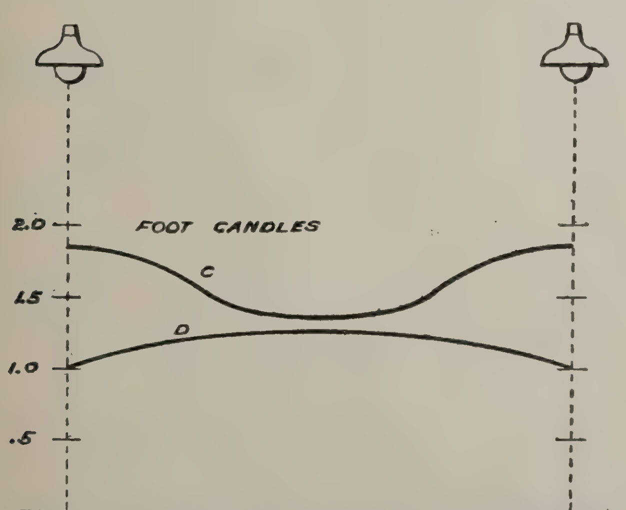


FIG. 3. INTENSITY BY TWO LAMPS WITH REFLECTORS.

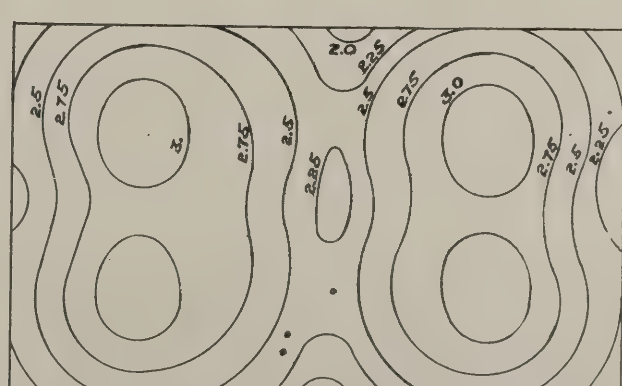


FIG. 4. ISOLUX LINES, ROOM LIGHTED BY FOUR UNITS.

Electrical Apparatus and Its Application During 1910.

(*Written Exclusively for* SOUTHERN ELECTRICIAN.)

PRE-EMINENT among the station equipments of considerable capacity, installed during the past year are the hydro-electric and the turbo-electric types. While the motive power for the generators of today is principally the steam unit, the increase in the use of the gas and water power type is decidedly noticeable, the water power type developing practically 10 per cent. of the horse power for the United States, while the gas, oil and water power type together make 15 per cent. of the total developed horse power. Among the noteworthy installations during the past year representing these types of generating equipments is the plant located at Necasa, Mexico, where there is installed water wheel driven General Electric generators of 12,500 K. V. A. capacity running at 300 revolutions per minute on a vertical shaft. A slow speed equipment of the General Electric design is that installed at the South Pennsylvania Water & Power plant at McCalls Ferry. The generator of this equipment operates on a vertical shaft, is of 7,500 kilowatt capacity, running at 94 R. P. M. with a generating voltage of 13,200 volts. It is understood that this type of generator is being built in a capacity of 10,000 kilowatts at 90 per cent. power factor. One of the most remarkable engineering developments in the building of hydraulic turbines and water wheels, is the mammouth machine which is to be installed by the Pacific Coast Power Co., on the White River north of Buckley, Washington. The turbines are rated at 20,400 horse power and are of the high pressure Francis type manufactured by the Allis-Chalmers Co., and will operate under a maximum of 480 feet. Each turbine is direct connected to generators of special designs, which will be of 10,000 K. W. capacity operating at 360 R. P. M. Notable among the turbine driven generators of considerable size recently installed are the General Electric 14,000 to 15,000 K. W. turbines operating on frequencies of 25, 35, 40 and 50 cycles and potentials of 4,600 volts to 13,200 volts.

A new line of direct current turbo generators have been recently developed by the Westinghouse Electric & Manufacturing Co. and the largest rotary converter ever built installed at the plant of the Transit Development Co., Brooklyn, N. Y. This rotary converter is of 3,000 K. W. capacity self starting from the direct current or alternating current side. The gas engine is being installed by a number of the steel companies in units as high as 4,000 horse power. The operation of these units on the by-products to the industry is one of the most efficient and economical arrangements of recent date.

STEAM TURBINES.

The turbine industry has grown so rapidly, that the development in the art of construction has been equally marked, exhibiting the dexterity of the designer to meet the increasing demand for large and efficient power generating apparatus. In 1900 the largest turbine built in this or any other country was a 1500 kw. unit at the Hartford Electric Company, Hartford, Mass.; there are machines in service at the present time capable of developing ten times this amount of energy. This installation was preceded by an installation of four 400 kw. turbines at the Westinghouse Air Brake Co., which was the first large turbine plant operated in America.

The distinguishing features of the various types of turbines are familiar. One method of utilization of the steam by converting the potential energy into velocity and abstracting the velocity by rotating wheels, is used in the DeLaval, the Rateau and the Curtis types, entirely; while in the Parsons construction, as now well understood, the work is performed through expansion in special shape blading, imparting the dynamic force to the turbine motor directly through reaction, by which term this type is usually designated. Furthermore, this effect is augmented by the action of the velocity produced in the stationary vanes in re-directing the steam upon the moving blades.

The present turbines differ largely from their predecessors, the steam engines, in that more consideration must be given the design for varying capacity and operating conditions, to obtain the best performance and mechanical structure, and at the same time conform with commercial demands. From the present turbine outlook the position of the steam engine is further imperiled. This does not imply, however, that the reciprocating engine will be immediately displaced or superseded entirely, but the fact is nevertheless apparent that the field in which this type has been strongly entrenched, slow speed and reversing, is being rapidly encroached upon by the turbine through improvement in existing machinery and new inventions. Noteworthy are adaptations to small generators, centrifugal pumps and blowers, the speeds of which have contributed to the more general use of the turbine. A recent device of important bearing is the Melville-Macalpine reduction gear, capable of high powers and large reductions. Reversing turbines have now been made practical.

The above is the turbine aspect, briefly summarizing, it has grown to be so important an economic factor for the following principal reasons: (1) Less space; (2) decreased oil consumption; (3) better economy in the use of steam; (4) less attention and adjustments necessary, and (5), lower maintenance cost. Where low fuel prices and heating requirements prevail, steam motors are more economical commercially than the internal combustion engine, and the reverse is true in the case of high coal cost and small heating.

One of the more prominent developments in turbine construction has been the advance in speed rating made practicable by improvements in the turbine and generator art. The latest construction embodies the double-flow principle, feasible by employment of high speeds. When large powers are reached, the construction of the single-flow reaction turbine is encumbered to a degree by the existence of disproportionate exhaust ports and excessive distances between bearing centers.

It may be correctly stated that turbines came as a matter of necessity for the large size units. However, the small sizes are also growing in importance. In the latter case, the commercial conditions are different, involving lower efficiency and cost. Nevertheless, these are necessarily in competition with the small engines and must compare favorably or excel them in efficiency. Turbine boiler pressures range from 125 to 225 pounds gauge. In general practice 175 pounds appears to be the best average for large capacities, as it is probably a balance of increased gain and investment for most cases.

As typical of excellent condenser practice a form brought out by M. Leblanc may be mentioned. A counter current effect is attained, and harmful effect of clearance in reciprocating pumps eliminated.

As regards the highly efficient operation which has been obtained with the high speed construction, the turbine built for the City Electric Co., San Francisco, is typical. The machine, as reported by E. D. Dreyfus in a paper before the Railway Club of Pittsburg, operates on 13.88 lbs. per kw. hr., with 175 lbs. steam pressure, 100° superheat and 28 inches vacuum as obtained on official test. Although with the smaller size turbines, the economy is somewhat less, it is nevertheless much better than reciprocating engine performance.

LOW PRESSURE TURBINES.

The low pressure turbine is an attractive means for increased economies in installations where the energy in steam below atmosphere is either wasted or inefficiently used. A typical example of conservation in an industrial plant in the vicinity of Pittsburg occurs at the McKees Rocks, Pa. plant of the Pressed Steel Car Co., where two low pressure turbines, one of 1000 kw. and one of 500 kw. capacity, are installed. They operate on the exhaust from steam hammers, pumps and air compressors, the entire electric power throughout being supplied from this source, except in extremely cold weather, when a part of the exhaust is diverted for heating purposes. The American Iron & Steel Mfg. Co., Lebanon, Pa., who have a 1000 kw. L. P. turbine, are obtaining a horse-power year at a total cost of $5.50 for this portion of their power. Through the introduction of a practical reduction gear, the large turbine will be used in other fields not hitherto possible on account of inadaptability of speed. With development in other apparatus, the turbine is used for auxiliary drive, boiler feed pumps, exciter sets, blowers and small generating units.

TRANSFORMERS.

In large power transformers, the developments of the past year have been mainly along the lines of increased voltage and size of both water cooled and self cooled transformers, and the further development of three-phase transformers to meet the growing demand for this type.

Transmission systems employing voltages of 100,000 to 110,000 volts were unknown a few years ago, but today such systems create no special comment. They have been tried out and found satisfactory. There is no trouble encountered in building transformers for still higher voltage; the trouble lies with the transmission line and not with the transformer. The use of such high voltages permits of the transmission of power over long distances and makes possible the utilization of large water powers heretofore too remotely located. In these large water power plants, as well as in many sub-stations of large capacity, economy and efficiency demand units of large capacity. Consequently single-phase transformers of 4,000 to 5,000 KVA. capacity and three-phase units of double this capacity are now being used. Some notable types of these are a 4,000 KVA. single-phase, 60 cycle, 100,000 to 50,000 volt, Westinghouse transformer installed by the Southern Power Company, and a 10,000 KVA., three-phase, 25 cycle, 60,000 to 13,200 volt, of same manufacture by the Pennsylvania Water & Power Company.

A contract is now in the hands of the General Electric Company, to build a three-phase, 100,000 volt, 14,000 KVA. transformer. The bringing out of leads on these extremely high potential types has been solved by the oil filled type. Leads tested up to 330,000 volts show no corona. Large three-phase transformers, which were almost unknown in this country a few years ago, are coming more and more into use. The three-phase transformer occupies less space than an equivalent bank of single-phase, is slightly more efficient and the wiring more simple.

Undoubtedly the most important development has been that of self cooling transformers of large size. Whereas the largest size that could heretofore be built self-cooling was about 800, or for comparatively low voltages, possibly 1,000 KVA., it is now possible, according to the latest developments, to build self-cooling transformers for 2,000 to 3,500 KVA., depending upon the voltage and frequency. Some 1,000 KVA. transformers, single-phase, 60 cycles, 100,000 to 2,400 volts installed for the Southern Power Company are typical of the development. There have also been built for the same Company several self-cooled transformers of 2,000 KVA. capacity, 100,000 volts high tension to 50,000 volts low tension to be used as tie-in transformers between two transmission lines.

Some very interesting combined transformers and voltage regulating devices have been built by the General Electric Company, for the Acheson Graphite Company, designed for use with resistance furnaces where it was necessary to handle 40,000 amperes and vary the potential from 40 to 160 volts.

A number of transformers for testing porcelain insulators, etc., have been built of potentials as high as 400,000 volts. A 750,000 volt transformer is now being built for testing such transformers.

The increased use of alternating current motors due to the wide distribution by Central Stations and the economies of alternating current transmission in large plants has made necessary the development of alternating current controlling devices. New or improved lines have during the past year been offered by the General Electric, Cutler-Hammer and Westinghouse Companies for printing presses, pumps, cranes, machines tools, elevators, coal and ore bridges, steel mill machinery, and single and polyphase starters, for squirrel cage and slipring motors.

ELECTRIC RAILWAY DEVELOPMENTS.

In the electric railway field, 1,200 volt D. C. operation has proved a success. For the first time rotary converters are operated in series for generating current at 1,200 volts, both 25 and 60 cycles, with success and no failures. Some of the notable 1,200 volt installations of General Electric equipment which went into operation in 1910 are Milwaukee Electric Railway & Lighting Co., Washington, Baltimore & Annapolis, and the Aroostook Valley Electric Railway Co. Complete D. C. electrification of the huge Pennsylvania System including the largest and most powerful electric locomotives in the world of entirely new design, have been made by the Westinghouse Co. The development of the new type of combined freight and passenger single-phase locomotive for the New Haven Railroad is an entirely different design from any locomotive heretofore used, and is the type adopted in the extensions of the New Haven system. Complete single-phase electrification of the Hoosac Tunnel section of the Boston and Maine R. R. with locomotives and equipment of the New Haven type, has also been accomplished.

Other noteworthy advancements are the multiple unit direct current train equipment of Long Island-Pennsylvania Terminal trains for all local service, the new development of Galt, Preston & Hespeler D. C. slow speed freight locomotive for heavy traction on interurban roads, and the single-phase equipment of the new Rock Island & Southern R. R. passenger, express and freight service. The D. C. equipment of the Rochester, Syracuse & Eastern R. R., is one of the first purely electric roads built and operated after the manner of a steam railroad for high speed and heavy traffic. The schedule speeds are over 60 miles an hour, and one mile was made in 54 seconds. Further, the single-phase equipment of Chicago, Lake Shore & South Bend Railway, has been successful by operation of single phase multiple unit trains with unit switch control.

A feature of urban electric traction has been the successful application of the new Edison storage battery and the gasoline electric units of General Electric design. While these units are at the present time in an experimental stage every indication points to a place of immediate usefulness.

ILLUMINATION.

A notable accomplishment in the illumination field was the development of thoroughly efficient metallic flame arc lamps for operating on multiple and series circuits by the Westinghouse and General Electric Companies. Mazda lamps of various capacities up to 500 volts have been developed together with the Westinghouse wire type tungsten lamp manufactured in 25, 40, and 60 watt sizes.

Considerable progress has been made throughout the country in street lighting with flaming arcs, and tungsten incandescents in decorative and ornamental systems for business thoroughfares. The schemes have been varied in certain sections, the principal arrangements being the suspension of lamps over the street in the form of an arch and the installation of poles carrying from two to five incandescent units either in a vertical or downward position. The later scheme seems to be generally popular and is being installed in a number of cities of moderate size.

The installation of electric signs in all cities of considerable size has been a rapid development during the past year. Typical of this progress are the new and wonderful motion signs of New York City.

ELECTRIC HEATING.

Foremost among the small electrical apparatus which may be classed as current consuming devices are the numerous new heating and cooking devices placed on the market by the various electrical manufacturers. The most recent new lines are those of the Cutler-Hammer Manufacturing, the Westinghouse, General Electric and Simplex Electric Heating companies. These lines which are either new or perfected devices, include cereal cooker, chafing dish, coffee percolator, curling iron heaters, cigar lighter, corn popper, flat irons, fans, food warmers, frying pans, griddles, heating pads, nursery warmer, plate warmer, radiators, range and cooking utensils, water heater, electric grate, hair dryer, sewing machine motor, washing machine motor, foot warmer, electric automobile charging outfit and lifting magnets.

TELEPHONE APPARATUS.

The development of new telephone apparatus, and the improvements of types already in use, has been remarkable during the past year. Notable among the events of the year in the telephone line have been the following: The Western Electric selector for use in railway dispatching circuits was placed on the market during the year. Many railroads during 1910 discarded the telegraph in favor of the more efficient and rapid telephone, and this selector, enabling any station along a line to be called by the dispatcher with a minimum loss of time, may be called an important development. Mine telephones and signal sets were placed on the market and installed in a great many underground shafts, due to the Legislation following the disasters of 1909. The sectional unit switchboard enabling small but rapidly growing telephone exchanges to install switching apparatus which will still be of use after the system has been extended to a large number of telephone stations. Convertible switchboards have been developed to take care of the exchange which wishes to install magneto switchboard equipment, but which sees in the future a possibility of a demand for central battery operation. The switchboard, equipped with the combined jack and signal, also has been placed on the market during the year, and has been put into use by many small telephone companies. The year has seen large developments in private branch exchange switchboars, and interphones, a number of new types of which to meet the various kinds of service are now in extended use.

1910 SOUTHERN DEVELOPMENTS.

The motive power of Southern establishments at the present time is principally steam, however, the past year has witnessed considerable activity in the establishing of hydro-electric, gas, and oil installations all of which are established on most satisfactory operating basis. The apparent tendency in steam development at the present time in large plants is toward the use of turbines direct connected to alternating current generators operating at such voltages as are most economically transmitted within the territory served. For the industrial plant with an already existing steam plant, the low and mixed pressure turbo-generators are growing in favor.

Those water power developments which have a variable storage are relaying with steam plants embodying steam turbine units. Notable among this type of development in the South is the Southern Power Company which when all of its connected plants are in operation, will be the largest connected station in the South and probably the second in the world.

During the past year, the Southern Power Co. has installed at their 99 Island station six 5,200 horsepower and one 600 horse power hydraulic turbines of Allis-Chalmers design, direct connected to alternating current generators. This company has also installed three steam relay plants, each of 800 kilowatt capacity containing Westinghouse double flow turbines, Leblanc condensers, and direct connected to A. C. generators. These plants are located at Greenville, S. C., Durham, N. C. and Greensboro, N. C. The Southern Power Co., with its four large water powers in operation and its three relay plants, is equipped to supply nearly 300,000 electrical horse power and distribute it over a territory by a transmission line some three hundred miles in length, lighting cities, running street cars, and furnishing power for hundreds of factories in the Carolinas.

Noteworthy among other recent hydro-electric plants of the South are the Central of Georgia Power Co. at Jackson, Ga., with four 3,000 K. W. Morgan-Smith water turbines driving Westinghouse 2,300 volt generators and transmitting energy at 66,000 volts. The James White Power Co., of Athens, Ga., with a hydro-electric equipment of Allis-Chalmers design aggregating 5,000 horse power. The Florida Power Co., of Osceola, Fla., with a hydro-electric equipment of the same design, consisting of three 1,000 kilowatt units.

Some turbo-electric equipments of considerable size are the Savannah Lighting Co., Savannah, Ga., with a 2,000 K. W. Westinghouse double flow turbine and generator; the Erwin Cotton Mills, of Durham, N. C., with a similar equipment, the municipal plant of the city of Jacksonville with four 1,500 Allis-Chalmers K. W. units, and a 850 K. W. Fort Wayne motor generator set. This station is the largest municipal electric light plant in the South and one of the largest in the country; the Consolidated Ice & Power Go., of Valdosta, Ga., with two 300-kw turbine generator sets generating at 2,300 volts; the Ducktown Sulphur & Iron Co., at Copperhill, Tenn., with two 625-kw Westinghouse turbo-generators.

Typical of the recent gas engine installations in the South, are the plants of the Southern Cotton Oil Co., at Savannah, Ga., Montgomery, Ala., Dillon, S. C., and Greenwood, S. C., each embodying Westinghouse gas engines, and soft coal producers connected to generators in sizes from 150 horse power to 500 horse power; the Palmetto Phosphate Co., of Tiger Bay, Fla., with a plant consisting of four 200 K. W. Allis-Chalmers units, also a similar plant installed by the Ware County Light & Power Co., at Waycross, Ga., and the Interstate Chemical Co., of Charleston, S. C., using 200 horse power Westinghouse gas engines and producers.

Typical of the low pressure installations in plants having an already existing steam equipment is the Great Southern Lumber Company, the largest saw mill in the South, which has recently installed a 1,000 K. W. low pressure turbine of Allis-Chalmers design. The Atlanta Steel Co., Atlanta, Ga., with two 500-kw low pressure turbo-generator sets using exhaust steam. The Tennessee Coal, Iron & Railway Co., of Ensley, Ala., using four 3,000 K. W. mixed pressure turbo-generator sets.

During the past year the use of steam turbo-generators has very largely increased, not only for central station work, but in various independent manufacturing enterprises. This has been particularly noticeable in the Lumber Industry. Formerly the lumber interests were very prodigal in their use and waste of fuel but now they are installing steam turbines and condenser apparatus, together with motor drive in an endeavor to secure highly efficient operation.

During the past year the textile industry has also further advanced in the use of electrical apparatus for power purposes. The majority of the larger textile mills with steam turbines and condenser out-fits. In some of the older mills group drive has been continued but individual motors have been used for driving the groups instead of employing a great amount of shafting as was done with the engine drive. In the newer mills individual drive has been used to a large extent although both group drive and four frame drive have been employed where these seem best to meet the conditions.

Water Powers and Resources of Tenn.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

BY GEO. H. ASHLEY, STATE GEOLOGIST OF TENNESSEE.

Through an enactment of the State Legislature of Tennessee in 1909, provision was made for the establishment of a State Geological Survey. The purpose of this Survey is to obtain accurate information of the natural resources of the State for the purpose of increasing the wealth of the State and its citizens through a more extensive use of its natural resources. Primarily, the Survey is to be a bureau of information on all matters relating to the geology and mineral resources of the State. Its work, therefore, will include the collecting of information and study and systemizing of it so that it can be supplied and used to the best advantage.

The investigation of the undeveloped water powers of Tennessee, will form no small part of the work laid out, and such an investigation has now been started. This will include a study of the run-off of the valleys, surface streams and the conditions effecting it, the possible source of water power, with minimum and maximum derivable power, the points at which such power can best be obtained so that those desiring to establish industrial plants or to avail themselves of power for other purposes, may secure from the Survey the information they need. It has been calculated that the developed water power of Tennessee is at present 95,060 horsepower, of this 85,548 horsepower are obtained from the Tennessee River, using 1,691 wheels; 8,576 horsepower from the Cumberland River, using 397 wheels; 796 horsepower from the small tributaries of the Mississippi River, using 62 wheels; 140 horsepower from the Green River, using 10 wheels. While no definite data is at hand to enable the writer to estimate exactly the undeveloped water powers of the State, such calculations as have been made indicate that Tennessee should furnish, under present conditions, about 600,000 horsepower all the year round, or probably 1,000,000 horsepower for six months to be supplemented during the other six months by steam power. By utilizing every available opportunity for water storage, under conditions which do not exist now, but which may exist in the future with the exhaustion of our coal supplies, it is probable that the streams of Tennessee will furnish at least 2,000,000 horsepower.

Further than this water power investigation, the Survey is covering the entire group of natural resources of the State, which includes the metals, fuels, structural materials and various other products. Already reconnaissance surveys have been made of the oil and gas resources of the State, of the clays of West Tennessee, and preliminary studies are in progress on the iron ores, zinc, marble, phosphate and other resources. The Survey is also lending its aid, in a most substantial way, to the problems of the reclamation of the river bottoms of West Tennessee.

The surveys already made indicate that Tennessee has, as is well known, large coal deposits covering some twenty counties, and yielding about $7,000,000 worth of coal a year. She has large deposits of iron in both east and western Tennessee, yielding about $1,000,000 worth of ore, and $3,000,000 or $4,000,000 worth of pig iron; she has a large deposit of copper, confined to one county in the southeast corner of the State, the production from which ranges from $3,000,000 to $4,000,000 per year. Tennessee is the second State in the production of phosphate rock, producing between $1,000,000 and $2,000,000 worth a year; she has large deposits of low grade zinc ore practically undeveloped, which are only awaiting capital to rival the Joplin district; her clays are unexcelled, and are being shipped in large quantities to nearly all of the northern and eastern states for the production of high grade clay products. With all the raw materials at hand the State would seem to offer an unusual opportunity for the establishment of plants for the manufacture of such wares to meet the southern and southwestern market. The State produces probably the best marble for interior decoration now on the market. In 1908 Tennessee stood third in the value of her marble output with a production valued at over $800,000; she produces, in addition to these substances, over a quarter of a million dollars worth of cement; over a half million dollars worth of coke, nearly a million dollars worth of gas, coke, tar and ammonia, about a quarter of a million dollars worth of lime; a half million dollars worth of limestone, over $100,000 worth of pottery, over a quarter of a million dollars worth of sand and gravel and smaller values of barytes, gold, mineral paints, mineral waters, silver, etc.

In the industrial awakening, which for the last ten years has been going on in the South, Tennessee has been a leading figure. The whole coutnry is coming to a realization that today the South stands for opportunity, much as did the far West thirty to sixty years ago. This is strongly reflected in the increase of population of the southern cities, in the multiplication of industrial plants of all kinds, in the reclamation of swamp lands and abandoned farms, in renewed interest in education, art and literature and in a thousand minor ways. Today capitalists looking for investments and young men looking for opportunities to worthily win their way have their faces turned toward the South, and the young men of the South no longer feel it to be necessary to go North or West to find the larger opportunities they desire.

The natural resources of any State or nation form the basis of its material advancement, and their development and use measure its wealth and progress. Tennessee is rich in mineral and other resources. Extending from the oldest rocks in the crest of the Appalachians to the newest rocks forming the bottoms of the Mississippi River, there is embraced within its borders a variety and richness of soils, of climate, of rock strata, of zones of ores and other minerals, hardly excelled by any other State in the Union. This is reflected in the fact that today she leads every other Southern State, except Alabama, in mineral production; that her mineral production in 1908 was larger than that of North Carolina, South Carolina, Georgia, Mississippi and Arkansas all put together; more than twice as large as that of Florida and nearly twice as large as that of Louisiana, but on the other hand, only a little more than half as large as that of Alabama.

And yet, with a few exceptions, she is making relatively little use of many of her resources, as compared with some other States no more favored, except by markets, and to a large degree Tennessee is one of the markets of those other States, rather than supplying her own needs. Thus, with probably as large deposits of clay as Ohio, she produces today only about one-twentieth as much value in clay products, and goes to Ohio and other States to supply more or less of her own needs. With probably as large deposits of suitable material for the manufacture of cement as Indiana, she produces only one-eighteenth as much, and makes a market for more or less of Indiana's supply. With many times as much iron ore as Pennsylvania, she produces only one-twenty-eighth as much pig iron. And similar examples might be multiplied. But it is not alone in the getting out of the materials that an advance is possible, but as much or more in their use. Every pound of raw material shipped out of the State is simply supplying some other state with wealth-making opportunities. Michigan supplies raw iron ore worth, in 1908, $2.85 a ton, and Pennsylvania works it up into pig iron worth about $15 per ton, or into steel rails or other materials worth still more. To how large an extent is Pennsylvania's wealth based on the natural resources of other states? To how large an extent is Tennessee today supplying other states with their wealth?

The Survey will be of indirect value to the State through its value to the individual citizens for whose welfare the State exists. It is of value to the landowner by showing what ores, minerals, rocks, or other resources underlie his land; their depth, volume, character and value, and to that extent it effects the possible sale value of his land, and second, by suggesting such use of his land as will make it yield the largest possible return. It is of value to those having capital to invest by supplying unbiased information upon which investments may be made or industries established. It is of value to transportation interests by increasing the volume of both crude and manufactured materials to be moved, through an increased production and an increased demand. It is of value to the purchasing public, which includes most of us, by reducing costs through the production in the State of things that must otherwise be obtained from without, and through increasing the supply of those things. It is of value to the man without work by increasing the demand for labor through the starting of new or enlarging of old industries.

In so far as the Survey may aid in the abating of the smoke nuisance in the cities, in obtaining cheaper light and power through a larger use of our water powers, in aiding and making effective plans for the drainage of the bottom lands, in converting poor farm lands into good farm lands, and in a thousand other ways, it may make it possible for all citizens to have more of the comforts and luxuries of life.

Southern Rural Telephone Development.*

BY M. S. ALLEN.

It is perhaps a curious fact that the part of the country which was first settled and which, in the beginning of our history, enjoyed the most advanced degree of prosperity, should have later fallen behind newer sections, particularly in its country life. The early history of the South is full of tales of fertile fields, great crops which were building up the wealth of the nation, and of a hospitality and lavish entertainment unheard of in other parts of our country either then or since. The people who settled the new lands across the sea found climate and virgin soil which would produce wonderful crops with the least effort, and their establishments and home life reflected the ease with which wealth came to them, and which endured for the first hundred years of this country's history. Their farming methods were naturally crude, but the great fertility of the soil made up for any lack of skill. They found that certain crops could be grown with comparatively little work, but did not realize that constant cropping with these certain things would soon exhaust the soil. The farms or plantations were of considerable extent, many containing thousands of acres, and when one piece of ground was worked out, it was allowed to run wild while another was worked. Labor was cheap and the cost of feeding and housing it was also low, good prices were secured for the crops, and as a natural result the condition of the country was very prosperous.

Two things which have done most to hamper the South have been lack of adequate transportation facilities and adequate means of quick communication. The three things which will most quickly overcome these handicaps are good roads, rural free delivery and universal telephone service. Of these three, the telephone by rights stands first. It is the one most accessible in all sections of the country, whether near a large city or away off from the railroad, ten or twenty miles from the county seat where there is only a small settlement or group of farms. To receive the benefit of the good roads, you must hitch up a team; you must wait for the whistle of the R. F. D. man to get your paper or letters; but with a telephone in the house, a turn of the crank puts you in touch with points near or far.

In thinking of the telephone, we are too prone to consider it only an integral part of a large community, because in such places it first became used and has become so absolutely indispensable. Competent engineers have said that if there were no telephone system in New York City, the streets would have to be three stories high to accommodate the messengers going from point to point, and that the modern sky-scraper would be an economic impossibility because so much room would be required for elevators and stairways that too little would be left for offices.

To give you an idea of what an important part the telephone plays in the life of a great city, let me tell you that in the City of New York there are 450,000 telephone stations. In the Waldorf-Astoria Hotel there are 1223 telephones, in the Singer Building 778 telephones, and in the New Metropolitan Life Building provision has been made for 1181 stations. The average number of telephone calls per day in New York City is one and one-quarter million.

If a telephone is so necessary in a large city, where distances are short and people accessible, how much more necessary is it in the country, where farms are far apart and the average roads poor in good weather and almost impassable in bad weather?

Now, to give you some idea of how the use of the telephone is growing in the South, as nearly as I can learn, on January 1, 1905, there was a total of 102,666 telephone stations in the six Southern States of Virginia, North Carolina, South Carolina, Georgia, Florida and Alabama. It is difficult to estimate how these stations were divided between exchange and rural subscribers, but it is probable that of the total number, only about 5 per cent, or 5100, were located outside of exchanges. On January 1, 1910, the grand total of telephone stations in the same territory had increased to 283,269, of which approximately 36,700 are rural stations. This shows an increase in rural stations alone of 740 per cent in five years. The year 1910 is showing a greater proportionate growth than any previous period, the gain in farmer line stations alone for the first ten months being approximately 15,000 stations and the total of all stations on November 1, 1910, being 313,000.

Probably the first and most direct appeal of the telephone is to the farmer's wife. She has less opportunities of getting away from home than other members of the family, she sees fewer new faces and receives fewer new ideas, so that anything which will serve to break the monotony of her life is welcomed as a God-send. Besides its social side, though, another and even greater appeal the telephone makes is as an aid in emergencies. But it is in other and more practical ways that the real value of the telephone is shown. You have some cotton or other produce to sell. Or, you find you need some machine parts or something with which to repair a tool and can ill spare a hand or a mule to send to town for it. What is easier than to call up your supplier and arrange to have it sent out by a neighbor?

Recent magazines have been full of the co-operative studies, showing how the potato growers of Virginia, the apple growers of Colorado, the celery growers of Florida and the Georgia peach growers have been getting together to properly market their crops and buy their fertilizers. But in order for a group of men thus to get together, there must be mutual confidence, a condition only to be attained by close acquaintance. Here again the telephone paves the way, for the rural telephone line is almost invariably a community affair, and the men who get together and build it are talking with one another daily even if they do not see one another once a week.

Telephone companies generally are making strenuous efforts to popularize the telephone in the country, and are

*Abstract of a paper read by Mr. Allen, Telephone Engineer for the Western Electric Co., at the Convention of Southern States Association Commission of Agriculture, held at Atlanta, Ga., Nov. 21 to 23, 1910.

making very liberal propositions for connections to their toll lines or exchanges. In localities through which the toll lines run but where there are no existing exchanges, they will permit farmers' lines to build up to the toll station and there connect direct to the toll line whenever toll connection is desired, the only requirements being that the lines be well constructed, the telephone sets efficient and a toll switching device installed. Each farmer may use the toll line as often as he desires, paying the regular toll charge for each connection. Conversations over the farmers' lines are, of course, free.

At exchanges, the usual plan is for the company to meet the farmers at the exchange limits, each owning the line and equipment to that point. The usual rate charged is 50 cents per set per month, with a minimum charge of $3.00 per month per line. For this charge the farmer receives service, not only with the other people on his line, but also with the subscribers of the exchange with which his line connects.

The low cost of farmers' telephone lines and the ease with which they may be constructed, together with the liberal offer of the telephone companies for connection, place the telephone within the reach of every farmer; and every farmer who has one is in a better position to farm his land and market his produce, aside from the other advantages a telephone brings him. Getting a telephone line started however in a section where there are none is usually slow, hard work, because in such a community the value of the telephone is not appreciated, while there are wholly incorrect ideas of first and final cost and the simplicity of building and maintaining lines and instruments.

Anyone who can build a fence can build a properly constructed telephone line and install his instrument. Any man or boy can quickly learn to clear the ordinary troubles which occur, and which usually consist of a tree falling across the line, grounded carbons, or burned out fuses in the lightning arrester, or the renewal of worn out batteries. Booklets illustrating and telling simply how to accomplish these things are to be had for the asking, while telephones are so well designed and durably built that any other kind of trouble seldom occurs.

Recent statistics show that of the ten million telephones and twenty-four million lines of wire in the world, over two-thirds of the telephones and wire mileage is in the United States. Let us try to make the South show the greatest proportionate development in the United States.

An Interesting Central Station Growth.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

BY T. K. JACKSON.

THE electrical department of the Electric Lighting Company of Mobile, was consolidated in June, 1906, with the electric lighting department of the Mobile Light and Railroad Company, under the name of the Mobile Electric Company. At the time of the consolidation of these two companies there were many who were customers of both companies, and who had service installed from both systems. One of the results of this consolidation was the taking out of the dual services and leaving only one installed. Therefore, the true growth of the company is but little reflected by the increase in the number of its consumers. However in spite of the elimination of all of this dual service, the company shows an increase of 24 per cent. in the number of its consumers during the past four years. As a better reflection of its true growth, the company shows an increase of 76 per cent. of the total connected load in kilowatts.

At the time that the Mobile Electric Company was organized and placed under the management of H. M. Byllesby and Company, the City of Mobile was in the high tide of its prosperity. It was, however, feared that with the gradual depletion of lumber in the territory which Mobile draws upon, that the city would suffer serious loss. The lumber industry has since 1906, dwindled down to practically nothing, and in spite of that the city of Mobile shows surprising and substantial growth indicated by the increase in connected load.

With the depletion of the growing timber much of the character of the development in the city has undergone a change and Mobile has gradually become as prominent as a manufacturing center as it has as a port. This fact is evidenced by an increase of 189 per cent. in the horse power connected load of motors attached to the lines of the Mobile Electric Company, which increase in four years is reflected by an increase in the power revenue of over 160 per cent. At the present time there are 3, 425-horsepower in motors connected to the lines of the company.

At the time of the organization of the Mobile Electric Company the power was supplied from two stations, which have been consolidated into one. This latter is a modern brick and steel power house containing many of the improved devices in engineering, including coal handling devices, chain grates, turbines, and condensing engines. The erection of this new power house rseulted in a saving of more than $12,000 per year in power house wages, and more than $30,000 per year in coal. The cost of the coal dropped from nearly 30 per cent. of the revenue of the company to under 15 per cent. of the revenue.

There was practically no sign business in Mobile, at the time of the organization of the Mobile Electric Company, there being no electric signs up, except internally illuminated signs of which number there were but three. At the present time there are in operation in Mobile 138 electric signs containing 8,957 lamps. At the same time there has been special street illumination installed, both of the arched over-head type, and of the illuminated post type. The number of street arcs in the city has also been increased from 288 to 481. On the first of October of this year a wiring campaign was started, arrangements being made with local contractors for special prices for wiring old houses; these special prices to be in force until November 15th, a total of forty-five days. During this campaign contracts for wiring 664 houses were secured. Four solicitors were employed in this campaign.

A part of the campaign consisted of a series of advertisements in local papers explaining the propositions of house wiring. A very attractive full page ad read, "Homes wired for electric light at actual cost. We pay the contractors profit." Following this heading, explanations were made under the titles, "Why we do it" and "What is done." The lower part of that ad was devoted the standard propo-

T. K. JACKSON, PRESIDENT AND GENERAL MANAGER OF MOBILE ELECTRIC COMPANY.

sitions as follows: Proposition A. Complete wiring for five-room house—five drop cords, five ornamental glass shades, five incandescent lamps. This will supply lighting for parlor or living room, dining room, kitchen and two bed rooms.

Wiring complete with lamps	$8.00
Underwriters' inspection fee	1.00
	$9.00

Proposition B. Complete wiring for five-room house—two two-light fixtures; three drop cords; six ornamental glass shades; seven incandescent lamps. This installation will give two lights in the living room and two lights in the dining room, one in each of the others.

Wiring complete with lamps	$10.75
Underwriters' inspection fee	1.50
	$12.25

Proposition C. Complete wiring for five-room house—square brass tubing fixtures, instead of drop cords; wall fixtures where desired; two fixtures have two lights each, the others one. Shades richly ornamented. This gives a really artistic installation of seven lights, the lamps being included in price.

Wiring complete with lamps	$12.50
Underwriters' inspection fee	1.50
	$14.00

It is felt here by the management that Mobile is firmly established, and in spite of the depletion of the standing timber, that its growth is assured. This growth was 38 per cent. in the last decade as shown by the Census. Future municipal development will be greatly increased with the deepening of the channel, appropriation for which has been passed by the United States Congress, and on which work has been actually begun, by the building of locks on the Alabama, Tombigbee and Warrior Rivers, work for which is well under way, and which will mean the bringing of coal, iron and cement to Mobile on barges.

The management also feels very much gratified with the support which the citizens of Mobile have given them, and which enabled them to increase their total connected load 76 per cent. in four years. We are glad to say that our property is located in a highly progressive community, whose citizens are eager to avail themselves of all modern comforts and advantages. This is shown by the fact that the Mobile Electric Company has installed at the present time, one electric meter for every 5.9 white inhabitants in the City of Mobile.

Profit-Sharing Plan of Edison Electric Illuminating Company, of Brooklyn.

At the end of the year 1910, employees of the Brooklyn Edison Company will be credited with a sum out of the profits of the company's operations for that year, in accordance with the following schedule: To those employes who have been in the company's service two full calendar years, a percentage of their salary or wages for the year 1910, equivalent to one-quarter of the rate of dividends paid on the capital stock during the year. To those employes who have been in the company's service three full calendar years, a percentage of their salary or wages for the year 1910, equivalent to one-half of the rate of dividends paid on the capital stock during the year. To those employes who have been in the company's service four full calendar years, a percentage of their salary or wages for the year 1910, equivalent to three-quarters of the rate of dividends paid on the capital stock during the year. To those who have been in the company's service five full calendar years, or more, a percentage of their salary or wages for the year 1910, equivalent to the full dividend rate paid on the capital stock during the year.

This profit-sharing plan is adopted for the current year only, and it will continue from year to year only as the board of directors may adopt it for each year. Provisions herein for more than one year are contingent upon the adoption of the plan by the board of directors for subsequent years. The amount of these credits will be paid in cash to the Trustees of the Brooklyn Edison Investment Fund to the credit of the individual employes and shall be subject to the conditions and by-laws of the said Fund, which are annexed hereto, except as modified by the following special restrictions: The sum credited in any year can not be withdrawn within three years, except with the consent of the provident committee and for one of the following reasons: To make payments upon the purchase of a home; because of death of the employee; unusual necessity in the opinion of the committee.

All moneys or credits to which any employe would be otherwise entitled and which have not previously been subject to withdrawal at the option of the employe, shall be wholly forfeited by him, and shall revert to the company, or if already paid to the Investment Fund, shall revert to the Fund, in the event that: Such employe is discharged by the company for misconduct; or such employe leaves the employment of the company without giving the company one month's prior notice in writing, unless the necessity of this notice is waived in writing by the company at the time of leaving; or such employe without the written consent of the committee assigns to any one or attempts to transfer, sell or encumber any interests he may have in said amounts; or such employe shall become insolvent or bankrupt.

The provident committee has the power to make and enforce rules and regulations to determine the eligibility of employes to receive pension allowances, to fix the amount of such allowances and to prescribe the conditions under which such allowances shall be paid, subject to the following conditions: Any employe who attains or who shall have attained the age of sixty-five years, and who shall have been at least ten years continuously in the service of the company, may be pensioned either at his option or that of the company. Any employe who has been at least ten years continuously in the service, and who, in the opinion of the provident committee, has become unfitted for full duty, may be retired and pensioned. Any such employe may make application for pension or be recommended by his employing officer for retirement.

The pension allowances authorized are to be computed upon the following basis: For each year of continuous service, not less than 1 per cent. nor more than 2 per cent. of the average pay received for the five years next preceding retirement, provided that no pension shall exceed 50 per cent. of the wages paid at the time of retirement; except that pensions of employes whose annual salaries exceed $2,500 shall be fixed by the Executive Committee of the company.

Electric Show at Chicago.

The Annual Chicago Electrical Show will be held at the Coliseum, January 7th to 21st. From all reports and from the fact that the space for exhibiting purposes at the show has sold rapidly, it is to be expected that the show will be one of the best in the history of electrical displays in Chicago. The method of conducting the exhibit and the fact that a percentage of the receipts are shared with the exhibitors, is one of the factors which is bringing exhibitors to the show and undoubtedly make the electrical display of all branches of the industry as complete as possible. The Chicago Electrical Show is under the management of the Electrical Trade Exposition Co., the officers of which are as follows: President, Samuel Insul; first vice-president, E. P. Obershimer; second vice-president, L. A. Ferguson; secretary and treasurer, Stewart Spaulding; directors, Samuel Insul, G. H. Atkins, Stewart Spaulding, Elworth B. Obersheimer, G. B. Foster, W. W. Low, L. A. Ferguson, S. B. Bennett, E. J. Mock. The review of the electrical show will be published in the February issue.

Lecture on Automobile Batteries.

An interesting and instructive lecture on the construction, operation and care of automobile batteries was given December 14, at the Carnegie Library, Atlanta, Ga., by A. N. Bentley of the Electric Storage Battery Co. The purpose of the lecture was to give automobile owners some idea of how automobile batteries should be treated and to analyze some of the features of operation and causes for trouble not only in the battery but in other parts of the electric automobile. Mr. Bentley is the Atlanta representative of the Electric Storage Battery Co., and a man of extensive experience in both the operation and the manufacture of automobile batteries. He treated the subject in a most able manner explaining all details in such a way that those who had never gone into the study of the storage cell and the way it generates electrical energy, could understand and follow the different chemical changes which take place.

Beginning with the elementary theory of the storage battery cell, Mr. Bentley showed how the cell was made applicable to the electric vehicle and also how it was possible to get the best efficiency from cells when normally charged and also how to restore the cell by charging after its mileage had been consumed. In view of the fact that a large number of automobile owners were present, the lecture was of great value to them as it relieved their minds by knowing that a large number of troubles which are attributed to the electric battery could be traced to other mechanical parts of the car. Numerous instances were recited in which this was pointed out.

The descriptive part of the lecture referring to the storage cell was made intensely interesting by the large number of lantern slides which were shown and the explanation by the lecturer of the various features of construction. One of the most instructive features of the lecture was a number of rules given, taking up the care of the battery. These are as follows: (1) The battery must always be charged with direct current, and in the right direction. (2) Be careful to charge at the proper rates and to give the right amount of charge. Do not undercharge or overcharge to excessive. (3) Do not bring a naked flame near the battery while charging or immediately afterwards. (4) Do not overdischarge. (5) Do not allow the battery to stand completely discharged. (6) Voltage reading should be taken only when the battery is charging or discharging. If taken while the battery is standing idle they are of little or no value. (7) Do not allow the battery temperature to exceed 110 degrees F. (8) Keep the electrolyte at the proper height above the top of the plate and at the proper specific gravity. Use only pure water to replace the evaporation. (9) Keep the cells free from dirt and all foreign substances both solid and liquid. (10) Keep the battery and all connections clean; keep all bolts connected tight. (11) If there is a lack of capacity in the battery due to low cells, do not delay in locating and bringing them back to condition. (12) Do not allow sediment to get into the plates.

The lecture was made possible through the efforts of William R. Collier, Contract Agent of the Georgia Railway Co. of Atlanta, Ga. The lecture was carried out purely on an educational basis rather than for any commercialism either to the Storage Battery Co. or to the local central station. Mr. Collier on account of his close connection with the vehicle side of central station business thoroughly realizes that people generally, do not understand the use of the electric vehicle as well as they should. Since the electric vehicle is now on a practical commercial basis, it is only by careful attention to details and plans to interest the public that the vehicle will be looked upon with the confidence it deserves. From the practical and informal discussions which followed the lecture referred to, it was plain that the object of the originators of the idea was accomplished. The example can well be followed in other sections.

New York Section N. E. L. A.

The first meeting of the season of the recently-formed Eastern New York Section of the National Electric Light Association was held at Schenectady on December 13th. A large gathering of men from the cities and towns of Eastern New York were present to welcome President W. W. Freeman and Secretary T. C. Martin of the National body, the principal speakers of the evening. Bryce E. Morrow of the Hudson River Electric Power Company, presided at the meeting, the address of welcome being given by Mayor Duryee of Schenectady. Mr. Freeman was then introduced as the first speaker, and his account of the growth of the National Association and its field of usefulness was very enlightening to the electrical men present. The benefits of the Association were very conclusively stated by the speaker, and he accounted for the rapid advancement of the Association to its position of today on the score of its great utility to the electrical industry.

National Secretary T. C. Martin elaborated some of the points brought out in President Freeman's speech, and especially interested the many young men present by picturing the splendid opportunities offered in both central station work and in the manufacturing industry. M. Webb Offutt, Manager of the Schenectady Illuminating Co., showed clearly the value of a local organization of men interested in the commercial phase of the electrical industry in bringing together the central station, contractor and general public. C. D. Haskins, Manager of the Lighting Department, General Electric Co., was very optimistic about the future of the local organization. He predicted for Schenectady, with its large body of men interested in things electrical, a large engineering building with headquarters for a number of scientific organizations.

The officers of the Eastern New York Section brought before the members some of the plans for the coming year's work, which promise to bring to Schenectady many of the foremost men in the electrical industry.

The Eastern New York Section already has 140 members, and it is certain that the membership committee, of which W. E. Brown, of Schenectady, is chairman, is making an active campaign among the central station men in the large and thriving towns and cities of Eastern New York. The officers of the new section are: President, B. E. Morrow, Hudson River Electric Power Co., Albany, N. Y.; vice-president, M. O. Troy, General Electric Co., Schenectady, N. Y.; treasurer, T. A. Kenney, Hudson River Electric Power Co., Albany, N. Y.; secretary, R. H. Carlton, General Electric Co., Schenectady, N. Y.

The executive committee is composed of the following members: Chairman, B. E. Morrow, Hudson River Electric Power Co., Albany, N. Y.; C. D. Haskins, General Electric Co., Schenectady, N. Y.; M. Webb Offutt, Schenectady Illuminating Co., Schenectady, N. Y.; Mohawk Gas Co., Schenectady, N. Y.; A. A. Anderson, Albany Illuminating Co., Albany, N. Y.; J. C. DeLong, Syracuse Lighting Co., Syracuse, N. Y.; F. H. Gale, General Electric Co., Schenectady, N. Y.

Electrical Engineering at the Massachusetts Institute of Technology.

The progress of the graduate electrical engineering work at the Institute of Technology is indicated by the number of students who are candidates for Master's and Doctor's degrees, which number is now greater than last year. The number of students in the undergraduate course in electrical engineering is also steadily increasing so that additional teaching staff is being added to the corps of laboratory instruction.

Various lines of research are being carried on in the department mostly under the direction of Professor Pender and Professor Wickenden. Some of these relate to the effects of heat treatment on the magnetic qualities of silicon iron, certain transient phenomena that may occur in long electric circuits, the effect of high frequencies on the permeability of iron, the effective resistance and reactance of steel rails when conveying alternating currents, the selective action of spark gap lightning arresters with respect to frequency, the reflection of light from walls or ceilings, the disruptive strength of rubber insulated coatings on wires, etc. Certain of these are continuations of work started last year, and researches in each will be carried on as may be convenient and needful to get knowledge of the phenomena under investigation.

The results of the thesis research of Dr. Harold Osborne on whom the degree of Doctor of Engineering, the first conferred by the Institute, was conferred last June were embodied in a paper presented before the American Institute of Electrical Engineers at its October meeting and brought out an interesting and valuable discussion.

The subject of illumination and photometry has been added to the subjects taught in the electrical engineering department. This is treated from the standpoint of what is generally called illuminating engineering and is made an optional study. The instruction is by lectures, recitations and laboratory work under the direction of Professor Wickenden, who is the author of a well-known book on "Illumination and Photometry." A preliminary edition of an important text book on "The Principles of Electrical Engineering" has recently been issued by Professor Pender of the department.

Membership of N. E. L. A. Grows.

The National Electric Light Association reports that it is continuing to enjoy the growth which it has experienced so remarkably during the past eighteen months. On December 12th the membership reached the high mark of 6007, inclusive of 904 operating companies and 222 manufacturing concerns. The operating companies and their sections have 4133 employees and members of their staff in Class B membership. The membership in July, 1909, was 3137, and at the meeting of the Executive Committee last January, was reported at 4500, so that the net growth during the present year, after dropping 250 individual members for various reasons, is around 1500. Mr. H. H. Scott, the energetic chairman of the membership committee, has with the aid of a large and enthusiastic committee, just set on foot another membership campaign and there seems every reason to believe that 1911 will witness a growth in every way equal to that just noted.

Development of Hydraulic Power in Italy.

Consul-General James A. Smith, Genoa, states in a recent consular report that in the northern section of Italy especially, the industrial development within the past ten years has been little short of remarkable. With this development the Italian capitalists and manufacturers have, in common with American industrial interests, awakened to the economic value of their tremendous natural resources in the way of hydraulic power, resources rendered particularly valuable by the fact that Italy produces no coal and was and is dependent for her industrial fuel supply upon other countries. It is interesting to note, however, that, notwithstanding the rapid progress made in the utilization of water power, during the past six years especially, coal imports have also steadily increased, a fact which shows the still more rapid progress made in her industries which, in spite of the more extended use of water power, have not found this to be sufficient to keep pace with their growth.

The hydraulic resources of the public domain in Italy are carefully controlled by laws dating back to 1865 and 1884. Applications for concessions for the use of water power are divided under three headings—power, irrigation and reclamation, and potable water. In granting concessions the Government Bureau of the Public Domain has adopted a unit of measurement in estimating the price to be paid the Government by the concessionary. This unit is known as a "modulo," which is equivalent to a supply of 100 liters (26.41 gallons) of water per second. Based upon this, the price is fixed at 50 lire ($9.65) per "modulo."

Some exceptions to this rule are, however, to be noted. Where the concession asked for is to be used for developing power for industrial or other purposes, the price is estimated according to the number of horsepower to be utilized and is fixed at 3 lire ($0.579) per horsepower. In certain cases where the obligation exists on the part of the concessionaire to deliver the water after use for further utilization the price per "modulo" is reduced by one-half, and in case the water is to be used for irrigation purposes and it is not found practicable to measure the quantity delivered the charge made is 0.50 lire ($0.10) per hectare (2.47 acres).

On June 30, 1909, 3,126 concessions had been granted for the use of the public water for power purposes, 1,094 for irrigation, and 145 for potable water. The two last have not much importance, as only about 340,000 acres of land are so irrigated. The larger part of the irrigation is accomplished by the use of water from private or public canals or from private wells, and the potable water is obtained largely, also, from springs, etc., of private ownership.

Electrical Supplies in England.

According to reports by Consul-General John H. Griffiths, there is a very healthy demand for electrical supplies in England, covering practically every article of electrical manufacture. Not only are all the houses and shops of the better class which are now being built fitted throughout with electric lights, but it is becoming more and more essential in order to lease premises of any character in desirable localities in London to install electricity. While electrical appliances of all sorts can be sold in London, the articles most in demand are carbons, tubing, batteries, arc lamps, signs, bells, dynamos, fans, lamp stands, light shades, fire and burglar alarms, motors, and telegraph and telephone cables. Electric signs are not nearly as extensively used in London as in the large cities in the United States, but they attract a great deal of attention, and are considered an excellent method of advertising. This field is not fully occupied, and it would appear that there is an opportunity for the sale of striking electric display signs in London.

In the eight months ended August 31, 1910, the importations of electrical goods into the United Kingdom increased by $755,738, and the exports by $5,690,943, the total trade being: Imports, $4,752,716; exports, $12,667,675. At the present time the imports of electrical supplies into the United Kingdom come very largely from Germany, and have so come in increasing quantities for the last few years. With the increased importations from Germany there has been a pronounced falling off in the imports from the United States. Proximity and price are given as the reason for Germany's success. There are at least two important American electrical companies which are represented in London, and I believe have factories in England.

With the nationalization of the telephone system, which will soon take place, there may be some important extensions made, and in that event there will be a demand for telephones, cables, and supplies generally. It would be advisable for American companies to keep closely in touch with this situation. If it is their purpose to make the effort to introduce their manufactures into Great Britain, agencies should be esablished in London in conspicuous localities, which should carry full assortments of supplies. Before establishing such agencies, very careful examination of the patent laws now in force in this country should be made, as in 1908 a law was passed for the purpose of compelling foreign manufacturers of patented articles who desired to do business in England to manufacture the articles in this country. It might be that the same end could be accomplished by having some one already in London act as representative, but more satisfactory and prompt results would be secured if the course first mentioned were followed.

The competition in a sense in the electrical world is much keener in Great Britain than in the United States, for the reason that the business is sub-divided to a much greater extent, and there are necessarily more bids submitted on large contracts.

Carbon Lamp Rating.

Irrespective of the particular kind of incandescent lamp employed, three important characteristics must be considered in order to correctly judge of its efficiency; wattage, candle power, and life. Now a significant fact is that no one of these three qualities can be changed without changing the other two, except the quality of the filament itself be also changed. In other words, if the wattage of a given lamp is increased, the candle power will be increased, and the life shortened in proportion.

Such has been the high plane of efficiency in the manufacture of incandescent lamps within the last few years that individual improvements, though frequent, were not sufficiently great to compel radical changes in lamp rating; and it was only by comparing lamp performance over a considerable period of time that the extent of this improvement was made manifest. On account of the above, the only improvement apparent to the average consumer was the longer lamp life thus secured.

But as is now well understood, the use of a lamp of higher efficiency than previously employed not only produces more light, but under ordinary circumstances, is actually more economical. This is accomplished by keeping the life of a lamp constant and giving up a greater candle power—thus providing the consumer with an increased amount of light at practically the same wattage consumption, and with no decrease in the lamp life.

The three voltage rating has been applied to carbon lamps for two reasons: (1) Because in complying with the new candle power unit, the International Candle, as adopted by the Bureau of Standards, a change in the apparent efficiency has occurred. If the old basis of efficiency were used a system of decimals would be required in selling lamps. The present three voltage rating does away with this complicated method by simply placing the three voltages on the lamp so that the efficiencies of a lamp may be known as "high," "medium," or "low." (2) An improvement in lamp quality has occurred, and in order to combine this improvement to the best advantage of the lamp-buying public the new method of rating incandescent lamps has been adopted.

The wattage ratings have been applied to carbon lamps for the following four reasons: (1) For simplicity in comparison; (2) to place all lamps on the same basis; (3) to reduce the number of lamps on the carbon schedule; (4) to educate the public to use high efficiency lamps.—*Juice.*

Central Station Insurance.

At the St. Louis meeting of the National Electric Light Association statistics were presented by Mr. W. H. Blood, Jr., insurance expert of the Association, tending to show that fire insurance premiums paid by the electric lighting companies of the country are fully twice as high as the low ratio of loss would warrant. Resolutions were adopted by the Association asking for an investigation of the subject by the fire insurance companies and directing that copies of the resolution be furnished to member operating companies so that they might take up the matter with their brokers. A thorough campaign along these lines has recently been organized as fitting at this season of the year, and large numbers of copies of the resolution have been placed in the hands of the operating companies, requesting them to bring the matter to the attention of their insurance brokers. Letters have also been written from Association headquarters to some two hundred and fifty insurance companies calling their attention to the matter and inviting them to investigate the subject with a view to a reduction in rates commensurate with the premiums received and the risks involved. An extremely interesting report and analysis of the subject generally was presented at St. Louis by Mr. Blood and has been reprinted in the annual proceedings of the Association.

Smelting By Electricity.

Consul P. Emerson Taylor, Stavanger, Norway reports that the Electro-Metallurgical commission has completed its work and filed its report. In speaking of the work of the commission Professor Farups, of the University of Christiania, one of the members, says:

"It is quite possible for us, in electric smelting of iron ore, to compete with smelting ovens of the old type in other countries. The iron ore is no more expensive here than in other places, and Norway is richer in electric energy, and electric power here is much cheaper than in other countries. Besides, we have very good export seaports, with our waterfalls and electric power close to the sea. Should the electric smelting of iron and steel, in spite of all this, become more expensive than smelting by the old methods, it will still be able to compete with the old method of smelting because of the much finer quality of the product. In Sweden, where the new electric smelting ovens have been installed, the results show that the new method is a success and in an advanced stage of progress, and Norway will, with her electric power and transportation facilities, have many advantages over Sweden.

Use of Poles.

The total number of poles reported to the Bureau of the Census as purchased during the calendar year 1909 by the telegraph and telephone companies, steam and electric railroads, and electric light and power companies of the United States was 3,739,000, as against 3,249,000 in 1908 and 3,283,000 in 1907. There were purchased in 1909 by the same class of users 3,509,000 cross-arms, 6,168,000 brackets, and 18,463,000 insulator pins. Cross-arms, brackets, and insulator pins were not included in the annual census of lumber and timber products prior to 1909.

This information appears in a preliminary comparative report covering 1909, 1908, and 1907, which was transmitted to Census Director Durand by Chief Statistician William M. Steuart, under whose supervision it was prepared by J. E. Whelchel, expert special agent of the Division of Manufactures. In co-operation with the Forest Service of the Department of Agriculture, the Bureau of the Census annually collects and publishes statistics pertaining to the group of lumber and timber industries.

Telephone and telegraph companies reported purchases during 1909 of 2,916,000 poles, or 78 per cent. of the total. This was an increase over 1908 in the number reported as bought by this class of users of 354,000 poles, or 14 per cent., and over 1907 of 604,000 poles, or 26 per cent. Steam railroads reported the purchase of 26 per cent. more poles in 1909 than in 1908, though 34 per cent. less than in 1907, while the reported purchases by electric railroads and electric light and power companies were 18 per cent. greater than in 1908 and 7 per cent. less than in 1907.

Cedar continues to be the principal pole timber, contributing 65 per cent. of the total purchases in 1909, 68 per cent. in 1908, and 64 per cent. in 1907. Chestnut, after cedar, was used in greatest quantity in all three years, forming 16 per cent of the total in 1909, 16 per cent in 1908, and 19 per cent. in 1907. Among the remaining species, the increase in the number of oak poles reported as purchased during the last three years is noteworthy; more than three times as many poles from this species having been reported as purchased during 1909 as was the case in 1907.

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.

VOLTAGE FOR SHORT DISTANCES.

Editor Southern Electrician:

(184) "Kindly obtain information from central station engineers as to the most economical practice which they have found for the following case. A factory one-half mile from the generating plant is to be equipped with 250 horsepower in motors running at 440 volts, 60-cycle, a 440 volt line is available 500 feet from the factory for use. Is it as economical to use this line or to transmit at 2,200 volts and transform at the factory? The necessary transformers are on hand."

W. E. D.

INDUCTION GENERATOR.

Editor Southern Electrician:

(185) "Kindly explain through the question and answer department, what is meant by an induction generator and under what conditions it is used. The writer is of the opinion that it is an induction motor driven above synchronism for raising the power factor by a leading current, same as with a synchronous motor. If this is true can the induction generator be made to carry a load?"

R. C. R.

COMMUTATION OF INTER-POLE MOTOR.

Editor Southern Electrician:

(186) "It is generally understood that the inter-pole motor helps commutation and a more uniform field is obtained. I would like to see an explanation by some one as to how this is brought about by the inter-pole."

H. A. W.

CHOICE OF CENTRAL STATION UNITS.

Editor Southern Electrician:

(187) "Kindly publish information from your central station readers who are using either steam engines, turbines or gas engines as prime movers, stating the real basis of comparison they used when deciding upon the size of equipment. What efficiencies were assumed for the differcut types? Kindly state the conditions which brought about the choice of the unit adopted. How was the question of skilled labor, maintenance, and depreciation treated for each unit? How was the ultimate load estimated and what weight did this feature have in the selection?"

H. A. P.

GENERATOR FOR CHARGING STORAGE BATTERIES.

Editor Southern Electrician:

(188) "Kindly request readers of SOUTHERN ELECTRICIAN to give information on the following: Can I use a compound wound generator for charging a storage battery of 60 cells without danger of reversing its polarity. The generator is a 110 volt machine. If it is necessary to make changes in the field windings, please give directions for such changes together with diagram of connections."

W. T. R.

TRANSMISSION LINE CONDUCTORS.

Editor Southern Electrician:

(189) "From our hydro electric plant generating A. C. at 2,200 volts, we are planning to run a line two miles to a small town where about 2,000 lamps will be connected. The lamps will be mixed about one-half 25 watt tungsten and the other half 16 candle power carbon. The distributing circuit at the town will be 110 volts. What percentage line loss on the transmission line and on the distributing circuit can be assumed to determine the size of conductors? Does the efficiency of the transformers have to be considered also?"

R. B. C.

Answer to Question No. 178.

Editor Southern Electrician:

"Since reading question 178 in your December issue, the writer has made some observations on tungsten lamps with a view to explaining the vibration mentioned. While it has never been called to my attention before, I believe this vibration is due to the effect of the magnetic field of one filament on its neighbor. In looking at various sized lamps to substantiate this idea, I believe I could detect a greater apparent vibration in the 100 watt tungsten, than in the 40 or 60 watt. This would lead me to believe that my opinion is correct because the larger current of the 100 watt would produce a stronger field and since the filaments are longer in the larger sizes, this vibration would be expected greater. I had only a 60 cycle source to observe from, I am wondering if a vibration is noticeable on 25 cycles. If the vibration is not due to the pulsation field will the engineers who read this please explain, giving observations on both 25 and 60 cycle circuits?"

W. M. HAYES.

Answer to Question No. 179.

Editor Southern Electrician:

"In answer to Question No. 179 of the December issue, I have the following to say: The rotary condenser is the application of a synchronous motor to a system having heavy induction motor and transformer loads, for the purpose of raising the power factor. The induction motor lowers the power factor by taking a current which lags behind the line voltage, while incandescent lamps take a current in phase with the voltage and operate at 100 per cent. power factor. Transformers require a magnetizing current so that when unloaded they also effect the power factor. The rotary condenser has the effect of altering these relations in the circuit by floating on the line. Through a variation in field excitation it can run at 100 per cent. power factor or nearly so or it may be over excited and made to deliver a leading current compensating for the induction motors running light or the partially loaded transformers. It will thus be seen that the rotary condenser supplies the magnetizing current when necessary to the induction motors and transformers while the generators are called upon for power only. Installations are known where the power factor of a system has been raised from 75 per cent. to 90 per cent. by the use of the synchronous motor as explained."

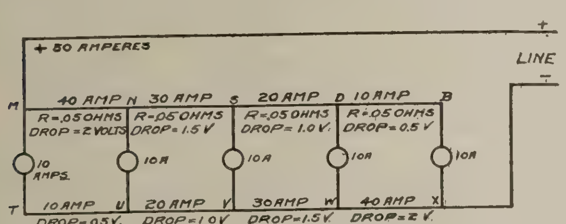
H. F. BOYLE.

Discussion on Question No. 158.

Editor Southern Electrician:

"In glancing over the October issue of the SOUTHERN ELECTRICIAN, I noticed the answer given to question No. 158 by Mr. H. F. Patton, and with your permission I beg to call attention to his erroneous statement, viz.: "By following out the connections, it will be found that each lamp is equally distant from the source of supply and, therefore, the drop at any one lamp is the same as that at any other. Hence the term 'equal voltage circuit.' This conclusion is not correct; if Mr. Patton assumes the main to be of uniform cross section, the middle group of lamps will receive the minimum voltage and the end group the maximum voltage. The following example will illustrate this point, the quantities being merely assumptions:

"In Fig. 1, assume five groups of lamps taking 10 amperes, the distance of the groups from each other being equal. Assume the resistance of each section of the main



CONICAL SYSTEM OF WIRING.

to be .05 ohms. Now section MN carries 40 amperes, section NS 30, section SD 20, and section DB 10. The drop of section MN equals 2 volts; the drop of section NS equals 1.5 volts; the drop of section SD equals 1 volt, and the drop of section DB equals .5 volts. Now if we follow the path of the current through section MNNS through the middle group of lamps, through section VW and section WX, we will get the final total drop of 2 plus 1.5 plus 1.5 plus 2, equals 7 volts drop at middle group of lamps, and if we consider the end group of lamps at B, the path of the current will be through sections MN, NS, SD, DB, and finally through the end lamps. Or the total drops will be 2 plus 1.5 plus 1, plus .5, equals 5 volts, or a difference of 2 volts. The middle group of lamps will then receive a lower voltage than those at the end, due to the fact that the former are supplied through the portions of the main conductors which carry heavy currents and in which the drop is greatest.

"It is possible, however, to secure a perfectly uniform pressure at all points between the mains if the cross section of the mains in each section is made proportional to the current in each section. This is the so-called conical system. In this way the drop in all systems will be the same and all groups of lamps will show the same pressure."

E. J. MORA.

Answer to Question No. 173.

Editor Southern Electrician:

"I notice that the author of Query No. 173 in November issue, desires information concerning portable desk telephone set, and as I have such a circuit on my premises, will show herewith the details of same. Of course it depends upon the type of telephone as to whether the circuits shown will answer in each individual case, but the scheme may be adapted to any circuit by proper modification of the apparatus to suit the requirements.

"The basis of the scheme is to place the bell box in the most convenient location as regards hearing the bell ring from all parts of the house or from each place it is desired

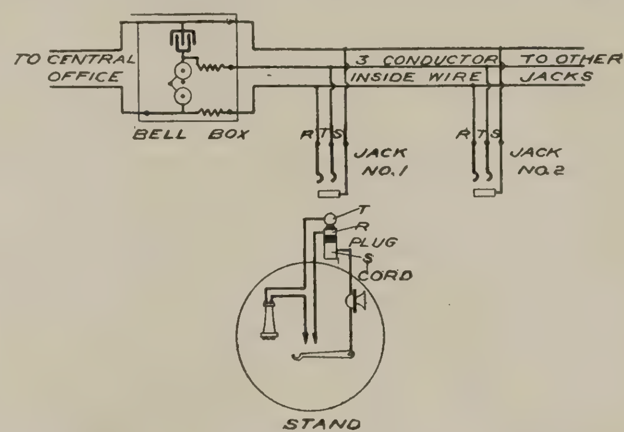


FIG. 1. CIRCUIT WITH THREE WIRE JACK.

to establish connection, and by use of the necessary wire and jacks to extend the cord to each of the desired points. In order to make the connection with the jacks thus installed and use the same set at each point, a switchboard cord and plug is substituted for the usual cord connecting the set with the bell box. This may be readily carried from one room to the other and by merely inserting the plug in the jack, connection is immediately established with the circuit the same as if with only the usual 6 foot cord. For the jacks I obtained a broken strip of answering jacks and by means of a hack saw cut them apart with sufficient space to one side of each jack to permit of holes being

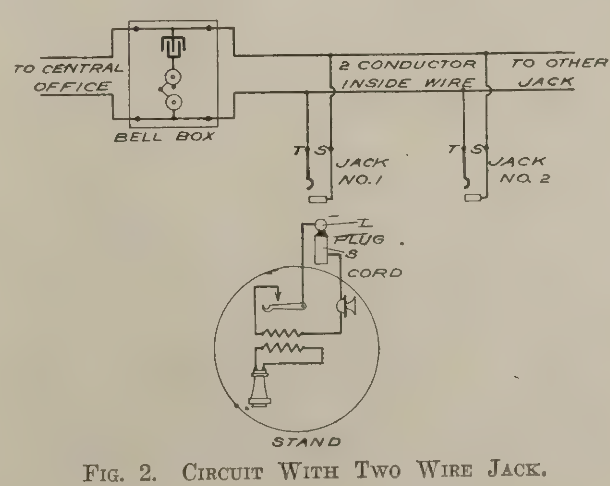


FIG. 2. CIRCUIT WITH TWO WIRE JACK.

drilled by which they could be fastened to the walls as desired. The edge of the window facing with the wires in the wall is a good place. I have an extra jack with a long section of wire and a plug on the opposite end by means of which I may extend the desk set from any permanent jack to any part of the room, as for instance near the bed at night, which of course, is very convenient in cold weather, obviating the necessity of getting up to answer a call, and especially a false call.

"The circuit for this arrangement is shown in Fig. 1, and is, as can be seen of the three wire jack type; same is easily understood and therefore I will not explain the details of the circuits of the set. Now, for the type of telephone with only two conductors to the cord the circuit shown in Fig. 2 may be used, of course, two conductor jacks and plugs being sufficient. Note that this type instrument has the induction coil in the base of the stand, which permits of the two conductor cord and some simpler circuit, but however, without a condenser connection within the receiver circuit. Other types of instruments may be connected by this scheme of wiring and if necessary, a double jack and plug may have to be provided that the requisite number of conductors in the cord may be extended as suggested. For instance, in the case of the Automatic set, at least six conductors are necessary and which would require two three wire jacks and plugs.

"Care must be taken with some types of sets, that the same wire is connected to the same spring of each jack respectively, as in Fig. 1, any other arrangement would cause a reversal of a part of the circuit design of the set, rendering same inoperative. Any other style of jack may be used in this work, but I have found that the ones mentioned herein are the most satisfactory on account of their compactness. Discussions along the lines of special circuits to suit various desires and needs of certain subscribers would make good matter for telephone men, and I would like to read of some such from some of your readers."

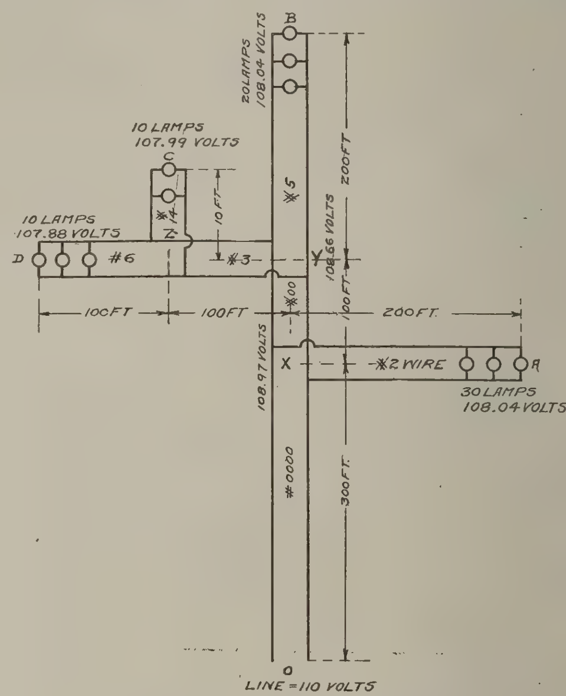
L. O. SURLES.

Answers to Questions Nos. 158, 161, and 169.

Editor Southern Electrician:

"The following information is submitted as answers to Questions 158 of the September issue, 161 of the October issue and 169 of the November issue.

"No. 158. The writer is not familiar with the term 'Equal voltage circuit' but infers that the questioner has in mind the problem of obtaining equal voltage at several different points in a system of lighting distribution. At any rate it will be interesting to consider the process of computing the proper sizes of conductors for such a circuit, although such computation has often to give way to other considerations. Fig. 1 shows a circuit with four groups of lamps of varying size and distance from the source, 0. The problem is to select such size of conductors as will give, say 108 volts at each of the points A, B, C, D. Assuming one-half amp. per lamp, we find that we have 35 amp. in part OX, 15 amp. in branch XA, 20 amp, in XY, 10 amp. in YB, etc. Now consider for a moment that we have four separate circuits, OA, OB, OC, and OD. To obtain 2 volts drop in 1,000 ft. of wire, with 15 amp. load calls for a resistance of .133 ohms total, or .000133 per ft. This is fulfilled by a No. 1 wire for circuit OA. In like manner we obtain No. 3 for OB, No. 6 for OC, and No. 5 for OD, each considered as a separate circuit. Now, in combination, we see that for part of circuit OX, we should use a wire about the cross section equal to the sum of No. 1, 3, 6 and 5, or about a No. 0000. Now 35 amps. flowing through 600 feet of No. 0000 gives 103 volts drop, therefore the voltage at point X will be 108.97 volts. Now we cannot assume that No. 1 wire will do for XA, but we must compute the proper size from this later figure. We find that No. 2 wire will produce a drop of .93 volt from X to A, so that the voltage at point A will be 108.04 volts. In this way we proceed from point to point. The method is somewhat cut and try, and often



LAYOUT OF LIGHTING SYSTEM.

we will come out on some little branch with a result that will compel us to change the size of a circuit previously considered. Following the previous methods we take No. 00 for part XY and with 20 amps. get a voltage of 108.66 at point Y. It will be noted that branch ZC figures out No. 14 wire, but for mechanical reasons larger wire may have to be used. We see also that there is a variation of only .16 volt over the system. In high tension A. C. systems, the transformer regulation has to be taken into account.

THE LUMEN.

"No. 161. A lumen is the unit of light flux, as distinguished from the intensity. It is the amount of light falling on a surface of one square foot to illuminate it with a brightness of one foot candle. A light having a mean spherical intensity of one candle power is giving forth 12.57 lumens. A 16 candle power Gem lamp, therefore, which has 13.2 mean spherical candle power, emits 166 lumens. Since the lamp consumes 50 watts, at 3.1 watts per candle power, this gives 3.32 lumens per watt. The total light flux multiplied by the burning hours gives lumen hours. For instance, this lamp burning 10 hours will have given altogether 1666 lumen hours.

STORAGE BATTERY ACTION.

"No. 169. We can explain to some extent the apparent chemical actions which take place in storage and other batteries, although some of them are not fully understood. If we immerse two plates of lead in a solution of a salt of lead and pass a current through the solution, spongy metallic lead will be deposited on one plate and lead oxide, PbO_2 on the other. If now these two plates are immersed in a solution of a sulphuric acid, H_2SO_4, we have a charged battery. During discharge the acid enters into combination with the lead and the lead oxide, forming a sulphate. During charging the action is reversed, and metallic lead and lead oxid deposited on the plates as before. The voltage given by this battery is two volts. We cannot explain why this particular voltage is produced. We only know that each chemical combination has a certain definite voltage, which is constant under all conditions. The current is not definite, but depends on the resistance in the external circuit. The maximum current which may be drawn from a battery without injury depends on the size of the plates, and is about 1-10 ampere per square inch of plate. A battery, therefore, with 11 plates, 15½ inches by 15½ inches should not be discharged at a higher rate than about 200 to 250 amperes."

A. G. Rakestraw.

Answer to Question No. 180.

Editor Southern Electrician:

"Being a regular subscriber to your valuable magazine I wish to answer question (180) by C. A. D. The circular mil is the unit used in measuring the area of conductors. It is the area of a circle one mil, that is, one one-thousandth of an inch in diameter. It is the most exact measurement for determining the carrying capacity of currents through conductors and is adopted by English and American electricians as a unit. Wires require from 350 to 650 circular mils per ampere capacity.

Frank Zuch.

Answer to Question No. 183.

Editor Southern Electrician:

"The writer has a general idea of the effect of resistance, inductance and capacity on an open wire transmission line and would like to state that in answering this question he is doing so in order that he may learn whether or not his opinions are correct.

"On any transmission line, however well designed, the voltage at the far or load end is considerably less than the generator voltage. If the resistance of the line is computed and this quantity multiplied by the current flowing, the voltage drop obtained does not show up the actual drop as measured by the instruments. This is due to the effect of the inductance of the line. The looping of the magnetic flux of one wire so as to enclose the others causes an inductive effect which cuts down the voltage. The combined action of inductance and resistance therefore causes the total voltage drop. It is generally understood that the resistance drop is in phase with the line current while the inductance drop is in quadrature, thus the total drop is the geometric sum of these two drops.

"It is often stated that a line takes a charging current and that this current has to be supplied by the generator over and above the load current. This is due to the electrostatic capacity of the line. With a high tension line this charging current becomes so large as to be a serious problem. In this case the inductance of the line is a benefit on account of the fact that, inductance balances capacity, as it is said. Usually inductance on a line is not desired on account of a lowering of the power factor by causing a lagging wattless current. Capacity, however, draws a leading current and when capacity effect is great the lagging current of inductance compensates the effect and improves the power factor.

"If your readers have a better explanation of this subject I should like to see it published."

H. L. Williamson.

Reply to Question No. 154.

Editor Southern Electrician:

"I am pleased to see the discussion on electrolysis in the article of your December issue, page 221. It was my intention to submit an explanation of the action of electrolysis on water mains as requested by question 154 of your September issue, however, as the theory of the action has been explained, permit me to offer a few suggestions as to how to prevent it. When laying out a new street railway system the sub-stations in case alternating current is converted to direct current, should be so located that the return current would have short distances to travel. This would diminish the voltage drop for any given current between any point on the line and the negative bus bar, and the stray currents liable to follow water mains would under these conditions also be diminished.

"Further than this method of prevention additional precautions can be taken by cross-bonding at intersections and careful bonding in all sections especially where near the water or gas mains. Good bonding reduces voltage drop between motor and station. Good authorities state that a drop of one-half volt per 300 feet should be the maximum allowed where electrolysis is liable to take place. This figure, however, depends upon the nature of the soil and distance between return rails and the water or gas mains. If other methods have been adopted with good results I should like to have your readers relate them."

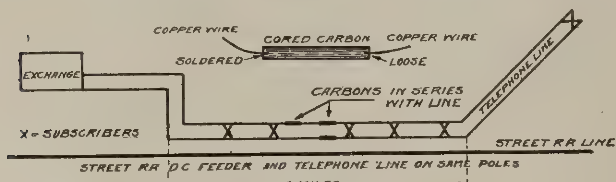
W. S. Reed.

A Noisy Telephone Line.

Editor Southern Electrician:

"A very interesting case of trouble was experienced by the writer not long ago, which may be of some interest to the readers of the Southern Electrician. A telephone company had a party telephone line, carrying approximately eight stations, running about six miles, four miles of this distance the wires being attached to the poles of an electric railway, carrying one D. C. feeder, whose voltage was approximately 550 volts. A great deal of trouble was experienced on this circuit, due to excessive noise, especially when the cars were passing over the section of track paralleling the telephone line. Several remedies were tried, among them being frequent transpositions, clearing the line of all possible grounds and the cutting in of drainage coils, as quite a little discharge was found to exist between the line and the ground. None of these remedies, however, seemed to have any effect. The drainage coils quieted the line a little, but proved a detriment to the ringing efficiency. The transposition and clearing up of the line seemed to have no appreciable effect.

"After covering the line a number of times the telephone company gave up the matter in disgust, and were about ready to remove the wires from the poles in question, and build a new pole line. As a last resort, however, the writer made a trip over the line with the express purpose of determining definitely whether or not any bad grounds, poor connections, etc., could be found, which had been overlooked previously. By testing the line both ways, at frequent intervals, with a head receiver, the trouble was narrowed down to about one-half mile of track. I then started to cover the line inch by inch, and examined all the poles, joints, etc. Not far from where the telephone wires joined the trolley poles, a short section of twisted



UNBALANCED TELEPHONE LINE.

pair copper wire had been connected in, to clear some branches of trees, for which trimming rights could not be secured. At one end of this twisted pair wire, and partially hidden by foliage, two rather long black objects were noticed, which were at first thought to be pieces of rubber tubing, and placed over the wires for insulating purposes. The company's lineman, after further thought suggested that they were a special type of fuse, which had been cut in the line at some previous time.

"Upon investigation, however, these tubes or fuses, proved to be cored electric light carbons, short pieces of copper wire being fastened into each end by means of a few drops of solder, this connection being rather poor. One of these was found in each side of the line at this point, and on the next pole only one side of the line was found so equipped, this, of course, solved our difficulty, for, as soon as these were removed, and the wires connected through solid, our line proved to be quite as satisfactory as any other line connected to the switchboard. The whole trouble being that those carbons offered too high a resistance in themselves, and, coupled with this, the fact that the connection was very poorly made, it can readily be seen that our line was badly out of balance, and it is no wonder that considerable trouble was experienced due to trolley induction. Before the trouble was removed this induction was so heavy at times, especially when a car was starting at any point along the telephone line, that it would be impossible to hear the voice of the person at the other end of the wire.

"The writer would suggest that any reader of this paper, who may have occasion to look for noises on telephone lines paralleling electric street railway wires, would do well to look for an unbalanced condition of his line before going into any more elaborate investigation."

A. G. KINGMAN.

Answer to Question No. 180.

Editor Southern Electrician:

"Referring to question No. 180 in the December issue, by cir mil is meant the area of a circle whose diameter is .001 inches. The cross-sectional area of an electrical conductor is generally expressed in terms of the cir mil. For instance a No. 10 B. & S. gage wire has a cross-sectional area of 10380 cir mils, that is it has an area equal to 10380 times the area of a circle .001 inches in diameter.

"The cir mil is usually chosen as the unit of area in formulas used in computing resistance and other properties of electrical conductors in which the cross-sectional area is a factor, while the length of the conductors in such formulas is expressed in feet."

FRANK HOBACK.

Suggestions to Operators of Small Lighting Plants.

Editor Southern Electrician:

At the present time it may be considered indiscreet by the central station to write on the side of the small lighting plant. The craze is for big things and much is said about such mammoth creations as the Lucitania, a dreadnought at full speed, the engine room of an immense steel plant or some other large accomplishment. In the opinion of the writer the average engineer reading such descriptions gets nothing more than a mental sensation of a huge mechanical and electrical equipment which humiliates the thought of his connection with the small plant. Dissatisfaction follows and his imagination begins to race. He begins to think that the engineers in the big plants are the only ones that are doing things worth while.

Human nature runs high in an engine room and although the above statements are rather pessimistic, yet such will be found to be the general impression of a large number of engineers who are holding good positions and doing a service which commands respect from their fellow-workers. Yet in view of all this the desire to be doing the big things suggests the idea that the position of the greaser in the 40,000 horsepower stations is a more desirable position that the chief of a 400 aggregation.

Speaking electrically, thoughts of this nature are generally wattless and denote a lower power factor of the individual. Better give the line more capacity so as to increase the efficiency of the human plant by reducing the heating effect. It is well to remember that there are thousands of little stations, but only one Gary steel plant; that few individuals ever see the inside of the big plants, and that it is fortunately so because the employees in such places are really in many cases fit subjects for our pity rather than envy. As an opportunity for advancement, individual's liberty, good health, and pursuit of happiness, the little station has a decided advantage over the large one. In the little station the average or ordinary kind of a man that pads the census reports, can get actual practice in all the different lines of the art of station operation. In the big one he is liable to lose his name and identity and become simply a number on the employees check board. Lest we forget, however, it should be stated here that no matter where a man may be located or what the nature of his present occupation, his rise in the world will depend immensely upon what he does toward making mental improvement.

One day I strolled into one of the smallest kind of a little lighting station. It was located in the fringe of a wood-lot, a truly isolated plant. It was erected by the enterprising citizens of a little country village that clustered about a small but historic college. What my camara saw is shown in the photo, and some of the things I saw and learned are as follows:

A metal smoke stack protrudde from a three-quarter story frame building. Inside a dynamo and engine found shelter under a corrugated roof that covered the one large room, while the boiler occupied a part of the enclosure, built wagon-shed style with open front and back. A 50 kilowatt, 1,100 volt, ring and commutator, 12 pole, belt driven alternator with a 1¼ kilowatt exciter generated the energy, being driven by a slide valve, outboard bearing engine. A single panel board did the regulating and forwarded the current to the street arcs and indoor incandescents by means of two pairs of wires. The boiler was a return tubular, with a furnace that easily handled the bituminous coal coming from the tunnel shown in the foreground of the photo. The tunnel portal is by the shaggy tree, and it leads to a 4½-foot seam of coal. The fuel is pushed by hand in a small car from where it is dug to the boiler furnace, the extra supply being dumped on the ground as shown.

The lighting service was from dusk to 10 p. m., and the rates were 30 cents per month for 16-candlepower incandescent. The lighting station also included the village waterworks that was rated at 23 cents per tap per month. The station was located on a high bank by a creek, so that a steam pipe was easily laid from the boiler down to the pump. The water was forced to a small reservoir on the hill.

The kind of a man wanted by the owners to operate this plant is indicated by the following advertisement in a city daily paper:

WANTED.—An electrician to operate a small lighting station and waterworks. Must understand electrical machinery, engines, boilers and pumps; $40 per month; living expenses very low; healthy location. Address ———.

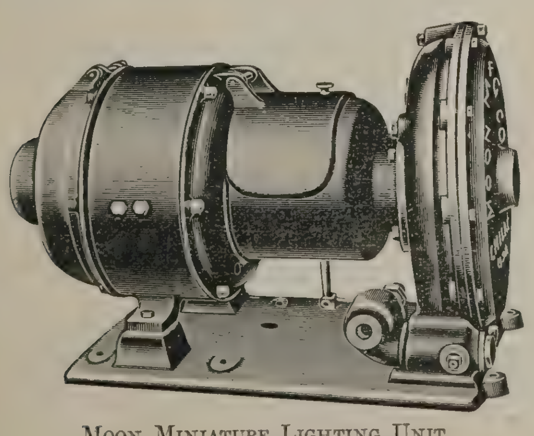
The expense item was not exaggerated. The rent of a house with a 2-acre garden plot was much less than would be paid for a shelf in a city apartment house. There was plenty of opportunity to keep chickens and any other kind of live stock that was useful and profitable. Socially, the new-comer in a small town finds plenty of room at the top, and it is entirely his own fault if he is incapable of profiting from the opportunity. In the small community the individual man is a valuable unit, and he owes it to himself and to his place in the community to render himself as efficient as possible.

Too few men realize the advantages of a plant similar to the one referred to and are prone to even consider the proposition. Although the subject of this article may be at the extreme of small stations it emphasises the possibilities and the openings for the man who at the present time has a struggle for existence in the large plants of a busy city. If some consolation is received by the reader of this class or those connected with the small plant, the object of this letter is accomplished. F. WEBSTER.

New Apparatus and Appliances.

A Minature Lighting Unit.

The new miniature lighting unit now being manufactured and placed on the market by the Moon Manufacturing Co., 120 N. Jefferson St., Chicago, consists of a small steam turbine and dynamo combined as one machine, and is so constructed that it is impervious to water and dust. It runs without noise or vibration, and has full ball bearings, requirng little oil, and little or no attention to operate. The unit is self regulating, requiring no rheostat or other instruments, and can be placed anywhere without foundation, driven from a regular boiler with 70 to 80 pounds pressure. The amount of steam used is hardly appreciable. The energy generated is sufficient for 20 standard 16 candle power lamps at 110 volts, or 35 to 40, 16 candle power tungsten lamps. The machine is well designed, and will furnish as steady a light as any large commercial lighting plant. Besides the manufacture of this lighting unit, this company has long been known to the Southern field as the manufacturers of Moon terminals for telephone lines.



MOON MINIATURE LIGHTING UNIT.

New Sectional Cutout Box.

A new sectional cutout box has recently been developed by the Columbia Metal Box Co., New York, which should be of considerable interest to the electrical trade. Ever since metal cabinets were required by the Underwriters jobbers and contractors have been compelled to carry a large assortment of sizes in stock in order that they might have the necessary size when required. This entailed a large investment of money and space. With this new cutout box a small assortment of sectional units can be carried in stock and enable the jobber or contractor to assemble a box of almost any size in a few minutes time. The cover is made in sections as well as the bodies thus entailing no delay while waiting for them to be shipped from the manufacturer.

One of the many valuable features of this new box is the fact that universal cutout holders are supplied with every body section. These holders eliminate all drilling for cutouts and switches. The box also contains knockouts for half inch conduit evenly spaced on all sides.

It frequently happens that boxes already installed must be enlarged, and formerly it was necessary to tear out and throw away the old box, substituting a new one of the required size. Where such a condition arises with the sectional box it will only be necessary to remove a few screws and add one or more sections as the work may require.

The sectional principal has a further advantage, in that it is often found necessary to use large conduits. The drilling of the holes has been very difficult to accomplish in boxes already made up, as few shops have drills suitable for the work. This necessitates having boxes made to order which adds to the cost and delays the work. With the sectional box it is only necessary to take a section to the nearest drill press and have the holes drilled to suit. When assembled, which is accomplished by means of a few stove bolts, the boxes present a very substantial and neat appearance, lending a dignity to an installation not hitherto at-

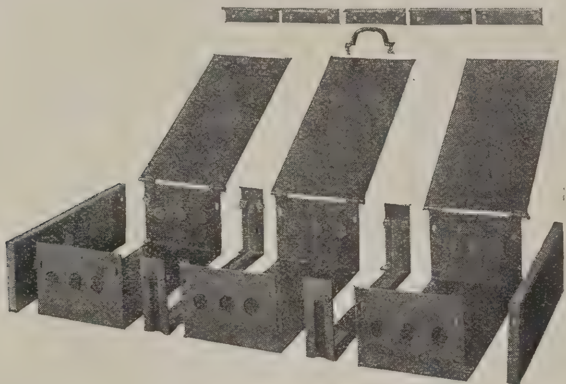


FIG. 1. SECTIONAL UNITS.

tained. The simple construction of this box is well illustrated by the cuts shown. It will be readily seen that the cover extends over the edges of the body of the box one quarter of an inch, allowing the box to be used on the cheaper grade of work requiring flush boxes, as well as for surface work. The fact that the covers can be applied at any time permits the installation of the bodies when the roughing is being done, which is often necessary in some classes of work. In some cases wooden doors and trims are required, and in such instances the covers need not be used at all.

FIG. 2. CUTOUT BOX COMPLETE.

The sections are stamped and drawn on heavy dies from sheet steel and absolute accuracy and uniformity are thereby assumed. They are made in three widths, nine inches, twelve inches and sixteen inches, which are considered the most practical sizes. The sections consist of a body section, cover section, end section, and connecting strip section and cover connecting strip. The boxes are approved by the Underwriters.

Indirect Illumination.

When it was announced about two years ago, that the scientifically designed reflectors and appliances which had been developed, were such as to make indirect illumination commercially available, the announcement created much interest, and more or less skepticism. This skepticism was probably the result of the failure at first, of appliances available to accomplish indirect illumination economically. The great favor with which indirect illumination has later been received, however, by the public, and the large number of satisfactory installations has dissipated this skepticism. It was supposed by those marketing the equipment that its field would be largely in residences. It has met with much favor there, however, the new fields of illumination in which it has been adopted, has been a source of constant surprises.

Of the many fields in which this system of illumination has proved successful, is that of church illumination. In this field it seems to have solved the problem that for years has been a serious one. About fifteen churches have installed, or have specified this system. Five new theatres as well as seven hosptials have adopted indirect illumination. It is finding favor in many classes of salesrooms and stores as well. It might be mentioned that there is one class of stores where this system of illumination is not desirable, and that is in jewelry stores, where direct rays to bring out the brilliancy is necessary to show off jewels, cut glass and other articles to the best advantage. However, the field for indirect illumination seems to be almost unlimited. The question of proper fixtures to contain these inverted lighting units has been solved by the National X-ray Reflector Company, of Chicago. This company does not sell to the consumer, but markets the fixtures entirely through the elec-

INDIRECT ILLUMINATION IN BLACKSTONE HOTEL, CHICAGO.

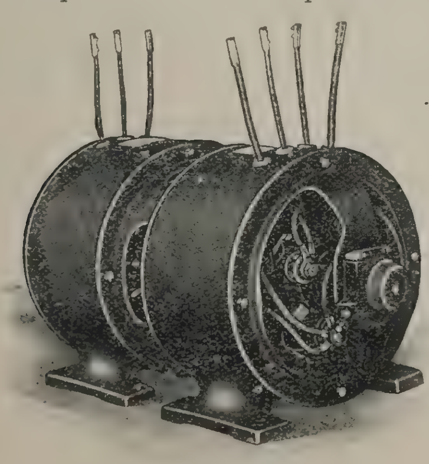
trical and fixture dealers. They have produced a line of standard fixtures which they sell to the trade either complete or in parts. These fixtures are mostly metal composition, but they also supply the larger fixtures made of composition. Many artistic and classic designs have been produced to meet the demands of the trade for the various kinds of interiors.

The Direct Current Compensarc.

In reality the direct current compensarc is a direct current compensator, that is, the output of the set equals the full capacity of both machines less the losses. The electrical connections are similar to those employed in a direct current balancer set. The machine is designed to be used on 115, 230 or 500 volt direct current circuits and is especially designed for the needs of moving picture machine arc lamps.
signed for the needs of moving picture machine arc lamps.
It is a two bearing machine, having two separate magnet frames complete with field windings and two separate armatures mounted on a common shaft. The frames are equipped with special windings so as to give a volt ampere characteristic curve, so that as the current at the arc reduces, the voltage will rise, maintaining stable arc conditions. This result is accomplished without any wasteful lamp steadying resistance.

The generator shunt has in circuit a small closed circuit field rheostat. This field rheostat can be adjusted to give different current at the arc ranging from approximately 20 to 45 amperes; the normal full load rating of the set being 35 amperes 50 volts. The motor end has three terminals which in installing are treated the same as the ordinary three connections from a standard shunt wound motor; the middle lead being the lead from the field coils, the outside two leads being the main line leads. The generator end has two main line leads for connecting direct to arc lamp. In addition to this, two smaller leads from the inner bushings are connected direct to a closed circuit rheostat used as above stated for adjusting the current of the arc lamp.

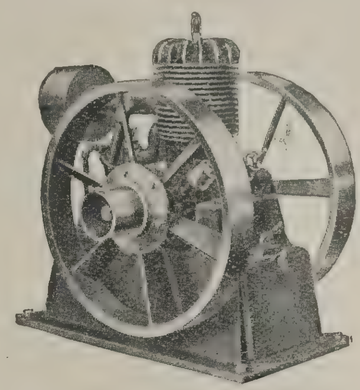
This rheostat is intended to be installed near the operator so the current can be adjusted from time to time for heavy or light films. In the case of the 230 volt D. C. compensarc the amount of energy taken from the line normally will be approximately 2415 watts, as compared with the use of the rheostat, which consumes 8050 watts. This equals a saving of 70 per cent. in the cost of power.



THE COMPENSARC.

The Elbridge Stationary Engine.

The accompanying illustration shows a five-horsepower, air-cooled engine manufactured by the Elbridge Engine Co., of Rochester, N. Y. For operations which require small power such as the machinery commonly used in general farm work, for operating small tools or for driving a small dynamo for lighting farm buildings, cottages, stables, etc., this engine is particularly adapted. The engine is simple in its design and very compact, the batteries, coil, fuel and lubricating oil being provided for in the base.



ELBRIDGE 5-HORSEPOWER ENGINE.

The Elbridge Engine Co. manufacture a similar engine in a 3-horsepower capacity, air-cooled and also water-cooled, in sizes ranging from 3-horsepower to 12-horsepower single cylinder and from 6-horsepower to 20-horsepower two cylinder. The company also manufactures engines of various designs and capacities for aeroplanes and motor-boats.

A Cable-Forming Board.

In order to make it easier for the electrical contractor who has had no experience whatever in installing intercommunicating telephones to install its inter-phones in an up-to-date manner the Western Electric Company is furnishing full-sized diagrams of cable-forming boards. These diagrams enable the contractor to make cable-forming boards for every variety of inter-phone sets.

The advantage of forming the cable is apparent to all those experienced in telephone work, but until recently its importance was not realized by many electrical contractors. Experience has shown that the very best plan to follow in cabling an interior telephone system is to form the cable at each telephone set so that each conductor or pair of conductors will be separated from the rest and sewed permanently into their respective places by the means of extra stout twine made especially for the purpose. In this way every conductor is brought out of the cable at its proper place and there can be no disarrangement of the conductors due to later handling. This reduces the likelihood of the conductors being crossed to a minimum.

Fig. 1 shows a cut of a diagram which, as furnished, is first glued upon a board about ½ in. thick and then the board sawed along the edges of the diagram. This makes the board of the proper size for the different types of telephones noted on the diagram. At the points marked small nails are driven into the board and the wires are formed around the nails and sewed into place as indicated on the diagram.

A completely formed cable, sewed as it should be, is illustrated in Fig. 2. The proper twine used for the purpose is twelve-strand linen, as this provides sufficient strength for allowing the stitches to be drawn up extremely tight without the chance of breaking the twine. When the cable is completed it is lifted off the forming board and is

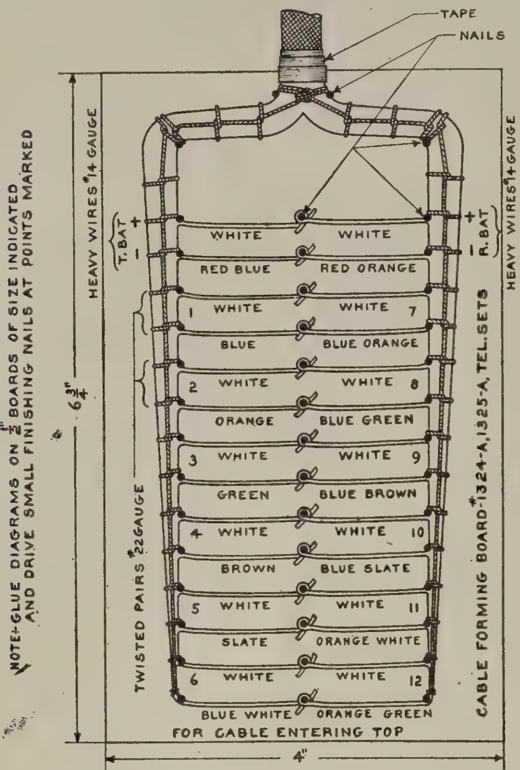


FIG. 1. DIAGRAM OF CABLE-FORMING BOARD.

then of the proper size, so that the conductors come out of the proper places to attach directly to the correct terminals in the telephone sets.

The use of these forming boards insures the continued satisfactory operation of an inter-phone system, as there is little chance of the apparatus itself getting out of order when properly installed.

Nokorode Soldering Paste.

The M. W. Dunton Company, of Providence, R. I., manufacturers of the well-known Nokorode soldering paste, advise that their success in placing this article on the market has been due as much as anything to the care and pains taken in compounding it, using nothing but the purest products and mixing same in proportions to make the flux homogeneous. All this work is done under the constant supervision of a graduate compounding chemist, and so thoroughly is this work carried out that even the smallest portion which may be picked up on the head of a pin has all of the elements of the flux. Nokorode is very economical to use and is put up in 2-ounce, 1-pound, 10-pound, 25-pound and 50-pound cans packed in new wooden cases ready for shipment in lots of three dozen two ounce cans or six one pound cans.

Renewed Incandescent Lamps.

It is claimed that a renewed incandescent lamp properly constructed by the latest invention and machinery is virtually a new lamp. The saving to the consumer, by having lamps renewed, is due to the fact that the material in the the lamp such as the bulb, the base and stem, originally cost in material, labor and assembling an amount which the consumer saves by having the burned out lamp renewed. The Renew Lamp Company, of Boston, Mass., state that in renewing lamps that otherwise would be thrown away, they save 40 per cent. in the cost of maintenance of lamps. This company is a licensee of the General Electric Company, and therefore use the same processes as new lamp manufacturers with the exception of making the bulb. The Renew Lamp Company has been in the business for over twelve years, and they are the largest manufacturers in their line.

An Instantaneous Water Heater.

The accompanying illustration shows a new and useful water heater recently placed on the market by the National Stamping & Electric Works, of Chicago. The heater is finished in nickel, and very appropriate for heating water in small quantities instantly, as a small quantity of water can be heated in less than one minute. The water does not

AN INSTANTANEOUS WATER HEATER.

come in contact with the heating elements and therefore is discharged perfectly pure and clean, making the heater an ideal device for home and lavatory. The heater can be operated on either direct or alternating current circuits.

New Speed Regulator for Small Motors.

A means of varying the speed of a small motor is desirable and for this purpose The Cutler-Hammer Manufacturing Company, of Milwaukee, has designed and placed

SPEED REGULATOR FOR SMALL MOTORS.

on the market a line of small six-inch speed regulators. These devices are made in standard capacities from one-twentieth to one-sixth horsepower.

They are adapted for many purposes, such as varying the speed of motors operating sewing machines, buffers, small blowers, washing machines, jewelers and dentists' lathes and drills, coffee mills, adding and copying machines. They are also used as dimmers for lighting circuits up to their capacities, as small field regulators in connection with plating lathes and for controlling heating circuits, such as tire vulcanizers.

The operation is by means of a simple sliding lever. Seven contacts are provided giving seven running positions, or these contacts can be arranged to provide one off point and six running positions. The resistance is moisture-proof and dust-proof, the resister wire being wound on a porcelain core and bedded in a special cement which encloses all portions. The shape of the unit is flat and is secured directly to the casting. The diameter of this regulator is six inches, the depth of casting one and five-eighths inches and the net weight two and one-half pounds.

Electric Water Heater.

A new electrical device which is useful for quickly boiling water or other liquid in connection with light cooking, is the Presto electric water heater, manufactured by the Presto Electrical Manufacturing Co., San Francisco, Cal. The heating element of the unit is of such construction that it can be immersed in the liquid and the connecting cord attached to a 110 or 220-volt direct or alternating current circuit. The heater is particularly suitable for travelers and is convenient in the home, hotel, hospital or on the train. It it finished in polished nickel, furnished complete with 8 feet of extension cord and a patent lamp socket plug.

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. According to recent reports an electric light plant will be established at Bessemer.

BIRMINGHAM. A franchise for 30 years has been granted to the Coosa River Development Company by the city council, for the purpose of supplying electricity to Birmingham. The franchise calls for a rate of electric service not to exceed 8 cents per kilowatt hour, with a 12½ cent discount for payment within ten days. The company under the franchise will also furnish arc lamps to the city at $50 each per year.

BOAZ. It is understood that the city has issued $20,000 in bonds for the construction of their waterworks system. The engineers are J. B. McCrary, of Atlanta, Ga., and bids will be open for machinery about March 1st.

DECATUR. It is understood that the fertilizer factory which is to be constructed by the Decatur Fertilizing Co. will be equipped for operating by electricity. The general manager of the company is A. J. Skedds and further information can be obtained from him.

HUNTSVILLE. The water supply system is to be considerably improved and new machinery and other equipment added.

MARION. According to reports, the Marion Electric Co., has been organized and will take charge of and improve the plant of the Marion Light & Power Co.

TROY. It is understood that a motor driven centrifugal pump will be added to the municipal waterworks equipment at Troy. Improvements at the lighting plant are also contemplated.

TUSCALOOSA.—It is reported that the establishment of a cement plant is being considered by G. B. Crowe, of Birmingham, Ala.

WETUMPKA. The Soloman-Norcross Company, engineers of Atlanta, Ga., is said to be making an investigation and report on improvements and extensions to the municipal electric light plant and waterworks system of Wetumpka.

Arkansas.

FORT SMITH. It is stated that the city has taken over the local waterworks and is to make extensive improvements. Machinery of the la. st type will be installed.

MALVERN. Recent reports state that the city is to install a municipal pumping plant and that plans and specifications are soon to be made.

NASHVILLE. The city council, it is understood, has granted a franchise to the Nashville Ice, Coal & Light Co. to construct and operate an electric light plant in Nashville.

JAMESTOWN. On November 11th the Penn Central Coal Co. suffered a loss of $75,000 by fire, which damaged the engine room, electric light plant and other machinery.

Florida.

SARASOTA. A bond issue of $25,000 has been voted for the construction of a waterworks system and sewerage plant.

JACKSONVILLE. It is understood that a $14,000 building is to be erected by the Seminole Building Co. at Jacksonville. The building is to be four stories and to be used as an apartment house. The building will be equipped for electric lighting.

PALATKA. The Florida Woodenware Co., it is understood, are planning to equip their factory with electric power.

TAMPA. It is understood that E. A. Noland desires prices on electric lighting fixtures. Mr. Noland's address is Curry Building, Tampa, Fla.

Georgia.

AMERICUS. While there has been some discussion over the installation of a municipal power plant at Americus, it is understood that a new election will be held to consider the subject.

ATLANTA. Plans and specifications for the remodelling of the old Post Office of Atlanta, are in the hands of A. Ten Eyck Brown, Atlanta, Ga. It is understood that bids are open for electric lighting fixtures, conduit and wiring, also a telephone switchboard for 20 stations.

AUGUSTA. It is understood that the Georgia and Carolina Railroad has been incorporated to complete an electric line from Augusta, Ga., to Spartanburg, S. C., a distance of 125 miles. The secretary of the company is A. E. Padgett, Edgefield, S. C.

AUGUSTA. It is stated in recent report that the Augusta-Aiken Railway Co. is to erect a steam power plant of 2,000-kilowatt capacity, as an auxiliary to its present system.

CAIRO. The work of improving the Electric Light plant has been given to J. B. McCrary & Co., Atlanta, Ga. It is estimated that the cost will be $15,000.

CARTERSVILLE. It is understood that equipment will be installed in the electric light plant sufficient to carry a day load.

CEDARTOWN. According to reports a proposition to develop the water power of Terrapin Creek is being promoted by George Cooper of Dallas, Ga.

DAHLONEGA. The Cedar Mountain Land Company, is considering the establishing of an electric light plant. It is understood that H. R. Robertson, of Atlanta, Ga., is secretary and general manager.

DOUGLASVILLE. The city is said to have under consideration the construction of an electric lighting and power plant.

DUBLIN. A bond issue of $30,000 has been voted by the city for improving the electric light and waterworks system. The mayor can give any further information.

LaFAYETTE. A contract for the construction of the electric light plant and waterworks system has been given to J. B. McCrary & Sons Co., of Atlanta, Ga. The approximate cost is $40,000.

MACON. It is understood that the city of Macon is to vote March 15th on the purchase of the waterworks system from the Macon Gas Light & Water Company. The mayor, J. T. Moore, can give any further information.

MACON. It is said that a $75,000 hotel is to be erected by Chauncey Grows, at Macon.

MACON. According to reports an electric drive is to be installed in the Brown Wagon Company's plant and current purchased from the local central station.

McDONOUGH. It is understood that a municipal electric light plant is to be established in McDonough.

MOULTRIE. According to recent reports, an office building will be erected by W. H. Barber, president of the Citizens Bank. The building will be five stories of modern steel construction and contain an isolated plant with electric elevators.

NEWMAN. It is understood that a company has been formed known as the Hill Power Company for the purpose of building a hydro-electric plant in the vicinity. It is understood that H. C. Grover is interested.

ROBERTA. According to recent reports, Roberta is to have an electric light and waterworks system. The plant will be of the hydro-electric type and it is understood that bids will be called for about the first of the year. The engineer in charge is said to be W. J. Marshall, whose address is Lizella, Ga., R. F. D.

WAYCROSS. Recent reports state that Waycross is to have an independent telephone system. Application has been made for the franchise to erect lines between Jacksonville and Savannah. T. H. Calhoun, of Beach, Ga., is interested.

WAYCROSS. According to recent reports the equipment of the Ware County Light & Power Co. is to be materially increased.

Kansas.

ALTOONA. A pumping plant and waterworks system is the subject on which plans are being prepared by J. S. Wooley Co., Kansas City, Mo.

COLDWATER. It is reported that the city has decided upon the installation of a municipal waterworks system and that plans have been given to engineers. It is understood that bids will be open for equipment after January 1st.

FALLS CITY. According to the latest reports the Achison Railway Light & Power Co., has begun work on its machine shop and that all tools will be motor driven.

STAFFORD. Plans and specifications have recently been finished for the new municipal power plant and pumping station and it is supposed that the purchase of machinery will be made soon.

WICHITA. It is understood that the city will be in the market very soon for a dredge of such a size as to contain its own power plant and a motor driven suction pump. This dredge will be used on the Little Arkansas River.

Kentucky.

BARBERVILLE. The plant of the Barberville Electric Light & Power Company has been leased and a new contract has been made with the city. It is understood that the plant will be in charge of Allory Smith.

CLAY CITY. The Clay City Telephone Co. is planning to erect a telephone line from Clay City to Hazel Green, a distance of 25 miles.

LEXINGTON. The construction of an electric light plant is being considered by A. G. Morgan, of North Broadway.

LOUISVILLE. It is understood that the General Construction Co., of Louisville, Ky., is to erect a $100,000 apartment house and is to install an electric light and power plant with the other necessary equipment.

MIDWAY. The city has made arrangements for the construction of a municipal power and lighting plant.

PIKEVILLE. Telephone lines from Pikeville to Brush Creek, a distance estimated to be 18 miles, is said to be planned by the Eastern Kentucky Home Telephone Company. The manager of the company is in Starkey with offices at Pikeville.

RUSSELL. It is understood that $50,000 has been appropriated for the construction of a waterworks system.

Louisiana.

ABITA SPRINGS. It is understood that arrangements are being made with the Mandeville Electric Lighting Co. to extend the lighting system some nine miles so as to furnish electricity to Abita Springs.

DONALDSONVILLE. It is understood that S. M. Welch, Charles Maurin, and others have organized the Lanfourche Valley and Gulf Railway Company, for the purpose of building an electric traction line between Donaldsonville and Lockport. According to reports, none of the equipment has been purchased and that bids will be received early in 1911.

DONALDSONVILLE. A train dispatching system is reported for the Lanfourche Valley and Gulf Railway Co.

HOMER. It is understood that the city is to construct a waterworks system and drill wells. The mayor can give any information.

LAKE CHARLES. According to recent reports plans have been prepared by the architects Favort & Livaudais, of New Orleans for the proposed Court House at Lake Charles. The structure is to cost approximately $155,000.

NEW ORLEANS. It is understood that Consumers Electric Light and Power Co. has recently been incorporated with a capital stock of one and one-half million dollars by C. E. Finner, W. B. Spencer, P. J. Mayo, M. S. Hart. This company has purchased the plant of the Consumers Electric Co. and will operate it.

NEW ORLEANS. Plans have been prepared for the new Central Baptist Church to be wired and equipped with electric lighting fixtures.

SHREVEPORT. A building to cost $40,000 is said to be the plans of the Elk Building Association, J. L. Abell is Secretary.

Mississippi.

FORT GIBSON. It is understood that an electric light is soon to be installed in the Chamberlain Academy for the purpose of lighting the buildings. The President of the Academy is Mr. M. E. Melvin.

GULFPORT. It is understood that the Gulfport Mississippi Coast Traction Co. are to make an extension to their lines. The extension is said to ultimately reach Handsboro.

GULFPORT. Engineer Rosell, of Biloxi, Miss., has drawn plans for an office building to cost approximately $7,000. The building will be equipped for lighting with electricity.

HATTIESBURG. It is understood that due to the damage resulting from the bursting of a fly wheel from the McInnis Lumber Co., that a new engine and other machinery will be purchased.

HATTIESBURG. Application has been made for a franchise to install electric power and lighting plant by W. S. Statum.

VICKSBURG. It is understood that plans are underway whereby the city will purchase the local waterworks system and enlarge the pumping plant.

Missouri.

BRAYMER. The city has under consideration the installation of a waterworks system, and it is probable that some action will be taken early in the spring.

JOPLIN. The Southwest Missouri Railway, of Webb City, Mo., are said to erect a sub-station with equipment for the transmission and distribution of power.

MARIONVILLE. It is understood that this city is to install an electric power plant and pumping station. The mayor can give any information.

PLEASANT HILL. It is understood that the city is to install a waterworks system.

ST. JOSEPH. It is understood that a recommendation has been made by the mayor for the issue of $250,000 in bonds, the purpose being to extend the electric street lighting system.

ST. LOUIS. It has recently been stated that the St. Louis Traction System is to purchase an electrical equipment for a new hydro-electric plant of the Northern Illinois Light and Traction Co. which forms a part of the McKinley system.

WELLVILLE. The Wellville Light, Power and Water Co. has been incorporated with a capital stock of $15,000 by C. H. Early, J. E. Mitchell, E. R. Barrett.

New Mexico.

ALAMOGORDO. It is understood that the Alamogordo Improvement Co., now constructing a hydro-electric power station, is planning to install a number of such plants and provide current for industrial purposes.

SILVER CITY. According to recent reports, the plans for the installation for a hydro-electric plant of 3,000-kilowatt capacity on the upper Gila River, are in the hands of Doulware and Johnson. It is understood that the construction work will begin very soon.

North Carolina.

BLACK MOUNTAIN. It is understood that preparations are being made for the construction of a hydro-electric plant and waterworks system.

CHARLOTTE. It is stated that C. R. Rucker has plans for a municipal power plant for Rockhill, S. C., and that the plant is to supply current for lighting purposes.

DILLSBORO. It is understood that C. S. Logan, of Wainesville, N. C., is to install a plant to furnish electric lighting to Dillsboro and Servia.

FLATROCK. It is said that a club house is to be erected at Flatrock by the Island Lake Club, the cost to be about $40,000. The building will be wired for electricity.

HENDERSONVILLE. It is understood that a hydro-electric plant is to be installed in Hendersonville, and that J. W. Hodge, is in the market for prices on equipment.

LENOIR. The Lenoir Chair Co., it is said, is to build a new plant in which the machinery will be driven by electric motors.

MT. AIRY. It is understood that the North Carolina Granite Corporation will install a power plant in their new crushing plant. The plant will consist of a steam driven unit and boilers.

SMITHFIELD. It is understood that a vote will be taken on February 21st for issuing $55,000 in bonds, the purpose being to construct an electric light plant, storage and water system. White & Platt, of Durham, N. C., are to prepare the plans.

SPARTANBURG. It is stated in recent reports that the Electric Power and Manufacturing Co., of Spartanburg, is to increase its power equipment and to extend its lines to other communities.

WARRENTON. It is stated in recent reports that an electric power and lighting plant will be installed at Warrenton. The engineer has been retained to prepare the plans.

Oklahoma.

ALLEN. A bond issue of $35,000 has been recently voted and E. K. Mann & Tolbert, of Ada, Okla., has been engaged to construct a waterworks system. It is understood that the equipment has not as yet been purchased.

ALTON. An irrigation system is the plan of the Alfalfa Irrigation Company. It is understood that the system will be electrically driven and will require a number of pumping units.

CADDO. The Caddo Power Company has been incorporated with a capital stock of $6,000 by J. G. Hartzog, B. M. Wilson and P. C. Tarver.

ENID. It is understood that improvements to the electric light plant will be made by the Enid Electric & Gas Co. The increase in the capacity of the plant is said to be sufficient to make the capacity nearly 2,000 kilowatt.

FAIRFAX. The plans are being prepared by E. G. Archer & Co., of Kansas City, Mo., for the construction of a waterworks system for the city of Fairfax. A contract for the work has been given to the Southwestern Engineering Co., of Oklahoma City, Okla.

HYDRO. Bonds to the extent of $25,000 have been voted by the town, and the proceeds will be used for the installation of a waterworks system and an electric lighting plant. Other information can be obtained from C. A. Chambers, of Hydro.

KAIOWA. Bonds have been voted to the extent of $18,000 for the enlarging of the electric light and waterworks system. Bids will be received, it is understood about January 1st for the work. The president of the board of trustees is W. N. Vernon.

MUSKOGEE. It is understood tnat plans have been prepared by Ashbey, Radford and Nieman, for a group of buildings to be known as the Oklahoma Women's College. The buildings will be steam heated and lighted with electricity. Donald Smith, of Muskogee, can give any information.

MUSKOGEE. It is understood that the Muskogee Industrial Development Company is to establish a packing and cold storage plant at Muskogee. G. E. Snyder, of Memphis, Tenn. is interested.

NELAGONY. It is stated that the Osago Mfg. Co. will install an electric power plant and supply current for lighting and power purposes.

STILLWELL. Bonds to the extent of $5,000 have been voted for the construction of an electric light plant. The mayor can give any further information.

TULSA. It is recently stated that the electric plant will be considerably enlarged and new machinery added.

South Carolina.

BATESBURG. A company has been formed to establish a rural telephone system from Batesburg to Clouds Creek. It is understood the president of the company is W. S. Smith.

CONWAY. It is understood that Hardwood Mfg. Co., of Conway, is in the market for prices on second hand dynamos from 1/5 to 2 kilowatts.

GREENVILLE. It is understood that the electrical work on the Y. M. C. A. building which is to cost $35,000 is open to bids. Information can be obtained from the Blue Ridge Construction Co., of Columbia, S. C., in charge of the work.

Tennessee.

BRISTOL. According to recent reports, plans are being considered for the construction of an electric railway from Bristol to Kingsport. Mr. G. L. Carter is said to be interested in the plans.

ERWIN. It is stated that an hydro-electric plant at Looking Glass Rock on Nilichucky River, near Erwin, is the plan of the Nilichucky Power Corporation of which company W. C. Heath is president. According to report the turbine water wheels will be of 1,300-horsepower capacity and the generators 8,000 kilowatt. Geo. E. Ladshaw is engineer in charge located at Spartanburg, S. C., the plans are at the office of the company at Charlotte, N. C.

KNOXVILLE. It is understood that the Appalachian Marble Co. of Knoxville, is to install a large amount of new machinery including an electric hoist.

SOUTH PITTSBURG. The electric light and power plant has been purchased by Harry Patton and it is understood that it will be remodeled.

Texas.

EL PASO. According to recent reports, it is contemplated by the Water Users Association of El Paso, Texas, to install a hydro-electric plant to be operated in connection with the Elephant Government Land in the upper valley of the Rio Grande. It is understood that the power will be used chiefly for the operating auxiliary pumping plant on the farms of the section. The cost of the hydro-electric development is estimated at $236,000.

BROWNVILLE. The city council has recently sold $30,000 in bonds. The proceeds will be used to enlarge the electric light plant and waterworks system.

CLARKSVILLE. The power plant of the Clarksville Light Co. which was destroyed by fire some time ago is to be soon rebuilt by the company. It is understood that new machinery will be installed and that bids for same are uot. The manager of the company is E. C. O'Neil.

COLORADO. A new plant is planned by the Colorado Salt Co., the plans are in the hands of Sangurnet and Stahes at Fort Worth, Texas. It is understood that bids will be received at once.

FORT WORTH. It is recently reported that the power pumping station of the Municipal Waterworks station of Fort Worth was completely destroyed by fire on December 8th. There was a loss of about $10,000 in machinery and buildings. It is understood that the plant will be rebuilt at once.

GALVESTON. The Texas City Traction Co. is in the market for a small power plant for operating four electric cars.

GEORGETOWN. According to reports the city will take over the plant of the Georgetown Water, Electric & Power Co. and enlarge the equipment considerably.

HOUSTON. A large warehouse is to be erected by the C. H. Standcliff Land Company and A. J. Harty, of Bay City, Texas. The structure will be fireproof equipped with automatic fire protection, electric hoists and electric lighting.

LAVACA. It is understood that a committee was appointed to investigate the possibility of constructing a modern and complete system of waterworks for the city.

MILES CITY. It is stated that a bond issue of $20,000 for waterworks system has been voted.

ROYSE. The City Mill and Light Company which has been organized by E. M. Vaulk, is said to equip their plant with electrical machinery.

SAN BENITO. An ice plant will be established which will include a 40-ton refrigerating machine costing approximately $30,000. The company interested in this enterprise consists of W. H. Morrison, of New York, O. B. Perkins, of Magnolia, Texas, J. B. Wright, of Hartford, Conn.

WACO. It is understood that the city is about to issue bonds for the construction of an electric light plant. Other information can be obtained from P. A. Gorman.

WACO. According to recent reports the National Light and Improvement Co. have in charge the installation of a 1,500-kilowatt steam ? ? ? ? ?

WEBSTER. It is understood that the Tri-City Telephone Co. is in the market for poles, wire and telephone in large quantities.

Virginia.

ABINGDON. It is understood that an isolated (?) to cost approximately $10,000 is to be installed at the building of the Martha Washington College.

CHASE CITY. According to recent reports the equipment for the municipal power plant and pumping station of Chase City, will be purchased about the first of the year.

COVINGTON. It is stated that the town council is to hold an election on February 11, 1911, to vote on the issue of $50,000 in bonds for the construction of a municipal electric light plant. The acting mayor is R. W. Crowder.

HERNDON. It is understood that J. H. Yates desires prices and information on electrical machinery of a capacity to light a town of 1,000 inhabitants.

HERNDSOM. An electric light plant with an output to serve a population of 1,000 is a proposition which is being entertained by J. H. Yates.

LEXINGTON. According to reports a steam plant of 250-horsepower will be installed by the Lexington Electric & Power Co.

STRASBURG. It is understood that the Strasburg Light & Manufacturing Co. are to build a large electric plant taking power from the Shenandoah River. The plant will furnish current for lighting and industrial purposes.

RICHMOND. It is understood that a new Methodist Church will be erected either of stone or brick and that the bids will be out by the 1st of the year. The type of lighting for the building has not been decided upon. The cost of the structure will be approximately $40,000. Higgins & Bates of Roanoke, Va., have the plans.

Personals.

H. B. LOGAN, President of Dossert & Company, has been elected President of the American Oil Storage Company, a New Jersey corporation capitalized at $500,000, which has acquired the patent rights for the manufacture, sale and rentals of Keefe's Patent Sectional Steel Flange Storage Tanks. Mr. Logan is well known in electrical trade circles through his connection with the successful development of Dossert Solderless Connectors. He will continue at the head of Dossert & Company. The New York offices of the American Oil Storage Company are at 74 Broadway.

HENRY H. HUMPHREY, Consulting and Mechanical Engineer, St. Louis, Mo. has recently announced the removal of offices from Suite 1505 to Suite 1312 Chemical Bldg., St. Louis, Mo.

H. G. SCOTT, Manager of the newly created branch of the Shelby Electric Company in Atlanta, is eminently qualified by experience and natural ability to discharge the responsibilities of his office. Born twenty-eight years ago of Southern parents, Mr. Scott gained his training and business experience in the North, where he received a technical education in electrical engineering. His practical experience was gained when he was in charge of the electrical equipment of the Rogers Locomotive Works. Later he became affiliated with a supply house in New York City, going from there to enter the home office of the Shelby Electric Company. Shelby, Ohio. Mr. Scott has a clear conception of the breadth of the incandescent lamp business and of its relations to other phases of the electrical industry, and furthermore has an enthusiastic confidence in the quality of the product he handles, which augurs well for his continued success.

H. M. BYLLESBY & COMPANY and affiliated companies will hold their second annual convention of the managers and department heads at the Congress Hotel, Chicago, January 17-20 inclusive. Byllesby & Company has headquarters at Chicago, and operates and manages a considerable number of electric, gas and street railway properties in the West and South. Since the first convention held last year, several properties have been added to the list and the former attendance of 200 will be largely increased. At a recent meeting of a committee of managers preliminary arrangements were made for a four days' program to be devoted to technical and professional subjects.

The incoming Congress of the Rejuvenated Sons of Jove has appointed Mr. L. S. Montgomery, Statesman for Georgia for the current year. Mr. Montgomery has been a very active member of the Order in the South, and his good work, popularity and extensive acquaintance among electrical men in the Southern States is responsible for his advancement. In his new capacity, he will be able to bring into the order a great number of influential men associated with the electrical business and localize the national slogan of the Order, "All together, al lthe time for everything electrical."

Mr. Montgomery is District Manager for the National Metal Molding Co., whose Southern offices are at 320 Fourth National Bank Building, Atlanta, Ga.

C. C. SCHOEN, who is well known in telephone circles throughout the South and West, has recently joined the sales force of the Western Electric Company, Atlanta. Mr. Schoen started his telephone career in the Engineering Department of the Southern Bell Telephone and Telegraph Company in 1898, under J. A. Wotton. In 1901, after Mr. Wotton had left the Southern Bell Company to go in business for himself, Mr. Schoen went with the Wotton Electric Manufacturing Company, doing the designing for the telephone apparatus, and afterwards became superintendent of the factory. Leaving the Woton Electric Manufacturing Company in 1903, he organized the Georgia Telephone Supply Company, doing engineering work, and promoting and constructing independent telephone plants. After this he served as District Inspector for the Southern Bell Telephone and Telegraph Company in Virginia, District Manager for the Missouri and Kansas Telephone Company at Hannibal, Mo., and General Manager of the Ozark Bell Telephone Company at Springfield, Missouri. In 1907 he again left the operating field to become telephone sales specialist for the Cincinnati house of the Western Electric Company, from which field he comes to Atlanta.

Such a varied experience in both the engineering and operating field has made him unusually well adapted for telephone sales work from the standpoint of the customer, because he is thoroughly competent to advise him as to operating, maintenance and construction methods in both central office and outside plant. He is a welcome addition to the sales force of the Atlanta house, and is being greeted by hosts of friends who knew him when he lived here years ago.

Obituary.

The sad news has reached us announcing the death of William Henry Bryan, M. E., the well known Consulting, Mechanical and Electrical Engineer, of St. Louis. Mr. Bryan's death was caused by heart disease, while in Chicago on December 6th. He had recently been appointed Chief Engineer of the Public School Board of the City of Chicago, having received this appointment through a competitive Civil Service examination.

Mr. Bryan was born at Washington, Mo., August 14, 1859, was educated in Washington University, receiving the degree of M. E. in 1881. He began business life on the Missouri River steam boats, following this work from 1870-75. Following this he studied telegraphy and worked during vacations in the machine shop of the Missouri Pacific R. R. from 1875-81, was Engineer with the Pond Engineering Co., of St. Louis from 1881-89, Secretary Heisler Electric Light Co., St. Louis in 1890 and Manager of the Chicago House of the Yale & Towne Mfg. Co. in 1891. Since 1892 he has conducted an office as Consulting, Mechanical, Electrical and Hydraulic Engineer in St. Louis, having offices at 418 and 419 Title Guarantee Bldg., at the time of his death. Mr. Bryan was formerly Smoke Commissioner of the City of St. Louis and has for several years been on the Smoke Abatement Committee of the Civic League. He was Ex-Treasurer of the Washington University Association and President of the Washington University Alumni Association for four terms. He was President of the St. Louis Engineers Club of St. Louis and Secretary for seven different terms. Mr. Bryan also held membership in the American Society of Mechanical Engineers and the American Society of Heating and Ventilating Engineers; also membership in the Mercantile Club of St. Louis and the St. Louis Railway Club. The Engineers Club of St. Louis passed resolutions of respect and condolence with the family and attended the funeral in a body, the honorary pall bearers being selected from the past Presidents of the Engineers Club and the active pall bearers from his immediate friends and associates among the Engineers of St. Louis.

BOOKS AND CATALOGUES.

THE REYNOLDS ELECTRIC FLASHER MFG. CO., of Chicago, Ill., has recently issued a twelve page folder describing and illustrating their various types of flashers for electric signs and displays of every description. The types of flashers thrown are the double pole type, single pole type, spelling, speed, chaser, script, three color, adjustable and combination types.

THE APPLE ELECTRIC CO., of North Canal St., Dayton, Ohio, has recently issued a bulletin describing and illustrating the Aplco Dynamo floating storage battery ignition system. The bulletin contains interesting material on a unique ignition system.

THE NATIONAL ELECTRIC LAMP ASSOCIATION is circulating the first edition of Bulletin No. 9-B., and one taking up in detail the engineering and scientific activities of the National Electric Lamp Association. This Bulletin takes up in detail the various branches of work carried on by the Association, and is illustrated by photographs from the various departments of their laboratory. Bulletin 9-B. is a reprint of a paper read by Mr. S. E. Doane before the National Electric Light Association at the Thirty-third Convention held at St. Louis in May, 1910. This paper entitled "High Efficiency Lamps" is a complete discussion on the cost of producing light by the central station. While a large part of the bulletin is devoted to the paper, one section is devoted to the editorial comment on the paper in the technical press.

THE COLONIAL ELECTRIC COMPANY, of Warren, Ohio, has issued an eight-page pamphlet covering prices, discounts, ordering instructions, and delivery charges for Colonial incandescent lamps of all types. The pamphlet is of envelope size, and gives a mass of commercial data, boiled down into compact and convenient form.

THE ELECTRIC STORAGE BATTERY CO., of Philadelphia, Pa., has recently issued a folder describing the storage battery installation of the system of the New River and Pocohontas Consolidated Coal Company's Plant at Gentry, West Virginia. This bulletin presents some interesting results accomplished by the use of the storage battery in connection with a generating equipment to regulate the voltage fluctuation and secure a comparatively steady pressure at any desired location.

THE WESTERN ELECTRIC COMPANY has just received from the press bulletin No. 1014, describing central battery, non-multiple telephone switchboards with magnetic signals.

The switchboards presented in this bulletin are those recommended for central battery exchanges where the ultimate number of lines will not exceed 500. In this publication are described the advantages of the magnetic signal board over the lamp signal board. In this type of apparatus the line and cord circuit apparatus and wiring are of similar design and the amount of current consumed is slightly less than that consumed by the lamp signal board.

The bulletin contains a description of the signals, jacks, circuits and apparatus in this line of switchboards, going thoroughly into details. It is well illustrated with photographs, diagrams and tabulations.

THE HIGH TENSION ELECTRIC SPECIALTY CO., of Newton, Mass., are circulating Bulletins No. 6 and No. 8. Bulletin No. 6 takes up the improved tree insulators with porcelain bushing. Bulletin No. 8 takes up water proof, oil brake switches for underground and overhead systems. Both bulletins contain descriptive matter and illustrations on the devices mentioned.

THE BRILLIANT ELECTRIC CO., of Cleveland, Ohio, manufacturers of incandescent lamps, in a co-operative advertising campaign with its distributing houses in the principal lrage cities, has prepared an attractive series of folders, blotters and mailing inserts. The blotted series, christtened "Brilliant Blots," consists of a series of twelve pithy descriptions of different types of lamps, each illustrated with a half-tone cut of the type in question. The blots are sent out at regular intervals to the company's distributors, who in turn supply them to their customers.

THE WESTINGHOUSE ELECTRIC MFG. CO., Pittsburg, Pa., is circulating Bulletin No. 1188, describing type M W slip ring induction motors for intermittant service and varying speed. This company has also issued its Part Catalogues Nos. 6141 and 6143. No. 6141 lists parts for Westinghouse type 306 Interpole Railway Motor for direct current circuits. No. 5143 lists Standard Metallic Brushes for A.C. and D.C. circuits.

THE WESTERN ELECTRIC COMPANY has just issued its bulletin No. 5500, describing Hawthorn Direct and Alternating Current Enclosed Arc Lamps. The bulletin contains twenty pages and is well illustrated with many photographs, diagrams and tables. Separate pages are devoted to direct current multiple enclosed arc lamps, including the marine type, for 100 to 125 volt circuits; direct current multiple enclosed arc lamps, including the mill type, for 200 to 250 volt circuits; power circuit lamps, direct current enclosed arc lamps for power circuits, alternating current multiple enclosed arc lamps for circuits of 100 to 125 volts, 200 to 250 and 400 to 460; direct current series enclosed arc lamps for 6.6 ampere circuits, alternating current series enclosed arc lamps for 6.6 and 7.5 ampere circuits, Solaris arc lamps, both alternating current and direct current, and arc lamp accessories.

THE CROUSE-HINDS COMPANY has issued a handsome and complete letter of introduction addressed to the electrical trade in the way of a catalogue; one that may well serve as an inspiration to agents and others who handle its wares. This catalogue is devoted to panel boards and cabinets and is profusely illustrated in two colors and printed on heavy coated white paper, 80 pages 9x12 being inclosed in an artistically embossed cover with cloth back.

Copper, slate, black enameled steel and grained wood parts of the different articles illustrated, are shown in striking fidelity of detail and coloring. Color is also used to good effect in the rule work, the soft shade employed being a relief from the solid black and guiding the eye unconsciously across or down the tabulated pages. Each detail of construction is described tersely, and listings and prices of individual and assembled parts, are presented so clearly that no reason can be found for a misunderstanding.

Panels and cabinets also are listed separately and together, which is a special feature that might be copied to advantage by other manufacturers, as it is a convenience appreciated by contractor and jobber alike. Any one in a position to make use of this catalogue can secure a copy by addressing a request to the Crouse-Hinds Company, Syracuse, N. Y.

THE AMERICAN CARBON & BATTERY CO., of East St. Louis, Ill. has recently acquired the plant and business of the Doe Battery & Mfg. Co., of Kent, Ohio, and will continue the manufacturing of dry cells, carbon and graphite products. The company announces that it is in a favorable position to manufacture high class dry cells by reason of their close identification in dry battery work during the past ten years. The experience obtained in manufacturing carbon elements for various dry cell manufacturers has given them a close insight in the work and have enabled them to make special improvements on the "Victor Cells" of their predecessors.

The cells which are handled by the American Carbon and Battery Co. will be known as No. 6 American Dry Cell, No. 6 American Special Ignition Dry Cell, No. 8 American Dry Cell. A descriptive catalogue has recently been issued giving considerable information on American dry cells. This catalogue will be sent upon request.

THE NATIONAL METAL MOLDING CO. has recently issued a 34-page booklet describing in detail, metal molding and a complete line of fittings manufactured by the company and provided with the non-corrosive sherardizing finish. The booklet is neatly arranged and well illustrated with the various fittings and types of construction wihch are possible with metal molding. While a large part of the booklet is devoted to descriptions of the molding and fittings, a part is devoted to the installation features taking up the separating, cutting, bending and supporting of molding. Metal molding provided with a sherardized finish is growing in ticularly applicable to lighting circuits where the wiring is ticularly applicable to lighting circuits wheer the wiring is run underground. The molding has already been adopted and is being used in Savannah and Atlanta for the decorative street lighting, the wiring being laid along the curb of the side-walk. The Southern sales office of the National Metal Molding Co. is located at Atlanta, Ga., and is in charge of L. S. Montgomery.

DOSSERT & CO., of New York City, has recently issued a new catalogue giving complete information on all sizes and parts of connectors which they manufacture. This new catalogue is considerably enlarged over the catalogue which this company previously issued, as it contains 62 pages, nine by six inches as compared with the 23 page booklet, four by six inches, previously issued. The new catalogue contains considerable material not found in the old one especially the stub connector, the connector for grounding and short circuited high tension lines, and the insulating covers for cable taps. The catalogue also contains useful information regarding the construction of cables, their diameters in inches and equivalent.

THE ALLIS-CHALMERS CO., of Milwaukee, Wis., has recently issued Bulletin No. 1501, describing the Allis-Chalmers Belted Corliss Engine of the Reliance pattern. Bulletin consists of 16 pages well illustrated with the various parts of the engine, each part being completely described.

THE PHILADELPHIA ELECTRIC AND MANUFACTURING, of Philadelphia, Pa., is circulating a booklet entitled "Tungsten Arc Lamps and Street Lighting Fixtures." This bulletin describes various arc lamps and street fixtures, presenting illustrations and giving prices.

THE CUTLER-HAMMER CLUTCH CO., of Milwaukee, Wis., has recently issued a new publication entitled, "An Epoch Making Magnet." This folder takes up features of the Cutler-Hammer lifting magnet giving answers to questions which have been raised in regard to its construction.

THE ALLEN BRADLEY CO., of Milwaukee, Wis., has issued a pocket size folder catalogue, entitled "Allen Bradley Rheostat and Electric Controlling Apparatus." The catalogue illustrates and briefly describes various types of rheostats including motor starting rheostats, motor starting mill and crane controllers, and starting rheostats for three phase squirrel induction, induction motors and slip ring induction motors.

THE TRUMBULL ELECTRIC MANUFACTURING CO., of Plainville, Conn., has recently issued a four page folder on their iron service boxes. The folder is devoted to data in connection with the different sizes and types of boxes and includes price lists.

THE F. BISSELL CO., of Toledo, Ohio, is circulating bulletin No. 33, taking up the subject of direct current switchboards and switch-board instruments and appliances. The bulletin is well illustrated with various types of switchboards and other apparatus which cover the usual requirements of 125 and 250 volts direct current service of central stations and isolated plants.

THE KIMBLE ELECTRIC CO., 1121 Washington Boulevard, Chicago, has recently issued a catalog taking up various types of variable speed single phase alternating current motors. These variable speed motors are designed for small power applications ranging in size from 1/8 horsepower to 1½ horsepower. The motors present unique features of design and are especially fitted for machines which run at a constant load, such as printing presses, laundry machines, static machines, ventilating fans forge blowers and church organs. They are also designed for variable loads for use in connection with such machines as laythes, generators, drill presses, circular saws, or any machinery on which a load is not constant. A feature of the motor is the control. The entire contol including the starting, speed changing, reversing and stopping, is vested in a single lever. This lever is a part of the motor itself and when it is in its off position there is no current flowing into the motor, since the lever cuts it off the same as an outside switch. The motors are reversible and the controlling switch may be thrown from full speed forward to full speed backwards without any disturbance to the circuit or damage to the windings. The design of this motor has received such careful attention that the starting current required is no greater than the full load running current. A booklet describing these motors will be sent upon request to the company.

THE KINETIC ENGINEERING CO., Baltimore Ave., Philadelphia, Pa., a catalog describing electrically driven organ blowers has recently been issued by this company. The bulletin takes up in detail the essential features of organ blowers together with the motor requirements for alternating and direct current circuit.

ROME WIRE CO., Rome, N. Y., the successors to the Wire & Telephone Company of America, has recently issued a booklet which gives price lists and useful information pertaining to bare and insulated wires for electrical purposes. Various copper wire products are taken up in detail and reference data given of interest on the subject. The booklet covers a variety of different wires, including tin and copper wire, magnet wire, annunciator wire, rubber covered wire, telephone wire, etc. The booklet is well illustrated and the information which it contains should be of interest to all those who have to do with electrical wiring.

W. & L. E. GURLEY of Troy N. Y. have published and are distributing a bulletin of 255 pages taking up in detail their physical and scientific instruments. The bulletin is bound in cloth, pocket size, well illustrated and filled with useful information in connection with the different instruments which are shown. It contains all the accessories for the laboratory or research department of a manufacturing company, or others who require the use of instruments of precision. The catalog is divided into the following sections: Accessories for laboratory use; mechanical laboratory apparatus; vacuum pumps; optical apparatus; apparatus for measuring of induction; electro-magnets and accessories; magneto-meters; keys for electrical measuring; galvenometers; wire and Carey-Foster bridges; resistances, resistance boxes and Wheat stone bridges.

THE ENGINEERING DEPARTMENT of the NATIONAL ELECTRIC LAMP ASSOCIATION has just issued bulletins Nos. 13 and 14, the first taking up Mazda Multiple Lamps, and the second Hylo-Economical Turn-Down Electric Lamps. Bulletin 13 contains 20 pages of practical information and technical data on Mazda Multiple Lamps for use on 100-125 volts and 200-250 volts. It has three tables and fourteen cuts. Bulletin 14 contains 12 pages and describes that unique electric lighting device, the turn-down lamp. The principle on which these lamps operate is fully explained and illustrated by means of diagrams. The bulletin contains one table and twelve cuts. Either or both of the above bulletins will be furnished upon request by the Engineering Department of the National Electric Lamp Association, 4411 Hough Avenue, Cleveland.

THE CUTLER HAMMER MFG. CO. has recently received from the press an illustrated catalog describing a new line of current consuming devices. This line of consuming devices consists of electric irons, including laundry and tailor irons, electric stoves, portable buffet heaters, bath heaters, tank heaters, electric radiators, and culinary devices. The catalog is well illustrated with half tone cuts showing these devices in detail. It also contains extensive descriptive matter giving details of construction and operation.

THE PACKARD ELECTRIC CO., of Warren, Ohio, has recently issued catalogue No. 10, taking up Packard transformers for all uses. The catalogue contains 16 pages of descriptive matter taking up lighting and power transformers, station and high voltage transformers, Mazda sign and house lighting transformers, multiple switch current transformers, shunt coils and bell ringing transformers. The catalogue is well illustrated and presents useful information in connection with Packard transformers. A sectional bulletin is devoted to testing instructions including diagrams of the circuits necessary.

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CONTENTS.

High Tension Transmission.

The limits of electrical power transmission seem to be fixed by the practical voltage that can be used. The effects of an increased voltage are met with in the apparatus at generating and receiving stations and also along the line. At the present stage of station apparatus design, however, the voltage which is practical is not that which can be generated or received, but that which can be transmitted by the line.

The principal factors tending to place a direct limitation on transmission voltage, are the temporary arcing between the conductors on a pole, a concentrated conduction at high current density, and secondly the constant passage of energy from one wire to another now known as corona, or brush discharge.

Practically the first attempt at a careful study of corona loss, was that made by R. D. Mershon on an experimental line near Telluride, Colorado, in 1896. Eight years later Prof. H. J. Ryan also made known the results of a research on this subject. This information has been much discussed, the facts being generally accepted that for a given set of line conditions, there exists a critical pressure beyond which the leakage loss between wires increases rapidly, making such a high voltage transmission line very wasteful of electric power and setting a limit to the voltage and length of transmission. Very fortunately the means to avoid this limit have not been difficult, for it has been found that for a given voltage and distance between conductors, the loss from one wire to another diminishes as the diameter increases. Evidently conductors of the same circuit may be separated sufficiently to decrease the leakage loss, but to carry this increase of distance very far involves radial changes in line construction.

We have seen the range of high tension transmission extended during the past few years to increasing distances, by the use of higher transmission voltages, and it has been natural to ask the ultimate distance which can be reached by this process. It has been suggested that the results of experimental research do not exactly apply to actual lines, and to clear up this impression Prof. H. J. Ryan, by a paper read before the American Institute of Electrical Engineers, has recently contributed information supplementing that given out by him some seven years ago, and explaining laboratory tests and actual line tests. On account of dirt and varying conditions about any line Prof. Ryan reduces the critical voltage of corona from laboratory results nearly 75 per cent. to compare with the actual loss on transmission lines.

The fine points of transmission line design for extreme voltages are yet to be worked out. It is evident that the present limit of transmission distance by increased voltage remains the resultant of economic conditions. The greatest distance to which electric power will be transmitted will be where the electrical energy ceases to bring a profitable return at the receiver end of the line.

Ornamental Street Lighting Systems in Southern Cities.

(*Written Exclusively for* SOUTHERN ELECTRICIAN.)

BY D. H. BRAYMER.

THE "great white way" idea of street lighting is becoming more popular in Southern cities with the installation of each new system. First among the cities, of considerable size, to take this important step on business thoroughfares, were Savannah and Jacksonville. The system installed in Savannah was described and illustrated in the October issue of SOUTHERN ELECTRICIAN, and due to the variety of ornamental schemes, this system has had much to do with the promotion of similar schemes in other neighboring sections. In Savannah, three and five light standards are used, spaced 30 feet. While this distance is somewhat closer than that which has been adopted in other places, the general results of illumination impress one that the distance is well selected. The effect is shown in Fig. 8.

FIG. 1. INTERSECTION OF PEACHTREE AND FORSYTH STREETS.

ATLANTA LIGHTING SYSTEM.

The most recent and perhaps the most extensive system in the South, is installed in the city of Atlanta, Ga. The system consists of five light decorative standards, of a design known as the Corinthian and furnished by the Flour City Ornamental Iron Works, the same posts as installed in a section of Savannah and Jacksonville. Through the main business streets of the city, 122 posts were used, these posts being placed on both sides of the street equally spaced on each block, approximately 70 feet apart and located as far as possible on the property lines and at each corner. The general scheme is shown in Fig. 4, which is a photograph taken on a street having heavy traffic both night and day. The posts installed are 14 feet high and carry five 100 watt tungsten lamps in 12 and 15 inch opal globes, the top globe being 15 and the other four 12 inches respectively. The diffusion of the light along the streets at night is such that all portions of the thoroughfare from building to building across the street are well illuminated. The opal globes screen the glare so that the 400 candlepower of light from each post does not distress the weakest eye when the lamps are in direct line of vision.

INSTALLATION FEATURES.

The installation features of the system at Atlanta are particularly interesting on account of the fact that all wiring was laid in the sidewalk and each section on each block made independent of that of any other. The accompanying illustrations give some idea of the methods of laying the conduit in the curb of the sidewalk and the setting of the bases for the lamp posts. As shown in Figs. 2 and 3, the different sections of the streets presented sidewalks of various construction from cement to paving blocks with curb edges faced with stone slabs. Along those sections of the walks made up of paving blocks, a section was taken up along the curb as shown in Fig. 3, which after the conduit was layed, was filled with cement grouting. In those cases where larger slabs of stone served as the sidewalk, these slabs were either chiseled at the edge or lifted and the trench made as shown in Fig. 2.

Fig. 2. Showing Foundations for Posts and Trench.

Fig. 3. Laying of Conduit in Curb.

As already stated each section of the lighting system is independent in operation from that of any other. The feeders for each block are led in at the end post, from the service box in the basement of the store adjoining. The wires entering the end feeder post are connected to a fuse block and switch which cuts in or out that particular section. Similar to the installation at Savannah, one-inch Sherarduct conduit, manufactured by the National Metal Molding Co., was used. The wiring was all triple braid, rubber covered, that leading from service box to end feeder post being No. 6 B. & S., that for the duct lines No. 8, and that for the posts No. 12. The system is two-wire, 220 volt, direct current, with the five lamps of each post wired in series, as shown in diagram Fig. 6.

A unique scheme of wiring in connection with the posts on any side of the street, is that providing for special decorative arrangements at special events. As shown in the sketch Fig. 6, besides the feeders for the lamps, an extra feed wire is led up to one arm of the post and a tap and plug provided on the under side for special connections to it. On any one side, these extra feed wires are connected alternately to the + and — line feeder so that a festoon of lights can be arranged between any two posts on any side. In addition to this arrangement the opposite sides of special feed wires to the posts are arranged so that festooning can be carried out across the street. Referring to the diagram it will be seen that the feed wire of one post on one side is connected to the + line feed while that of the post opposite is connected to the — line feed. This arrangement will lend much to the possible effects which can be produced on any particular section and also enable the whole section of the city to be illuminated not only along the curb line but in any manner chosen for the particular occasion.

DEVELOPMENTS FROM ORIGINAL GREAT WHITE WAY AT ATLANTA.

The original scheme for lighting the streets of Atlanta, was to install the ornamental lights from the Terminal

Fig. 4. Mitchell Street Toward Terminal Station.

Fig. 5. From Mitchell on Whitehall Street.

station along Mitchell street, then turning at Whitehall street up Whitehall through the business section of Peachtree as far as Ellis street. The system was installed according to these plans and opened for the first time December 15th. So well pleased were all concerned and especially the business men, that plans were immediately pushed for extending the system. Referring to the map Fig. 7,

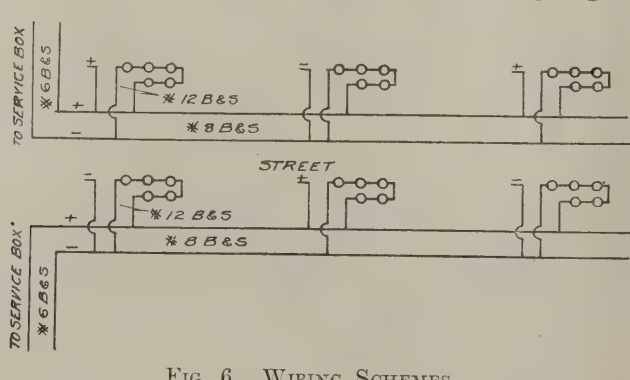


Fig. 6. Wiring Schemes.

the original system is marked in black spots, the extended system now installed by circles.

The ornamental lighting standards are now placed on Marietta to Cone as seen from the map and on Forsyth street from Marietta to Peachtree, and on Luckie from

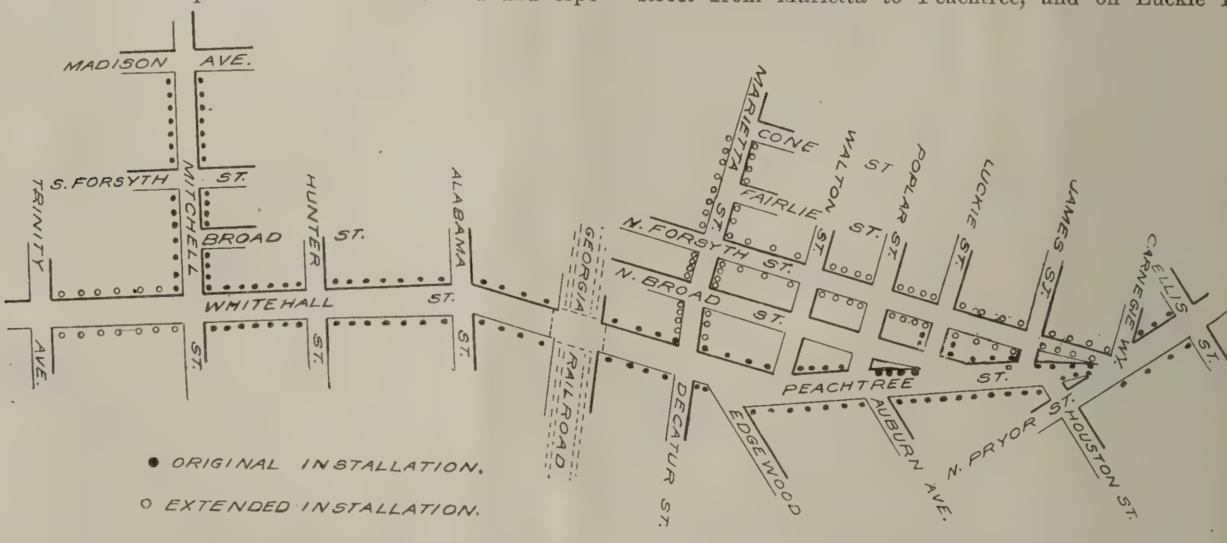


Fig. 7. Layout of Ornamental Lighting in Atlanta.

Forsyth to Peachtree, as shown in the accompanying Fig. 7. This second installation will probably be turned on about the first of February, thus adding another large portion of the down town business streets to the system of lighting. Plans are already formulated to still further extend the system by installing lights on Broad street, from Marietta to Peachtree. The various people who have interests on Pryor street have recently gotten together and have signed up practically all frontages, thus insuring the spread of the lights to Pryor street and it is probable that other adjacent streets in the very near future will also be canvassed and added to this third installation.

The property owners and business men of Atlanta when once convinced, not only of the beauty but commercial features of ornamental lighting have become very enthusias-

FIG. 8. BROUGHTON STREET AT SAVANNAH.

tic over it. Never before has Atlanta had the opportunity to note how truly "business follows the lights." It is generally conceded as a fair and proper move that the city council light and maintain the system on other down town business streets and undoubtedly this will be the attitude of the council when the recently canvassed blocks have been presented for their consideration. When the light is turned on the whole section as outlined, it will be readily seen that the city of Atlanta will have a system of lighting in size and intensity, the first in the South and equal to that of any city of its size in the United States.

COST OF INSTALLATION, OPERATION AND MAINTENANCE.

The system of Atlanta has been installed by the property owners and merchants on a flat rate per front foot on the street. The rate was set at $1.92, the merchants and property owners each paying one half. While there were a few of the owners and merchants who did not deem the proposition beneficial, such number was very small and the system was installed in spite of this objection. The operation and maintenance of the system is paid by the city on a contract of three years based on a rate which amounts to practically $45 per post per year.

The following is the actual cost of the completed lighting system at Atlanta as near as it can be obtained at the present time, with the system yet unfinished:

COST OF LIGHTING SYSTEM.

	Total Cost.	Cost Per Post.
226 posts, globes, lamps, fuses and fixtures	$ 16,000	$70.78
Conduit and wire	1,800	7.96
Installation cost	3,800	16.80
Total	$ 21,600	$95.54
Operation and maintenance of present system per year	$ 10,170	$45.00

The street frontage for the entire system as it is now installed, is about 14,500 feet. It will therefore be seen from the above data that the actual cost of the complete ornamental lighting system is in the neighborhood of $1.50 per foot on the streets. The cost per post, spaced on an average of about 68 feet, as given above is about $96.00. It is to be understood from the above data that no attempt has been made to place a valuation on the time necessary to promote the system, this amount not being chargeable direct to the system. It is obvious that a system such as is now enjoyed by Atlanta, is not only an improvement to the city, a benefit to the merchants, but a very good proposition for the central station.

As to the introduction and sale of electrically heated household devices in England, according to Vice-Consul George B. Stephenson, it is found that the only two articles of such a nature known to any extent are electric radiators and electric flatirons. The electric radiators are mostly of what is called the tubular lamp pattern. These range in price for a four-tube burner from $11 for a polished brass finished frame, coppered interior, and reflector, two switches, 22 inches high, 17 inches wide, and 6 inches deep, to a more fancy style, lacquered gilt frame, 28 inches high, 16 inches wide, and 7 inches deep, which sells for about $24. The popular size would seem to be the four-lamp burner.

Another style not in so general use is the convector radiators, in artistic designs, taking about the same room as tubular lamp burners, and selling from $11 to $25.50. This style is the one generally used in street cars in the United States.

The use of electrically heated flatirons is quite general in the district. These average in price about $3.65 each, the greater number of which are imported from the United States. Dealers state the American flatiron gives much better satisfaction than the same article of English manufacture.

While it is true that practically no electric cookers are used, there are such articles upon the market. One of these cookers seen is so constructed that six different degrees of heat can be obtained. The cooker itself consists of a round body on the top of which is a circular iron plate, the heat being applied to the latter. Special grills, saucepans, and all needed appliances have been arranged for the cooker. It is said that the cooker will boil a quart of water in seven minutes.

Review of Central Station Practice and Developments in England.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

BY C. TOONE, AN ELECTRICAL ENGINEER IN ENGLAND.*

IN THIS series of articles, the writer proposes to review the various developments and expansions which have occurred during the last five or ten years in English electric lighting practice. The general information given applies broadly to all British districts but where quantitative data is included, attention is confined, unless otherwise stated, to areas supplied by stations having no traction load. Such stations have not an exclusively lighting load, see Table 3, but the absence of traction demand enables a more pertinent analysis of the factors with which the data referred to is concerned. Though the discrimination between "lighting" and "power" stations and loads cannot be absolute, the partial separation, obtained by isolating undertakings with traction load, is certainly desirable.

GENERAL DEVELOPMENTS.

From the summary shown in Table I, it will be seen that there has been little increase in the number of central stations actually in operation in the British Isles during the last six years, June, 1904, to June, 1910, while a considerable number of projected schemes have been abandoned, probably as a result of trade depression and the financial instability of many stations already in operation.

TABLE I. STATIONS COMPLETED, IN PROGRESS, AND PROJECTED, 1904-1910.

		Stations with no Tramway load.	Stations with Tramway load.*
1904	Completed	268	98
	In Progress	23	----
	Projected	79	19
	Total	370	117
1910	Completed	272	140
	In Progress	----	----
	Projected	28	----
	Total	300	140

*Some stations coming under this heading in 1910 had no tramway load in 1904.

The most rapid development of central stations in this country occurred between 1900 and 1905, but the majority of large towns have had electric supply for many years. The stations at present in operation, with no traction load, commenced supply as follows:

STATIONS IN OPERATION BY PERIODS ESTABLISHED.

	1880-85.*	1885-90.*	1890-95.*	1895-1900.	1900-05.	1905-10
Number	3	18	46	67	119	19
% of Total	1.1	6.6	16.9	24.6	43.8	7.0

*In these stations improved plant has, in many cases, been installed.

The total area under electric supply has not greatly increased during the past five years, for each undertaking has its working district specifically determined by its Provisional Order and subsequent expansion beyond this area is exceptional.

In Table II, a summary is given of the total kilowatts generator capacity of various stations with no traction load. It illustrates the very considerable extensions that have been made of late.

TABLE II. GENERATOR CAPACITY OF VARIOUS STATIONS IN KILOWATTS.

Stations with Total Generator Kilowatts.

Year 1903	Less than 100	100 to 500	500 to 1000	1000 to 2000	2000 to 3000	3000 to 4000	4000 to 5000	5000 to 7500	7500 to 10000	10000 to 15000	15000 to 20000	over 20000
Number	30	102	53	36	7	11	7	7	3	2	----	2
% of Total	11.5	39.3	20.4	13.7	2.7	4.2	2.7	2.7	1.2	0.8	----	0.8
1910												
Number	33	107	50	30	11	7	6	10	7	4	4	3
% of Total	12.1	39.3	18.3	11.0	4.1	2.6	2.2	3.7	2.6	1.5	1.5	1.1

From Table II, it follows that the mean total generator capacity of 260 stations in 1903 was 1360 kw., and of 272 stations in 1910 was 1905 kw., an increase of 40 per cent. in the average capacity in seven years. The developments which have taken place in motor connections, as a percentage of the total connections, to these stations, is similarly illustrated by Table III.

TABLE III. MOTOR CONNECTIONS TO STATIONS.

Stations with Motor Connections, as % of Total Connections.

Year 1903	Less than 1	1 to 5	5 to 10	10 to 20	20 to 30	30 to 40	40 to 50	50 to 60	60 to 70	70 to 80	80 to 90
Number	16	54	44	45	27	10	6	3	1	1	1
Percent of Total	7.7	26.0	21.2	21.6	13.0	4.8	2.9	1.4	0.48	0.48	0.48
1910											
Number	2	41	41	55	43	35	18	10	5	1	2
Percent of Total	0.8	16.2	16.2	21.7	17.0	13.8	7.1	4.0	2.0	0.4	0.8

The mean percentages of motor and lamp loads connected to these stations was thus: 13.5 per cent. motors, 86.5 per cent. lamps in 1903 for 208 stations, and 21.6 per cent. motors, 78.4 per cent. lamps in 1910 for 253 stations. This considerable increase in the motor connections, largely representing small power users, denotes a wide expansion in the popularity of electric supply and a considerable improvement in the load factor of the stations concerned. The latter increase is closely connected with the financial stability of the stations and it is an agreeable fact that most British central stations are now in a better financial position than was the case a few years ago, and this in spite of the set-back caused by the advent of the metallic filament lamps, taken up later.

TABLE IV. CUSTOMERS CONNECTED FOR LIGHTING ONLY.

Stations with Consumers

Year 1904	Less than 500	500 to 1000	1000 to 2000	2000 to 3000	3000 to 4000	4000 to 5000	5000 to 7500	7500 to 10000	10000 to 15000	15000 to 20000
Number	171	41	19	8	5	----	2	----	----	1
Percent of Total	69.3	16.6	7.7	3.2	2.0	----	0.8	----	----	04.
1910										
Number	121	46	31	9	10	5	3	----	5	1
Percent of Total	52.4	19.9	13.4	3.9	4.3	2.2	1.3	----	2.2	0.4

*This article by Mr. Toone is the first of a series taking up in detail the practical and commercial features of the central station industry in the United Kingdom. The tables presented in these articles are original and the analysis of them bespeaks an engineer thoroughly familiar with central station work. The information on current practice set forth herewith, the discussion of rates, municipal ownership and station equipment, are subjects in which every central station in this country will be interested.—Editor.

The information in Table IV, demonstrating the increase in the number of consumers connected to "purely lighting," represents even more clearly the magnitude of the development which has occurred. Here and hereafter the term "purely lighting" is used to denote stations having no traction load, though the motor load connected may be very considerable; see Table III.

Whence the average number of consumers per station in 1904 equals 685, the mean of 247 stations, and in 1910 1255, the mean of 231 stations, which is an increase to date of 83½ per cent. in six years. Though the total annual sale of electricity has shown a steady increase in the majority of stations, with occasional retrogressions caused by the use of metallic filament lamps, the value of the ratio, mean generator kilowatts per station divided by mean consumers per station, has fallen from 1.99 in 1904 to 1.52 in 1910, thus indicating in conjunction with the increase in total sales, a considerable improvement in the "plant factor" of the central station machinery.

Great though the expansion has been, there is still an ample field for further development. Thus, to quote only a single instance, in the London district of Marylebone, of 2,000 premises, taken consecutively and not selected in any way, less than 40 per cent. were electrical consumers in June, 1910. The successful exploitation of so vast a field, itself by no means exceptional, is rendered doubly hopeful by the recent improvements in electric lamps which have rendered competition with the most efficient gas burners very favorably to the former.

GENERAL BRITISH CONDITIONS.

In the majority of English towns, gas companies were in commercial operation many years before the electrical undertakings were inaugurated and to a great extent, therefore, gas supply possesses the advantage of already "holding the field." This, together with the superior business and publicity methods of gas companies, for which there can be no excuse but concerning which more is said in a later section, has greatly retarded the development of electric supply; whereas gas pipes are installed in new houses as a matter of course, wiring for electric supply is seldom executed unless by the prospective tenants' express desire. This, of course, does not apply to high class residential districts. Moreover, gas companies are continually worrying builders to install complete pipe systems whereas electrical supply companies have, until recently, been very lethargical in this respect.

TABLE V. OWNERSHIP OF UNDERTAKINGS.

Year	Electrical Undertakings.		Gas Supplies.		Areas with both Electric and Gas Supplies.	
1904	Companies.	Local Authorities.	Companies.	Local Authorities.	Company.	Local Authority.
Number	122	142	206	54	109	49
Percent.*	46.2	53.8	79.2	20.8	20.8	9.4
1910						
Number	131	136	213	51	118	40
Percent	49.0	51.0	80.7	19.3	22.2	7.5

*The per cents given are for total number of electrical undertakings considered, total number of gas undertakings considered, and total number of electrical and gas undertakings considered, respectively.

Company managed enterprises are generally administered with more energy and economy than municipal concerns, and, as shown in Table 5, a larger percentage of electrical than gas undertakings are, in the United Kingdom, owned by municipalities or local authorities. This has no doubt been a considerable handicap to electrical undertakings in the past, both by lack of expert knowledge and of enterprise on the part of the public bodies and by the formality of procedure which, requiring detailed information concerning developments, improvements and so on to be submitted for approval at meetings to which the public has entrance, has often enabled competitors to take prompt advantage thereof. Both these disabilities are fast disappearing; municipal showrooms and information bureaus being established with satisfactory results and written statements of current or future proposals being laid on council tables and submitted to a minimum oral discussion.

When both gas and electricity supplies are municipally owned, as was the case in 18½ per cent. in 1904 and 15 per cent. in 1910, of "purely lighting" British supply areas, conditions are clearly very unfavorable. The normal conservatism, cautiousness, inertia or lethargy of the municipality is unstimulated by any competition. The best that can be hoped for in such cases is that improved gas burners be employed in those streets already lighted by gas and improved electric lamps in those electrically lighted. The English daily press and many town councils, the latter not always disinterestedly, are prejudiced to gas and often favor it in spite of the undoubted overall economic and illuminating superiority of modern electrical equipment as practically demonstrated in similar towns and even in some of the towns themselves. These conditions, influencing in no small measure the development of domestic and general private electricity consumption, naturally affect still more potently the street lighting practice followed.

CENTRAL STATION ECONOMIES.

The increased keenness of competition and, perhaps more than all, the advent of high efficiency electric lamps with their involved decrease in consumption per 1000 candle power hours, have greatly stimulated the organization and economical operation of British central stations during the past five years. Vigorous and systematic canvassing has been carried out on an increasing scale and appreciable co-operation has been arranged between stations and contractors and particularly in large towns where several electrical undertakings compete with a single gas company, between stations themselves. In the generating works every nerve has been strained to reduce costs to a minimum.

The cost of coal and stores of given quality cannot be further reduced and frequently shows a tendency to rise. The efficiency of boilers, engines and generators has for long approached finality, but in boiler furnaces and the operation thereof great improvements have recently been effected and further advance may yet be looked for. Any saving secured in the furnace plant is clearly of great value since the boiler fires are, day and night, in more or less active operation. The use of cheaper grade fuels, such as refuse, breeze and shale, has been accomplished by an increase in grate area per horse power, scientific mechanical stoking and the use of forced draught. Refuse destructors have been considerably adopted in connection with electricity works and, in many cases, with gratifying financial results, thus some 10 to 12 municipally controlled destructor plants are able to show a surplus of annual returns over total annual costs. In other instances, the economic aspect has not been so favorable but the destructors have been considered justifiable from the sanitary standpoint. In at least one instance, combined destructor working and electricity generation has been abandoned in favor of separate operation. Refuse destructors, to act as satisfactory steam raisers, require very careful firing and in several instances well-paid hand stoking has proved more economical than mechanical or "tub" firing.

The use of low grade fuels frequently results in a net increase in the cost of handling and firing in spite of full application of mechanical conveyors and stokers and this, together with increased carriage on the greater bulk of fuel required and the increased capital cost of the furnace equipment or the cost of its conversion, may quite well determine the advisability of adhering to a better though more expensive steam coal. It is found, however, that the majority of stations near pit-heads, with their breeze and shale "tips" and coal washeries, can economically employ very low grade fuels. For more detailed notes on furnace economies the reader should refer to an article on this subject in the Southern Electrician, October, 1910, pages 132 to 137. By the use of up-to-date mechanical stokers at Shrewsbury an annual saving of some $1,500 is obtained on a capital outlay of about $15,000, clearly an excellent investment.

Sinking of artesian wells is an increasingly common means of lowering the heavy annual cost of water supply, especially near large towns. At Croydon, London, for instance, a 300 foot well is to be sunk at a cost of $5,750, the present water bill being thus reduced $1,625 per annum. Apart from the increased efficiency of condensing engines, the reduced water consumption is alone sufficient, in most large towns, to determine the substitution of condensing for non-condensing plant at the earliest opportunity. Southwark, London, is a particularly striking example of the economy thus effected. The replacement of non-condensing engines by modern condensing plant has enabled a reduction of 30 to 40 per cent. in the yearly coal bill and some 40 to 50 per cent. increase in station output has been attained without any addition to the works costs. It is hardly necessary to add that the majority of new stations, especially when over 1,000 kw. capacity, adopt turbo-machinery and the necessary elaborate condensing apparatus. This would doubtless have been still more the case but for the fact that direct current supply is generally preferred, see Table VI, and direct current turbo-generators have not proved very satisfactory, mainly owing to commutation difficulties.

Every endeavor has been made of late, by energetic canvassing and by offering tariffs, to even up the daily load curve of purely lighting stations. The electrolytic and chemical works, which prove so beneficial to many American stations, exist to a very limited, even negligible, extent in England; while, of the ice machines so universally employed in the States, probably not a score exist in this country, apart from the ice companies supplying fishmongers, butchers, restaurants, etc., in towns. The English climate is so different from that of America that the ice machine in summer and the thawing transformer in winter are here, perfectly negligible so far as concerns their influence on electricity supply. The English central station has to rely upon the miscellaneous power user and the domestic utilization of electricity for heating and cooking to level up its load curve and though considerable extensions have been made in the utilization of electric motors, Table III, domestic heating and cooking develops very slowly, chiefly owing to the high cost of reliable apparatus. The extension of the double rate tariff to enable the cheap utilization of energy for heating and cooking during light-load hours, without the expense of duplicate wiring, has led to considerable increase in this class of business in many districts.

Few stations have been foolish enough to increase the selling price per unit, consequent upon the reduced demand of consumers adopting metallic flament lamps. Rather have they endeavoured, by central station economies, to increase the profit per kw. hour sold at the old rate per unit, to compensate for the reduced or retarded, total sale. One Board of Trade "Unit" (= 1 B. T. U.) = 1 kw. hour.

DIRECT AND ALTERNATING CURRENT, VOLTAGE DEVELOPMENT AND DISTRIBUTING SYSTEMS.

As shown by Table VI, by far the greater number of English central stations have direct current generators and the percentage of these undertakings is slowly but decidedly increasing. Alternating current supply is not convenient for short distance traction purposes, is inferior to direct current in most small power applications and is less satisfactory for lighting purposes than continuous current. For suburban electric railways and in large supply areas of all natures, high tension A. C. transmission, usually by insulated cable, is considerably adopted but in most cases is converted to direct current before utilization at low pressure.

There are in England no long distance power transmissions comparable with those of America, even the longest of our colliery power transmission routes would be considered very ordinary in the States hence, and for the above general reasons, the much smaller percentage of alternating current stations in this country.

TABLE VI. DIRECT CURRENT AND ALTERNATING CURRENT STATIONS.

Year.		D. C. Supply.	A. C. Supply.	Both D. C. and A. C. Supply.	Total.
1903	Number	182	64	19	265
	Percent	68.6	24.2	7.2	100.0
1909	Number	202	50	21	273
	Percent	74.0	18.3	7.7	100.0

The early English central stations supplied their consumers mainly at 100 to 150 volts but, as the result of an increasing total demand and the ease with which satisfactory high voltage carbon filament lamps could be made, a wholesale raising of supply pressures occurred some ten years ago and practically all stations laid down since that time have been arranged to supply consumers at a minimum pressure of 200 to 250 volts. Double the lighting pressure is usually supplied, by the 3 wire system of distribution, for motor circuits and it is probable that, had it been considered safe, still higher lighting voltages would have been adopted. This increase in supply pressures is clearly shown by Table VII from which it follows that, as the average of all voltages available to consumers on non-traction systems, those pressures above 250 volts being mainly confined to motor circuits. In 1900, of 247 voltages available in 194 supply areas, the mean was 174 volts, and in 1910, of 412 voltages available in 272 supply areas, the mean was 270 volts.

With the advent of metallic filament lamps which can with difficulty be made in small candle power units for pressures exceeding 100 to 150 volts and which are certainly most satisfactory on 50 to 100 volt circuits, then equalling or exceeding the carbon filament lamp in robustness and longevity, regret is widely expressed at the change to a higher standard voltage. Central station engineers are generally satisfied with the change since the cost of cables per kilowatt transmitted is much lower than would otherwise be the case. The inconvenience is mainly confined to the consumer who finds himself compelled to employ lamps of higher candle power than hitherto, or to adopt series winding. Undoubtedly this fact, which is naturally much less applicable to A. C., supply systems, has appreciably retarded the utilization of metallic filament lamps.

Board of Trade regulations. Though doubtless wise on the whole, these restrictions have appreciably impeded the utilization of electrical energy in small villages and similar places where the capital cost of underground or elaborate overhead mains would not be justified by the business resulting. There are now numerous overhead high tension transmissions in England, chiefly in the coal and iron districts of South Wales, Yorkshire, Durham and Northumberland, but few low tension supplies are by overhead mains.

Among the most interesting of the latter is the recent installation in Dowlais, a S. Wales colliery and iron working town. An overhead 3 wire D. C. supply, 460 and 230 volts, serves private consumers and public lighting alike.

TABLE VIII. SHOWING INCREASE IN SUPPLY VOLTAGES.

Available Pressures at Consumer's Terminals—Volts.

		50	100	105	110	120	150	200	210	220	230	240	250	300	400	420	440	450	500	550
Year 1900	Number	1	75	10	19	----	3	53	17	38	16	1	4	1	2	----	3	2	2	----
	Per cent	0.4	30.4	4.0	7.7	----	1.2	21.4	6.9	15.5	6.5	0.4	1.6	0.4	0.8	----	1.2	0.8	0.8	----
1910	Number	----	34	8	7	1	2	49	25	64	66	37	8	----	18	6	19	28	36	4
	Per cent	----	8.3	1.9	1.7	0.2	0.5	11.9	6.1	15.5	16.0	9.0	1.9	----	4.4	1.5	4.6	6.8	8.7	1.0

Were any reversion made to a low voltage supply, say 100 volts, which is unthinkable in most cases, a considerable increase in cable sections would be necessary, the increased number of consumers rapidly making up for the lower demand of each candle power of metallic filament lamps installed. Though supply companies may, by a fixed selling price per kilowatt hour, have handed all benefit from high efficiency lamps to their consumers, they have certainly, by the increased supply voltage, made consumers indirectly bear a large part of the cost and inconvenience of the distributing problem. Of course, were low voltage mains of large section installed, the consumer would suffer directly by an increase in the cost per kilowatt hour to cover the interest on the capital thus sunk.

Where alternating current supply is adopted, single phase generation is usually preferred in England, see Table VIII, but three phase is becoming more common. As it is to single phase motors that we must look for machines which shall approach direct current motors in general applicability to various power services and suitability for traction work, it appears probable that single phase will in future increase rather than decrease in comparison with three phase supply.

TABLE VIII. SUPPLY AND DISTRIBUTING SYSTEMS EMPLOYED BY VARIOUS STATIONS.

Year	Supply and Distributing Systems Employed by Various Stations.							
	Phase			Wire		Over-head	Total Distribution Systems.	Total Und rtakings.
1904	1	2	3	2	3			
Number	63	11	13	76	190	3	356	268
Percent	17.7	3.1	3.6	21.3	53.4	0.9	100	---
1910								
Number	52	10	22	65	204	4	357	272
Percent	14.6	2.8	6.2	18.2	57.1	1.1	100	---

Of the two wire distributions shown in Table VIII, the majority belong to the single phase supplies. Two phase supply is about as frequently used by two as by four wires. Three phase supply is very commonly by four wires. Few direct current networks employ merely two conductors, the well known 3 wire system, enabling supply at double the lighting voltage for motors, etc., being preferred in the majority of English districts, see Table VI.

Overhead distribution is greatly restricted in England by

The conductors are fitted with fuses and lightning arrestors on certain of the poles and the whole scheme is neat, cheap, safe and reliable. The street lamps in certain districts are controlled by Venner time switches while in other districts the lamps are switched on en bloc at the supply station. Unrestricted control of private supply is allowed at all times. The atmosphere in this particular town is exceptionally bad even for a mining area and the great number of cross streets and narrow alleys greatly complicates the system; an official stipulation that the overhead wires should not be installed in streets of less than 22 feet width cuts out many of the smaller by-roads from overhead service.

Where underground cables are employed, 3-core paper-insulated mains are largely favoured in new installations. Concentric cores, largely adopted in the past, are less generally employed to-day, the difficulty of making fresh connections being a considerable disadvantage of this type. A very common method of laying is to support the cables on wooden bridges in concrete, earthenware or wooden troughs, then running the duct full of molten bitumen; a preferable, though more expensive method for large towns is the drawn-in system of laying, spare conduits being allowed for extensions.

The next article in this series will take up rate problems and a comparison of the electric and gas lighting fields.

Electrical Signs in England.

The city of Leeds is lacking in modern electric display signs. There is only one sign of that order. There are many of the stationary-light style, inclosed or open, but the attractive display signs of most progressive cities are not seen. Some American concern might find it profitable to develop this field.

The streets of the business section are somewhat narrow and congested, and when stores are closed are dark and dismal in appearance. The electric-lighting system is owned by the corporation, but it does not seem to have sought increased business. The corporation also owns the gas plant, which may explain a continued use of gas where electricity would be more beneficial. The charge for electricity for lighting purposes is 8 cents per unit with a continuous current.

Principles of Illuminating Engineering.

(Continued from January.)
(Contributed Exclusively to SOUTHERN ELECTRICIAN.)
BY A. G. RAKESTRAW.

CONSIDERING now the different factors affecting distribution, it is found first, that the size and number of the units is important. The smaller and more numerous the light sources, the more uniform will be the intensity. In general, however, it is better to use as large a unit as possible without causing too much variation. The cost of installation will be less and the efficiency of the larger units is better. One reason why the largest units are not always used is that in case of a burn out, there will not be such a large dark spot produced.

Next the spacing of the units and the height at which they shall be hung must be determined. This latter dimension is usually not subject to a great deal of variation, being limited by the height of the ceiling and the general appearance of the lamps when installed. If other considerations do not prevent, the higher the lamps can be hung the better, as they will be further out of the range of vision. With the newer types of incandescent lamps, the relation of height to horizontal spacing to give the most nearly uniform illumination has been very carefully worked out and is available to anyone interested. For instance, with tungsten lamps and Holophane reflectors, the horizontal spacing should be twice the height of the lamps above the plane of illumination when reflectors that distribute the light widely are used, one and one-fourth times when concentrating reflectors are used, and three-quarter times when reflectors giving a strong concentration of light are used.

One thing in this connection which is worth noting is the fact that if a certain height is assumed and the corresponding horizontal spacing determined and the lamps lowered, a series of light and dark spots would result, but if the level of the lamps is raised, the distributon and the intensity are practically unchanged, in spite of the fact that the intensity decreases with the square of the distance. The decrease of light under any lamp is compensated for by the increased amount from surrounding lamps.

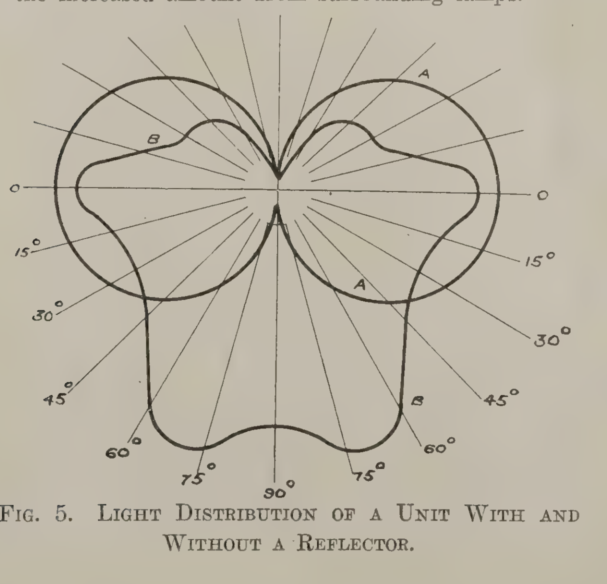


FIG. 5. LIGHT DISTRIBUTION OF A UNIT WITH AND WITHOUT A REFLECTOR.

In considering the distribution curve of individual light sources reflectors play an important part. Aside from the fact that most of the light sources are too bright to be placed so as to be visible to the eye unless shaded in some manner; as a rule some reflector is needed for considerations of efficiency or to prevent waste of light. To take up the entire range of light sources, and consider all the kinds of reflectors which are applicable to each would require a volume in itself. The writer will, therefore, simply take up certain general classes in common use. Fig. 5 shows the difference in distribution of a tungsten meridian unit, with and without reflector. Curve A represents the lamp alone and B when equipped with a prismatic Holophane reflector. In this connection the reader should be cautioned against comparing these curves according to the area enclosed, which is absolutely valueless as a measure of the light flux. A moment's reflection will show that the light values at angles near the horizontal cover large zonal areas while values near the vertical illuminate the smaller zones with correspondingly less area. For instance, curve B in Fig. 5, encloses a greater area than curve A, and yet the total light flux of A is the greater, since there is no absorption.

There is an almost endless variety of reflectors used for the various incandescent units. Some merely reflect the light, without directing it, while others are purely decorative, without attempt at efficiency. Neglecting these, it is

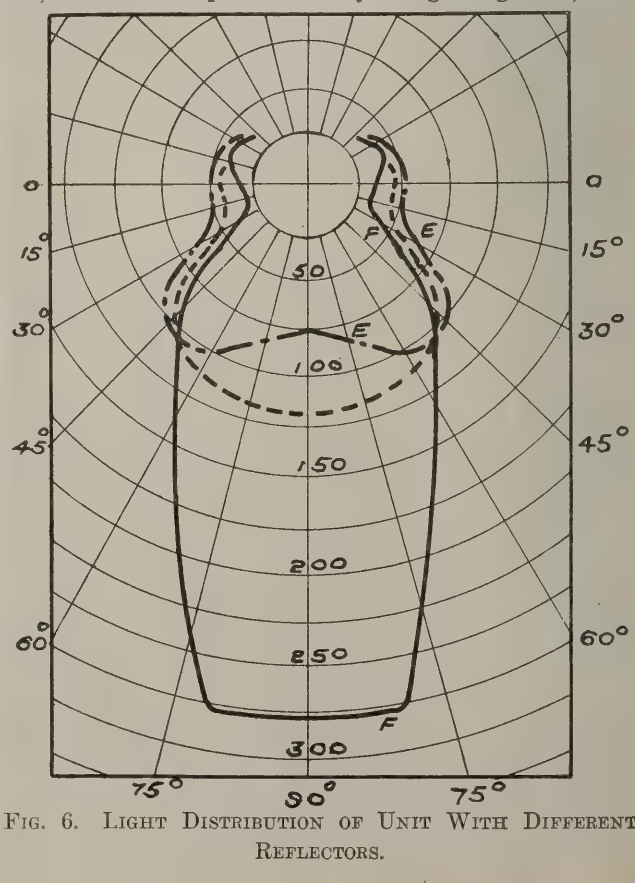


FIG. 6. LIGHT DISTRIBUTION OF UNIT WITH DIFFERENT REFLECTORS.

found that the reflectors designed to accomplish certain purposes fall within three general classes: (1) The distributing, which scatters the light over a wide angle; (2) the concentrating, which throws the light strongly downward; (3) a class intermediate between those two. These types have been called by some reflector manufacturers, extensive, intensive, and focusing. Fig. 6 shows the distribution of a 100-watt tungsten lamp with these three reflectors, the curves being indicated by the initial letters E, I and F. This shows in a striking manner what results can be secured by properly designed reflectors. The curve shows also very clearly the futility of comparison by area, since the total light flux is practically the same for each of these reflectors while the areas vary widely. In fitting lamps with reflectors it is of great importance that the two shall be in a definite relation, otherwise results may be secured totally different from those desired. Fig. 7 shows the distribution of light using the same 100-watt tungsten lamp as in Fig. 6 and reflector, but with different shade holders. The manufacturers data upon these reflectors is so complete, and so widely disseminated that it is not necessary to more than call attention to these different types in this article.

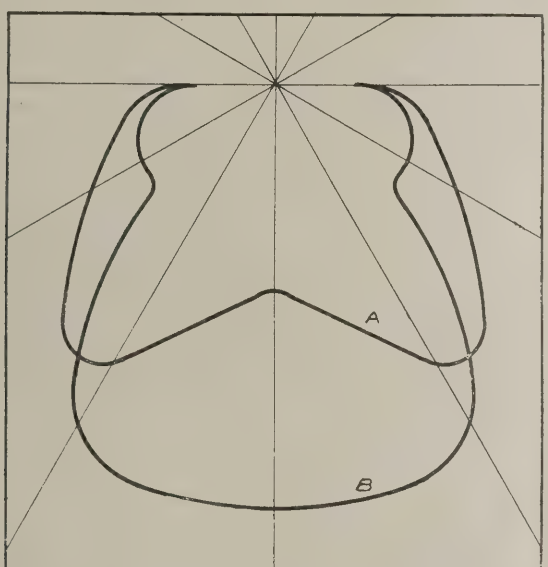


FIG. 7. SAME UNIT AND REFLECTORS AS FIG. 6, BUT DIFFERENT SHADE HOLDER.

Besides securing the desired distribution by reflection, it is also possible to utilize refraction. A lamp is placed inside of a hollow glass sphere or hemisphere the outer surface of which is pressed in the form of carefully designed prisms which direct the light, and also diffuse it. The result is beautiful. The entire surface of the sphere seems to glow with a clear and brilliant radiance, yet so mild that the eye is not fatigued. For public buildings and churches, these large spheres nearly two feet in diameter are unsurpassed for elegant and efficient illumination.

Besides reflection from designed surfaces, reflection from other surfaces should be considered, such as walls and ceilings. This is often of great value in increasing the effective illumination. In the case of outdoor illumination this question of course, does not arise. In the case of a large shop or factory, the gain from such reflection is practically negligible, but in rooms of moderate size it becomes an important factor. The co-efficient of reflection from these surfaces may vary from 5 per cent. in the case of a room with entirely dark furnishings to as great as 75 per cent. from a fresh white surface. Further, since a bare lamp suspended in the middle of a room may throw as much as three-fourths of its total light on the walls and ceiling, we see that a change in the furnishings from light to dark may increase the illumination 3 to 4 times. However, walls and ceilings can not reflect light which is not directed to them, and therefore the use of reflectors tends to render this of less importance, a change from dark to light furnishings increasing the illumination somewhat less than twice the former value. The following table for bare lamps, compiled from data furnished by the Engineering Department of the National Electric Lamp Association may be of interest in this connection:

Color of Paper.	Co-efficient of Reflection.	Effective Illumination Factor.
White	.70	3.33
Chrome Yellow	.62	2.63
Orange	.50	2.00
Yellow	.40	1.67
Light Pink	.36	1.56
Emerald Green	.18	1.22
Dark Brown	.13	1.15
Red	.12	1.14
Dark Blue	.12	1.14
Dark Chocolate	.04	1.04

In the case of lamps with well designed reflectors, it may be assumed that in rooms of moderate size, the illumination will be increased over the calculated by about 40 per cent. for a very light wall or ceiling, or by 20 per cent. for medium tones. Therefore if both walls and ceiling be light the increase would be about 80 per cent. or if both medium, 40 per cent. or if one light and one medium 60 per cent.

The net efficiency of the lighting installation is the result produced divided by the energy necessary to produce it. The effectiveness of illumination is usually expressed in foot candles, and the energy in watts per square foot, therefore the mean foot candles divided by the watts per square foot is the net efficiency. There is another way of expressing this. The lumen is the unit of light flux which is required to illuminate one square foot with a brightness of one foot candle. The amount of light which actually reaches the plane of illumination is termed the effective lumens. The effective lumens divided by the total wattage of the installation is termed effective lumens per watt, and this is the term now generally used in expressing the net efficiency of any system of lighting.

In the next section of this article the writer will take up the questions of contrast and color.

National Telephone Convention.

The annual meeting of the National Independent Telephone Association, has been postponed from January 17 to 18, to February 8 to 10. The meeting will be held at the LaSalle Hotel at Chicago. It is expected from the present outlook that a large number of independent companies will be in attendance.

The Fundamental Principles of D. C. and A. C. Machines.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

BY GEORGE J. KIRCHGASSER.

A CURRENT of electricity when flowing through a conductor produces or gives rise to a definite number of lines of magnetic flux which become linked with the circuit. This flux is made up of concentric lines of magnetic force which, as the current starts to flow, upon closing of the circuit, form at the center or axis of the conductor and expand outward cutting the conductor as long as the current increases. This action can be likened to the expanding concentric ripples produced by dropping an object into a quiet body of water.

To further illustrate this action the sketch, Fig. I may be of assistance. In this diagram let S be a round wire represented by the full line circle, in which a continuous current is flowing in the direction indicated by the arrow. In this conductor as current begins to flow, upon closing the circuit, lines of magnetic force form at the axis and expand outward. If this wire is caused to move across a magnetic field in such a way as to cut lines of force, an electromotive force will be generated in it which will be opposed to the electromotive force causing the current to flow. In case the cutting conductor moves through the magnetic field as indicated with no current flowing in it, the induced voltage will cause an alternating current to flow.

The illustration presented herewith shows the relation of these various quantities as regards direction. If the motion of the conductor is to the right, which is the same as moving the magnetic field lines of force to the left, and the flux be directed upwards the induced EMF, will be as indicated, which is opposite to the direction of the current as shown in Fig. I. The flux, or the lines of magnetic force existing in a magnetic field, is directed according to the location of the magnet poles. In the case of a motor or dynamo, if the north pole is below and the south pole above a conductor, the flux will be directed upwards through the conductor.

These principles explain the action of the motor and the production of current in a dynamo, where the conductors are passed through lines of magnetic force, which pass from pole to pole. Faraday in 1831 is said to have discovered that when a conductor moved through a magnetic field, a current was set up in it. As an armature conductor loop is turned around its shaft by some mechanical means the lines of magnetic force which pass from the north to the south pole are cut by the wire and a current of electricity generated in it, just as the cutting of the conductor by lines of force causes a current to flow in it. Because the current is induced in the two flat portions of the armature loop which turn between the poles, they are called inductors. This example is given to show that the entire foundation of electrical engineering is based on Faraday's discovery of the induction of currents.

When a circuit in which a current is flowing is opened, the lines of force surrounding the conductor decrease concentrically cutting the conductor and disappearing at the center. As this is the reverse of what occurs when the circuit is closed, the current set up by this cutting will act in the opposite direction to that occurring when the lines are expanding. Thus it will be seen that this current always acts in the opposite direction to that impressed on the circuit.

Since with an alternating current circuit the value increases and decreases from instant to instant the lines of force increase and diminish in the same cycle. This constant cutting of the conductor which occurs when alternating current is present, sets up currents first in one direction then in the opposite and these currents are called EMFs caused by self-induction because they always oppose or are in the counter direction of the direction of flow of the current in the circuit. The phrases or terms impressed EMF or impressed current are used to distinguish from other EMFs or currents which usually exist when alternating current flows in a circuit.

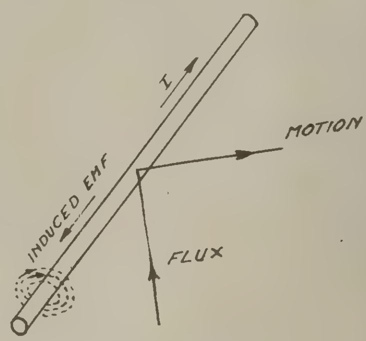


FIG. 1. RELATION OF CURRENT, ELECTROMOTIVE FORCE, FLUX, AND MOTION.

In direct current circuits Ohm's C=E/R determines the value of the current but it is obvious that resistance is not the only factor determining current flow in alternating current circuits for the ever changing currents cause continuous current inducing actions which are constantly opposing the flow of the impressed current. For alternating current circuits therefore having inductance and resistance we have the following formula:

$$\text{Current} = \frac{\text{Voltage}}{\sqrt{\text{Resistance}^2 + (2\ (3.1416)\ \text{frequency} \times \text{henrys})^2}}$$

The rate at which the magnetic lines of force cut the conductor as they expand and decrease and the field in which the conductor is placed determines the value of the induced current which in other words are currents caused by self-induction. In the presence or proximity of iron, for instance, more lines of force are formed than if the conductor is suspended in air, because iron has a greater permeability; that is, it furnishes a better field for conveying the magnetic lines of force.

Inductance represents the value or quantity of self-induction in a circuit. Co-efficient of self-induction was at one time and is now sometimes used in place of inductance. We say the circuit has an inductance of .02 henrys, or the value of the self-induction amounts to .02 henrys.

The henry is the unit of inductance. It represents the effect of a certain amount of induced currents, or counter currents in an alternating current circuit. It is the quantity, flux or lines of force linked with the circuit when conveying a unit current and it is represented by the letter L. In a solenoid; that is a cylindrical coil of wire, the inductance is found by the formula $L = \frac{4\,(3.1416)\, r^2 N^2}{l \times 10^9}$ in which r is radius of the cylinder in centimeters; N is number of turns of wire in coil; l is length of cylinder in centimeters.

If the coil of wire is wound around a core of iron the value obtained must be multiplied by the permeability factor of the iron because the iron will provide a field for more lines of force and therefore the effect of self-induction will be greater and the value of the inductance in henrys larger.

A non-inductive alternating current circuit is one in which practically no self-induction occurs; one in which the inductance is negligibly small, such as an incandescent light circuit. It is desirable to arrange the resistance used in resistance boxes and starting and speed regulating rheostats for alternating current work so that the amount of self-induction is reduced to a minimum so that the inductance is small. This is necessary to provide as good a power factor as possible in running the motor. If the rheostat had large inductance it would not be desirable for the motor or electric system. To make this small the resistance wire is wound back on itself so that the counter currents tend to cancel each other. This could be more fully explained but it is a subject in itself.

The Municipal Plant at Monroe, N. C.

(*Contributed Exclusively to* Southern Electrician.)

BY ERVIN B. STACK.

IN the heart of the Piedmont section of North Carolina, which may be called the electrical center of the South, there are some electric plants which deserve mention from the fact that they are strictly modern in every respect and present systematised methods of operation. On the Southern Power Company's line, about midway between Great Falls, S. C., and Albemarle, N. C., is the Monroe substation. Power is transmitted from Great Falls to this substation at 100,000 volts and passed through three 1,000 K. V. A. single phase transformers connected in delta, and stepped down to 2,300 volts. At this pressure it is transmitted to the municipal plant which is located just one mile east of the substation in the center of Monroe.

The substation is shown in Fig. 1. On the left the 100,000 volt line enters the substation and on the right of the building the lines which carry the power at 2,300 volts pass to the city plant for local distribution. The energy from the high tension power lines entering the substation passes through three oil switches and then through the transformers. After it has been stepped down to 2,300 volts it is delivered to a switchboard located in one corner of the building. On this switchboard are several oil switches and watthour meters, the watthour meters being used to measure the power consumed by several nearby cotton mills which have special circuits run from this substation. All the substations built by the Southern Power Co., are very artistically designed and the apparatus conveniently arranged.

The Monroe plant which is located about the center of the city is shown in Fig. 2. The 2,300 volt lines coming from the substation enter at the right, the power passing through a switchboard and then over lines for local dis-

Fig. 1. Substation of Southern Power Company.

Fig. 2. Monroe Electric Plant.

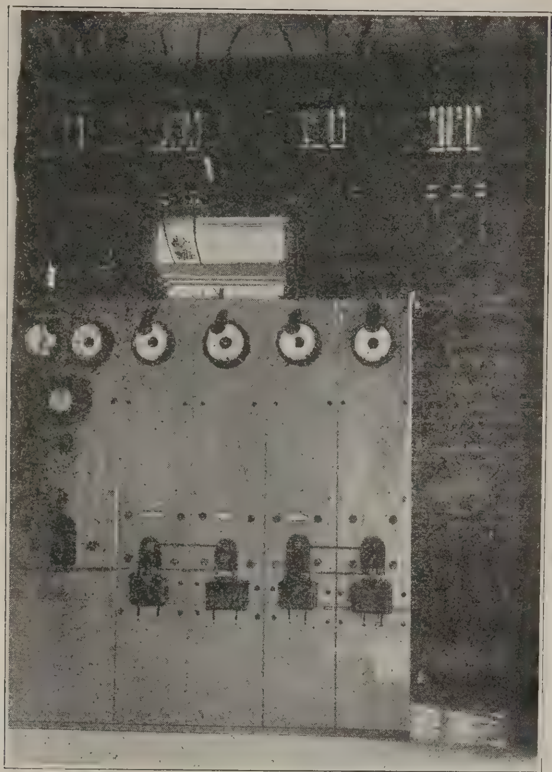


FIG. 3. SWITCHBOARD IN SUBSTATION, 2,300 VOLTS.

tribution. In this building there are two 50 light Cooper Hewitt mercury rectifier sets used for the arc light system. These rectifier sets have a primary voltage of 2,300 and 4 amperes on the secondary. Individual panels are installed in front of each rectifier so that the lights on any circuit may be thrown on or off as desired. Also, there are two 15 horse power motor driven centrifugal pumps used to supply the city with water and one 100 horse power motor driven pump used for fire purposes. A bank of delta connected transformers used to supply power for the motor pumps at 220 volts, and also to furnish power for two other motor lift pumps is located just outside of the building.

The city runs its own water system in connection with this plant and the writer is inclined to think that the water supply system is as interesting as the electrical system. The water supply system consists of two artesian wells, one 700 feet deep and 6 inch bore, and the other 1,000 feet deep with 8 inch bore.

Until very recently the water was pumped from these wells by steam lift pumps, but they were abandoned, and the electric drive has been installed. The steam pumps were very flexible and gave entire satisfaction, except that they were somewhat overloaded, and a high steam pressure was always necessary to keep them going. When these pumps were operated by steam, they made about sixty strokes per minute, since the motor drive has been installed, however, they make about eighty strokes per minute.

The water is lifted from these wells by several long, wooden rods, coupled together and extended to the bottom of the well, on the extreme lower end of which is fastened a series of leather buckets and a ball lift valve. The wells are operated day and night, and the water is pumped into an underground reservoir of 300,000 gallons capacity, located just back of the power plant. From this reservoir, the water is pumped over the city by two 15 horse power motor driven pumps, as mentioned above.

The municipal plant is located in a low section of the city and with these small pumps, it is hard to get a pressure of over 40 or 50 pounds up at the main part of the city. To get fire protection, a 100 horse power centrifugal pump, motor driven has been installed. With this large pump, the pressure up town can be brought up as high as one hundred pounds.

The Traffic Commercial and Maintenance Sides of the Telephone Business.

(Continued from December.)

(Contributed Exclusively to SOUTHERN ELECTRICIAN.*)*

BY L. O. SURLES.

THE following information is a continuation of the subject of Peg Counts from the December issue, arranged in the form of notes covering minor details: There are usually more operators than positions, this is on account of holidays, sickness, etc. Operators are not taken off as soon as the load begins to diminish, for they are beginning to tire and team work will be interfered with if this be done. Trunk, Party Line, Message rate and Pay Station positions are worked by the Senior operators and one out of three consecutive other positions should be assigned to a Senior. Excess operators provide for holidays, absences on account of sickness, etc., on the schedule. Eight hours per day in as nearly two equal tricks of four hours each with 15 minutes relief each trick, is considered an operator's day. Each one must work the same number of hours, and must be proportioned, Seniors and Juniors on duty together. The afternoon is not as busy as the forenoon, so certain Junior positions equal in number to the difference between the morning and afternoon staff may be selected and loaded half load, thereby making up for the deficiency in speed. Counts are not taken on Sundays or Holidays, but are taken on the next business day following that upon which the count date falls. This date is usually a normal day of the month.

Considerable ingenuity is required to arrange a schedule to conform to the requirements demanded by the traffic; this however, forms subject matter for a separate paper and will not be covered here. A peg count taken in a certain Pacific coast city on a very hot day was 10 per cent. in excess of normal, on account of people staying indoors as much as possible. Not only were the calls throughout the day much higher than usual, but the peak of the load ran much higher, as during the middle of the day practically the only method of communication employed in the entire city was the telephone. Further and more elaborate statistics could be gathered on the Peg Count, but the details already covered will give the average telephonist methods which will enable him to determine for himself any feature he may desire to have brought out at length.

A DISCUSSION OF MEASURED SERVICE.

Under the above heading the writer will endeavor to take up another telephone problem of interest from the commercial side of the telephone business. It is on account of the rapid development of the telephone business and the prospects of even greater development that the adoption of an ideal method of rendering service is essential in order that safe return on investment may be properly secured. By the ideal method of rendering service is meant the "measured," by which each person using the service is required to pay in proportion to the extent to which same is rendered, whether he uses his own telephone or that of someone else.

It is a singular and remarkable fact that in the midst of the present day "pay as you go" spirit, that the telephone is singled out from the other public services, and sold upon a flat rate basis, while the gas, water and electric companies have their meters, the railroads their mileage, the express companies their weight and distance charge, and the telegraph companies their rate per word. Having no means of knowing whether the telephone is being used by the subscriber who pays for the service, or by outsiders who do not, the company has to furnish service to all who come, with no power to control the amount used by the one who seems to be using the line unnecessarily. It costs a definite amount to handle each call, and those that do not produce any revenue cause a loss.

Those who use the telephone of a friend or neighbor do not stop to consider that the mere use of same by them is not the extent of the borrowed courtesy, for not only are they confiscating the visible property of other people for their own use temporarily, but are closing one of the entrances of the establishment, if a business telephone, to all who wish to call on matters of more importance than their conversation. Usually the borrower has a longer conversation than the subscriber would have, which of course, further extends the evil, and decreases the efficiency of the service for the subscriber who pays the bill. One of the largest items of cost which makes it possible for people to telephone, is the handling of the traffic, and it is readily seen that when the "deadheads" are permitted to obtain telephone service through the subscribers, that the traffic is correspondingly increased.

The main question involved in measuring telephone service is the item to be measured. It is altogether a different proposition from that of the measurement of gas, water and electricity, from the fact that calls are coming in and going out, both of which are expense items. The plan usually adopted and probably the most equitable for all concerned is that of charging only for the calls originating from each telephone. It would not be just to charge a subscriber for those calls that are incoming, for he has no control over them. The result obtained is the extent of the average subscribers view of the telephone business and he has no concern as to how much it costs the company to which he looks to render him service. If the burden fell on the subscribers as it does when measured, the "deadhead" would soon find how unwelcome his too frequent visits to his neighbor's telephone would be.

A measured method will correct most of the abuses to which the telephone is now subjected by even the subscribers themselves. The calls will be limited to the necessary business and social calls, and the frivolous conversations will be eliminated to a great extent. A large percentage of subscribers do not exercise judgment in the use of the telephone, but call at very unreasonable times and on every trivial pretext. A strong argument in favor of measured service for business places was made by an investigation made in one certain city and the calls classified. The result was that of the originating calls observed, 23 per cent. were made about affairs pertaining to the subscribers business, and 77 per cent. were personal. A sub-division of the personal calls showed that a large per cent of them were about trivial matters, 28 per cent. were theater calls, bucket shops 8 per cent., loans 4 per cent., poker engagements 7 per cent.

Thus it is that the company which operates under a flat rate is burdened with a large number of calls over each line which could be avoided; the result of this is, an additional load on the operating force, a large number of busy reports, and greater length of each conversation.

Measured service stands out as a factor which will not only decrease many of the objectionable factors of a flat rate system but will act at the same time as one which will increase the service efficiency to a very appreciable extent. How this is done is easily explained, for when it is considered that with flat rate service there are 12 calls per day per line or about 10 per telephone, and that each conversation lasts on an average of two minutes, it will require 20 minutes to handle the business of each line. Further consider that the average number of calls that may be expected from a telephone, for which there is a fixed charge for each call, is five, then it is clear that it will require but half the time to handle the business of each line. The only additional work required of the operator in handling measured calls is the pressing of a button associated with the answering cord, to return the coin or token deposited when the desired connection is not completed, this on the pre-payment plan, or to register, in either system, the call if completed. While it does take a fraction longer to handle the call than to handle the flat rate call on account of the operator having to push the button referred to, it is doubtful if in the end any time is lost, for the party making a call from a metered telephone is likely to be more brief, and thereby facilitate the handling of the work.

Varieties of apparatus for collecting and registering calls made are in use and it will not be necessary to discuss the details further than to outline the different methods of collection, of which there are four, viz: (1) Collection before the call is made. (2) After the call is made, but before the connection is completed to the called party who has answered. (3) Registering by the operator of the call when completed. (4) By some act on the part of the subscriber which registers the call on a meter at his telephone and sends a signal over the circuit that the operator may be assured that the call is registered properly.

In justice to both the telephone company and the subscriber, the measured plan of rendering service should be universally adopted for it is inequitable to charge the small user the same rate as that charged the more extensive user when he does not derive the proportionate benefit therefrom. An equitable rate and one which is adopted by some companies, is to install a telephone under a guarantee charge of 5 cents per day, which is a minimum to cover the actual investment, while any additional calls are charged at a fixed rate, whether it be 5 cents for each call or less using a token. Thus, persons making only a few calls each day pay for just what they use, and if their neighbors wish to call they pay the same rate and the company or the subscribers are not losers. Such a rate is attractive to those subscribers who have little outgoing service, from the fact that others may reach them. This causes those calling to pay the rate at some other telephone, which revenue is really originated by the subscriber mentioned having a telephone; so two sources of income are created whenever a new telephone is installed where this system is in vogue.

Nickel in the slot, or "token" service is practical and will be an important feature of future development in the telephone industry, as by its adoption the traffic per line can be reduced by at least fifty per cent., one operator can handle twice as many lines with better attention than formerly under the flat rate method. This, of course, will reduce the number of operators required; and likewise the equipment and maintenance. Two advantages are evident, that on the part of the company of collecting in advance for the service, and that on the part of the subscriber of being allowed to pay the rental in installments, thereby putting the service within reach of some who could not otherwise enjoy the conveniences of the telephone.

The phenomenal growth of the number of telephones in New York and Chicago are examples of the direct outcome of the adoption of the measured service. Each telephone added to a system makes the service more valuable to those already connected, just the same as the new subscribers to a newspaper or magazine increase its value to advertisers; in other words, the circulation indicates the value of the commodity in both advertising and telephony. It is possible, where measured service is in use to secure a larger number of patrons who will be willing to take the party-line contract on the message basis, than could be secured in any other way; this makes it possible to get any number of incoming calls without extra cost, the calling party paying for the calls. As the value of telephone service depends to a large extent upon the number of people who may be reached over the lines, it is evident that this class of subscriber is not undesirable, if of course, a guarantee is embodied in the contract whereby the cost of installation and maintenance may be offset sufficiently to justify the outlay. These lines, however, should not have over four or six parties to each, selective ringing being more desirable than code signals on each limb of the line. Lockout party line circuits are not simple enough to be recommended for this class of line and will not be discussed here.

Selling measured service in the smaller towns where everyone has a neighborly feeling for everyone else, and where the flat rate is already in evidence, is the hardest part of the proposition with which the Commercial man has to deal. There should be no reason, however, why subscribers could not be gradually induced to at least give it a trial with an offer to go back to the old plan with proper refund, should it not be more satisfactory. It is not as intricate a matter in the larger towns and cities where the people of moderate means practice economy in other lines and are naturally easier to approach with the offer of a telephone which only costs in proportion to the amount of service used. The charge for this service depends upon the local conditions, and where five cents is considered too much for each call, a "token" of metal the same size as a five-cent piece is sold to the telephone user, each of which represents a fixed charge; sometimes, a reduction in quantity is made, which is in favor of the largest users and depends upon the extent of such increased use. One plan which is what might be called a combination of the flat rate and measured service, provides for a minimum rate allowing a limited number of calls to be made, after which a fixed charge is made for each call; this method causes the patron to be as careful about allowing the minimum to be exceeded as he would if he had to drop in the nickel for the borrower.

Summarizing the several reasons for making a change from the flat rate to measured class of service are: It yields a larger income per telephone, increases the list of subscribers and last of all, rids the patrons of the intolerable "deadhead" who uses the service in many cases more than a regular subscriber without paying for it and ninety-nine cases out of every hundred not only fails to show his appreciation for the convenience by thanking the subscriber or the company, but is loudest in his complaints of service.

In flat rate service the percentage of "busy," "don't answer" and "line out of order" calls, will reach between ten and fifteen per cent, while if it were all of the measured class this percentage could be reduced to less than five per cent, having a very telling effect on the quality and speed of the service. A few rules which if placed near the telephone and followed by all, would aid materially in reducing the irregularities encountered in the service; the following are suggested: (1) Don't call a man to the telephone for a sociable chat during business hours. (2) Don't waste the time of other people by talking longer than is necessary. (3) Don't jolly central and keep others waiting. Give central your number only. Anything more is an imposition on the other subscribers. (4) Don't use the office telephone to carry on personal conversations. (5) Don't relate gossip over the wire. If you must tell it, write it. (6) Don't use the telephone at all unless you have something to say.

It is said that straws show which way the wind blows, it may be seen therefore by the present tendency toward measured service, that ultimately the telephone will come to its own and be classed as a valuable necessity, both in the household and business, instead of a nuisance which only attracts the undesirable borrower. It will then be no more unusual to see the telephone meter reader making his rounds than those of the other public service companies, and the bill for service will be rendered in the number of calls and not for the month. When this stage of the telephone business has been reached, the ideal method of rendering service will have smoothed the load down to a standard that would today be the envy of every ambitious telephonist.

The Interpretation of Curves Representing Engineering Data.

(*Contributed Exclusively to* Southern Electrician.)
BY F. P. M'DERMOTT, JR.

As an illustration of the features represented by a curve, the action of a direct current shunt wound machine connected to constant voltage mains is considered. The rotation of the armature induces an electromotive force in its windings. Below a certain speed however, this electromotive force is less than the electromotive force of the supply circuit, and current is forced through the armature in the opposite direction to the electromotive force therein induced. When this occurs the machine operates as a motor. If the machine be driven at an increased speed by supplying mechanical power to the shaft, the electromotive force generated in the armature may be made so great that the current in the armature will be reversed, assuming the same direction as the electromotive force generated in the armature. The machine now acts as a generator.

To construct a curve completely illustrating the relation between the armature current and the speed, some means should be provided to indicate not only the number of amperes, but also the direction of the current. As a hint at the method for obtaining this result, attention is called to those direct current ammeters which have the point of zero current in the middle of their scale, and graduations extending both ways from this zero point. If such an ammeter were connected in the armature circuit of the machine, the needle would be deflected to one side, the right for example, when current flowed contrary to the electromotive force generated in the armature, and to the other side, the left, when the current had the same direction as the armature electromotive force. In figure 4 the horizontal axis is selected for the scale of current, and is graduated with the zero point in the middle, as was the case with the scale of the ammeter. The vertical axis is graduated to represent the speed of the machine, each division corresponding to 100 revolutions per minute. The dots through which the curve is drawn are here omitted. This is usually done when curves are published, since the reader is generally interested in the curve itself and not with the details of its construction.

Curves may be constructed in which either one or both of the axes is extended in both directions, according to requirements. This construction is useful whenever it is desired to indicate in which one of two opposite directions something acts. A downward force can thus be contrasted with an upward force. Power supplied to the shaft of a machine can be distinguished from power supplied by the shaft, thereby distinguishing between the action of a machine as a generator and as a motor. The relation between the power and the speed of the machine just discussed might thus have been shown. As a further use of this type of construction may be mentioned the curve showing the error of a measuring instrument, at various points of the scale. The horizontal axis denotes the readings of the instrument, and the vertical axis the error for each reading. One portion of the vertical axis denotes that the reading of the instrument is too high, and the other that it is too low.

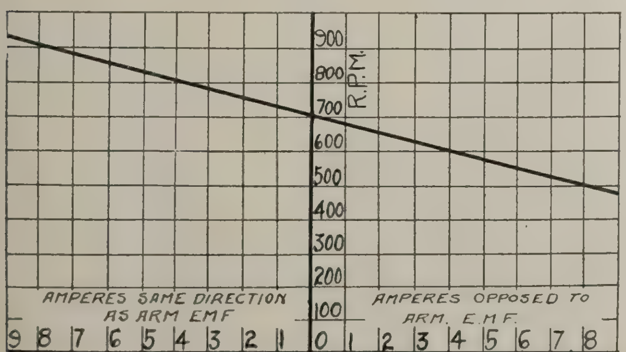


Fig. 4. Curve With Positive and Negative Values.

It is customary to call quantities represented by the horizontal axis to the left of the origin and the vertical axis below the origin, negative, and the quantities represented by the other portions of the axis, positive.

It is frequently desirable to draw several curves to one set of axes, one of the axes representing several things, so as to apply to each of the curves. This is illustrated in Fig. 5 by the performance curve of a 220 volt shunt wound motor, wherein are shown the relations between the current supplied to the motor and each of the following: Horse power input, horse power output, speed, and efficiency. For each curve the horizontal axis represents amperes, and the vertical axis denotes the quantity with which each curve is labeled. The scale to be used with each curve is appropriately marked. In graduating the vertical axis as a scale, we simply label each horizontal line at the point where it intersects the vertical axis. But the horizontal lines might have their values marked at some distance from the vertical axis just as well, and this is done in the case of the efficiency scale, in order to avoid crowding near the vertical axis. For the same reason only such portions of the R. P. M. scale as are necessary in interpreting the curve are marked. It will be seen that there are no figures for 100, 200 or 300 R. P. M.

In describing the construction of curves, it was assumed that enough points of the curve had been indicated by dots to show the course of the curve. When there are but few dots, it may be possible to draw several regular curves which pass through all of them, but which differ widely from one another in the spaces between the dots. Whatever curve be then drawn, it cannot be relied on to accurately represent the facts, but judgment, based on experience with other curves for similar cases, may be brought into play to draw the curve most likely to represent the true conditions. If, for example, previous experience has shown that the performance of some apparatus is represented by a straight line, which, as we have said above, is classed as a curve, then two dots are sufficient to locate the curve. A person unacquainted with the form of the curve, however, could not locate it without further information.

Another source of inaccuracy is that the data from which the curve is to be constructed may be in error. In locating a point on the cross-section-paper, or in estimating the position of one already marked, the error in either the horizontal or the vertical direction need not exceed one-tenth of the distance between adjacent lines. If it is known that the accuracy of the data is greater than the accuracy with which the points of the curve can be located, the curve should be drawn so as to pass through all of the dots, as was done in figures 2 and 3. Where the data is the result of calculations, such accuracy is obtainable by carrying out the calculations to a sufficient number of places. When, however, the data represents the results of experiment or measurement, the accuracy is limited by the instruments and the method of using them. Such errors as are irregular in their nature are made apparent when the points are located for drawing the curve.

As an illustration, suppose that experiments are performed for determining the current flowing in an inductive circuit for various fractions of a second after the circuit is closed, and that the results are shown by the dots in figure 6, where the horizontal axis denotes the time since the circuit was closed, and the vertical axis, amperes. A curve through all of the dots would be kinky, and would differ so much from what might reasonably be expected that we are forced to conclude that there are inaccuracies in the results, and a compromise between the various readings of the instruments is effected by drawing the curve as shown. This shows how a number of observations possessing irregular errors may be utilized in obtaining a fairly accurate result. Certain large errors, of a regular character,

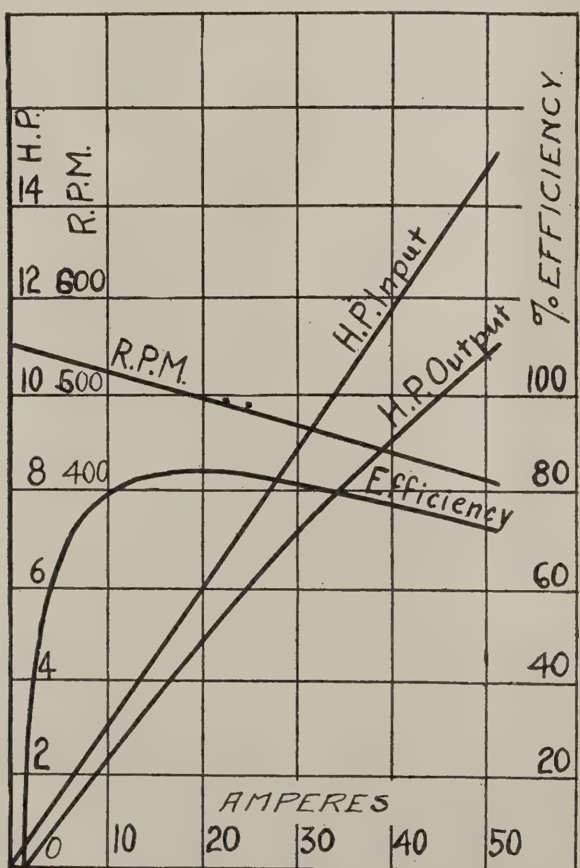


FIG. 5. PERFORMANCE CURVES PLOTTED FOR CONVENIENT REFERENCE.

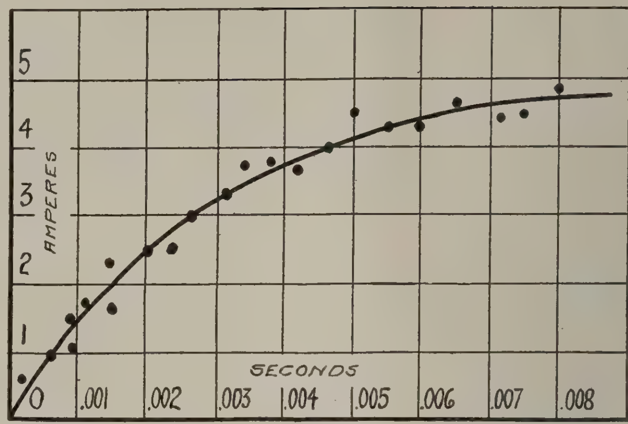


FIG. 6. DETERMINING DIRECTIONS OF A CURVE FROM EXPERIMENTAL DATA.

might be present without being betrayed by any irregularity of the dots. These can be eliminated only by a knowledge of the errors of the measuring instruments and an investigation of the conditions under which they are used. Such an investigation would include the effect of the room temperature on the instruments, the effect of the earth's magnetic field, the existence of a constant error, and many other things depending on the peculiarity of the instruments used.

Electric Lighting and Supplies in India.

In a recent Consular report it is stated that the city of Bombay, with nearly 1,000,000 inhabitants, has less than 2,000 telephone subscribers and no long-distance lines. It must be remembered that time is not of such importance here as in the United States. The lack of a common language is also a great drawback to telephone development.

In regard to electric-light supplies the prospects are much brighter. The Bombay Electric Supply and Tramways Company was formed in 1905 to combine with electric traction the business of electric supplies. The work of electrifying the tramways and supplying energy for industrial and domestic purposes began in 1906, and the demand for electrical energy promises to assume large proportions in the near future. On January 1, 1909, the city had 18 miles of streets served by electrical mains, with lamps equivalent to 123,430 lamps of 8 candlepower, and 5,400 electric fans. Since then installations have continued at a rapid rate.

The rates charged by the local company are calculated on the maximum demand system, at 16 cents per unit for the equivalent of the first hour's use per day of the maximum demand and 4 cents per unit for all further consumption. This rate gives an average of rather under 8 cents per unit, and is a good deal lower than the rates obtaining in Calcutta and other Eastern cities. These low rates have made the electric light most popular, especially among the native middle and upper classes, whose houses are ablaze with electric lights when their circumstances permit it.

In the beginning of this year the government of India increased the import duty on foreign kerosene oil by 50 per cent, and has under consideration the question of placing an export duty on Burma oil. This has caused a corresponding increase in the price of oil locally consumed, and will, no doubt, have its effect in increasing the demand for the electric light.

Some Important Features of Patents.

(Continued from December.)

(Contributed Exclusively to SOUTHERN ELECTRICIAN.*)*

BY MAX W. ZABEL.

RELATIVE to the subject of patent claims, the importance of properly drawn claims and the necessity of having as few elements as possible in a given claim were features discussed in a previous article. Continuing the subject, the claim must set forth sufficient elements to provide an operative structure. The patent laws do not contemplate claims which cover a function, pure and simple, but a claim is proper if it covers means, generally speaking, to perform a given result. The result alone of course, cannot be patented. It is likewise true that it is impossible to patent a natural law. This may be illustrated by the telegraph invention. In 1729 Stephen Gray discovered the electric current. In 1820 Oersted discovered that a magnetic needle could be deflected by an electric current. Arago discovered subsequently that an electric current will magnetize a piece of soft iron and when the current is broken the magnetism subsides. These three discoveries made possible the telegraph. Neither one of the above three discoverers could have patented the natural law that he discovered, but the application of this law, or either one of these laws is of course patentable. Prof. Morse who was not a scientist did not discover either of these laws, yet he realized that the use of these natural laws in a certain way would produce the telegraph and this he conceived in 1832 and completed in 1837, patented in 1840 and embodied in 1844 in a working telegraph from Washington to Baltimore.

The Morse patent was sustained with the exception of claim 8, which merely aimed to cover the use of electric current for making intelligent signals at a distance, and this of course, the Supreme Court held to be void because it practically attempted to cover a natural law. The claims however, covering the telegraph feature were held to be entirely novel.

Neither do the patent laws contemplate or allow a discoverers to claim a law of nature, or what might be called a scientific principle. Means which use this principle to obtain a given specific result, however, are patentable. For instance, in one of the earlier cases, the Bell telephone case, the Court broadly upheld a claim which covered the art of transmitting speech by causing electrical undulations similar in form to sound waves. The Supreme Court held this to be for a process and not for a natural law and consequently sustained it.

The situation leading to this decision was approximately as follows: Sounds had been reproduced by using two diaphragms which were attached together by a tightly drawn cord so that a person speaking against one diaphragm could be heard at the other. This of course was without using the electrical undulations.

In 1831 it was discovered by Faraday that moving an armature in proximity to an electro-magnet changes the magnetism in said electro-magnet and that this motion has a corresponding influence on the current flowing through the coil of the electro-magnet. It had also been known that a fluctuating current in an electro-magnet will cause the armature to operate in accordance with the fluctuations.

These were all laws of nature which were well understood by scientists at the time when Prof. Bell entered the field. He placed one diaphragm in proximity to an electro-magnet and then connected the coil of said electro-magnet to a second electro-magnet. This second electro-magnet also had an armature and when he talked against the first armature, the second armature reproduced the sound and speech was thereby electrically transmitted.

Prior to this time the German inventor Reis had used a diaphragm in close proximity to a contact point and associated a battery with this arrangement and included in his circuit an electro-magnet having an armature. When a musical note was sounded close to the first diaphragm, the first diaphragm vibrated with the proper number of vibrations of that musical note, and made the same number of contacts with the contact element, thereby causing a like number of impulses to be transmitted to the distant electro-magnet with its armature. The armature of this distant electro-magnet was thereby agitated by impulses equal in number to the rate of vibration of a given note and consequently emitted that same note.

This latter arrangement according to the decision of the Supreme Court was not available to produce speech transmission because the human voice emits a sound very complex and not as simple as an ordinary musical note which can be transmitted by a make and break device.

All of these devices having been known, none of them however, according to the testimony such as we find in the records, were able to transmit speech, and Prof. Bell was the first one to give to the public, according to these records, an instrument which could transmit speech. He having obtained a new result was entitled to a patent, no matter how similar the old devices were so long as these old devices failed to produce that same result. It is therefore the new result which counts and means which produce a new result are patentable even though they may be identical with means hitherto known, although not used to produce that result. Even if old and well known means by a slight modification might have produced that same result, yet unless that modification has been made prior to the alleged invention, such old means are not anticipations of the latter invention. This may be illustrated in so far as the Reis structure is concerned, in that if Reis had moved his contact point, possibly a hundredth or a thousandth part of an inch toward the diaphragm so that it touched the diaphragm he would have had a contact transmitter and might have transmitted speech, but as he failed to get the result of transmitting speech, his structure could not interfere with the broad interpretation of the Bell claims.

(To be Continued.)

Economy in Telephone Construction.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

BY ROY C. FRYER.

IN discussing the question of economics relative to telephony, it must not be supposed that the purchase of the cheapest equipment, installing it in the cheapest manner possible, and operating it with the lowest priced labor will be economy. On the other hand, quite the opposite is more often the most economical, for in deciding upon a course to pursue to bring about the best proceeds as many points must be considered as in greater business enterprises.

One of the first questions entering the mind of the prospective telephone engineer in deciding upon equipment, is first cost. He must first make a thorough examination of the conditions governing the proposed business, and before he in any way tries to decide upon the equipment to be used, he must learn the number of the customers, as nearly as may be ascertained, that his system can serve. Further he must take into consideration the territory covered, and the possible income from toll as well as subscription. In general he must view the prospects from much the same point that any business man would look at a prospective business. At this point the writer desires to call attention to a very common mistake. A man to be really efficient in any profession, it is said, must specialize. If there is an exception, it is in the business of the telephone engineer. If he is a man of purely technical education, he will neglect seemingly non-essential points which once neglected require a remedy often severe. For instance, how many of the independent telephone companies have been forced to sell or combine upon unequal terms, only because they went into the business with inadequate long distance contracts. The cause of this, the investors troubled by the technicalities, placed the business in the hands of the engineer, and he although probably a good engineer, was a poor business man outside of telephone work, because he had studied nothing else. Or if placed in the hands of a good business man, the erring was on the technical side.

As a typical example of what has and might happen a recently elected superintendent, selected because of his business qualifications, was engaged to "pull a company out of the hole." This he started to accomplish by enlarging the business which was commendable as the company was prepared to handle a larger amount of business in some branches without additional operating cost. This being the case, he contracted with a number of subscribers in the out-skirts of the city at a reduced rate intending to string a few miles of wires, and take care of them temporarily. Great was his consternation, however, when he found his new lines almost useless on account of some high potential wires across the street parallel to his lines causing a terrible noise. The remedy selected was cable, and an indignant board meeting where deferred dividends were freely discussed.

It is plain that the engineer should take into consideration these and attendant circumstances, and make a decision that with proper capital, proper management, etc., a business to insure a safe earning capacity is assured. He may, then after deciding upon the general requirements in way of locations, proceed to consider equipment, as far as it is related and governed by initial cost, taxes, interest, depreciation, effect upon service rendered, extension of system, durability, cost of operation and maintenance, cost of installation, liability to incur suits for damage on any grounds, appearances, reliability of the firm furnishing the material, ease and dispatch with which duplicate parts and supplies may be purchased. At this point is the place for him to begin to systematize, for unless the system is perfect in detail, every part of it will be hampered by its incompleteness.

SUPERVISION OF CONSTRUCTION WORK.

If the selection of a superintendent devolves upon the consulting engineer and it should, in conjunction with the directors, he must select a man of reliability, well known for his honesty, and a man whom he knows would not sacrifice the good of the company for his own personal gain. Outside of experience, reliability is therefore a requisite of importance second to none. While experience is desirable, a man who has served in similar positions is not always desirable, as sometimes he might have lost his position from some good reason. Often a man of less experience, as a superintendent will be more energetic and capable, than the man of long experience. If upon assuming his duties, he will as in many instances, act as advisor to the directors, his business qualifications must be investigated. It should not be understood that his business qualifications should not be investigated otherwise, for although the management of the business may not be intrusted to his care, his carelessness and igncrance of business as superintendent would make it next to impossible for any good manager to produce profits.

The work of the superintendent, should be taken up in the most economical way possible. Having consulted with the consulting engineer, and ascertained the general route through the country to be telephoned, and having made the necessary arrangements such as right of way in the rural districts, and franchises in the small towns and cities, and having carefully looked over his route in sort of a preliminary survey, he should decide as nearly as possible on the number of wires each pole line will have to carry in order to handle the work in view, and also allow for future business. Some future business in way of through toll can easily be handled by phantoming, but where an increasing amount of rural subscription work is taken up, provision for additional arms and circuits should be made.

It is the opinion of the writer that the superintendent should take these points into consideration before any survey proper is made, for it will sometimes be possible to carry light lines in places where heavy lines carried in the same places would mean additional trouble and expense. Having decided upon these points then, let him engage his surveying crew. If the supervision of the crew is left in the hands of a competent civil engineer, the superintendent will not be required to select surveying equipment, but he should accompany the engineer, and assist him in laying out the work.

PROPER CONSTRUCTION METHODS.

For installing plants in towns of 1,000 to 5,000 inhabitants the telephone company often does not engage an engineer, because the lines or conduits are located in accordance with the municipal specifications and usually under municipal supervision. The laying out of the lines through the surrounding country then falls to the superintendent, and is sometimes accomplished with stakes from neighboring fence rails and with the assistance of a good eye.

Under these conditions a better way would be for the superintendent to select his crew, not necessarily experienced, and procure a moderately good transit, with which he can soon acquaint himself sufficiently to do the work in a very good style. Then he should equip his forerodsman with a staff, preferably painted white, also with stakes, the top of which should also be painted white. This may seem a useless expense, but the writer has known a workman in digging holes to look for three hours in high weeds common in some places, and then have to call for the foreman before he located the line.

Besides the stakes, which can be slung in a bag from his shoulder, the forerodsman should carry a heavy hand axe, well sharpened, and it is well, though optional with the superintendent, that he should carry a brass tag, each stamped with the number of each pole to occupy the place of the stake. The tags should all be numbered in rotation, before starting, slipped upon a wire carrier, and carried in the belt.

If the stakes are numbered, the noteman may specify any certain length or size pole or stub guy delivered at that number stake, and thus make it unnecessary that the man delivering poles should be accompanied by an overseer.

The superintendent should also choose a transitman, who may carry transit and chain, and let the forerodsman carry the other end of the chain. This chain may be laid off in feet and hundredths, although he will find it unnecessary to often read to tenths or hundredths. The crew should also be accompanied by backrodsman, provided with rod similar to one carried by the forerodsman. His duty will be to remain on the station behind the transitman to give backsight. The next article will take up the survey and layout of a rural telephone line.

Test of 9,000 K. W. Turbo-Generator Set.

BY F. H. VARNEY.

FOR about five years prior to 1908 the City of Oakland, Cal., had been practically dependent for its electrical energy on the water-power stations and transmission lines of the Pacific Gas and Electric Co., located 125 to 150 miles from Oakland. In the year 1908 it became evident that this service would necessarily have to be bettered, not alone for capacity, but also for regulation, and after considerable preliminary estimating, it was decided on the first day of July of that year to endeavor to have a turbo-generator set installed and operating in time for the Christmas holidays. Plans and specifications were immediately prepared and to hurry the work as much as possible a heavy bonus and penalty clause was made a part of every contract.

The delivery of the turbine seemed to be the one point that might cause delay, as boilers, superheaters, steam piping, condenser and all auxiliaries were promised on time. The turbine was, however, shipped 38 days in advance of promised shipment and the work progressed without delay until the unit was started and put into regular service on December 18, 1908, thus making 171 days from the beginning of the plans and specifications to the successful operation of the station. It is interesting also to know that the station, including turbo-generator, boilers, steam piping and auxiliaries, buildings, crane and everything necessary for a complete steam plant, excepting land, cost $51 per K. W.

It was with considerable satisfaction that the turbine was started, as this was one of the driest years the water-power station had ever experienced and the demand for power greatly exceeded that of previous years.

The turbine was immediately put in parallel with the hydro-electric system, which consists of eleven water-power stations, three reciprocating-engine stations, and one gas-engine plant. It operated perfectly in every particular and soon demonstrated the superiority of this class of prime mover over reciprocating steam or gas engines, both in regulation and in maintenance.

The plant is situated on the Oakland estuary, between Grove and Jefferson Streets on First Street, distant about one mile from the center of Oakland. The estuary is a branch of the San Francisco Bay and has an ample supply of clean salt water from which circulating water for the condenser is drawn. A wharf was built into the estuary for the purpose of landing the fuel supply as the Southern Pacific Railroad tracks adjoin the First Street side of the station. The location is considered ideal.

The apparatus installed consists of a 9000 K. W. vertical Curtis turbo-generator, maximum rated, Worthington condenser and vacuum pumps, and eight 754 H. P. McNaull water-tube boilers. The plant is oil-burning, using what is known as the back-shot burners. The boilers are equipped with superheaters for 100 deg. superheat.

Owing to the urgent need for the plant, the efficiency test was postponed until the station had been in operation for 14 months. The conditions of the test were as follows: The turbo-generator was run on a closely regulated commercial load, which was maintained as nearly uniform as possible by the load dispatcher. Two runs of four hours each were made at loads approximating 700 K. W. and 9000 K. W. The boilers were operated on the usual program, the number employed being adapted to the load carried. No attempt was made to obtain complete data regarding the economical operation of the boilers.

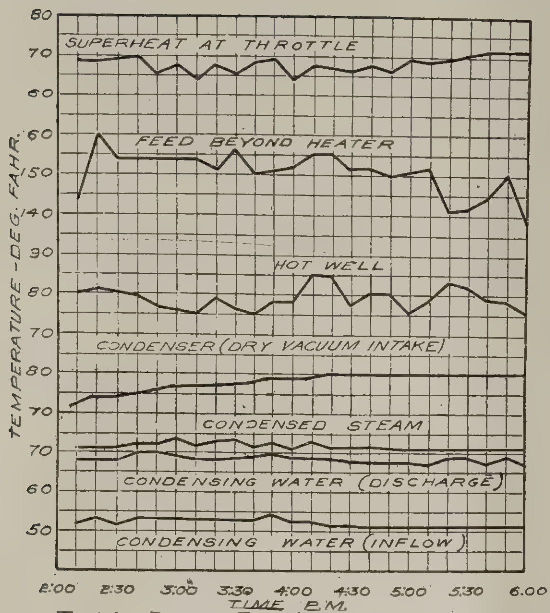


FIG. 1. LOG OF TEST DATA, FIRST TEST.

In view of these conditions, it was decided to provide for the measurement of the following items: (a) Water from turbine (b) Total make-up and auxiliary water (c) Power delivered by generator at switchboard (d) Exciter output (e) Pressures and temperatures required to complete and interpret the above observations.

Measurements of water were made by tank weighings with standard scales in lots averaging 1800 lb. to 1900 lb. and in accordance with the general methods recommended by the engineering societies for such purposes. The power delivered by the generator was measured by duplicate installations of integrating wattmeters connected in accordance with the three-meter method for three-phase circuits. Observations of all electrical readings and of all pressures and temperatures were made at ten-minute intervals. Weighings of water were made at intervals as determined by

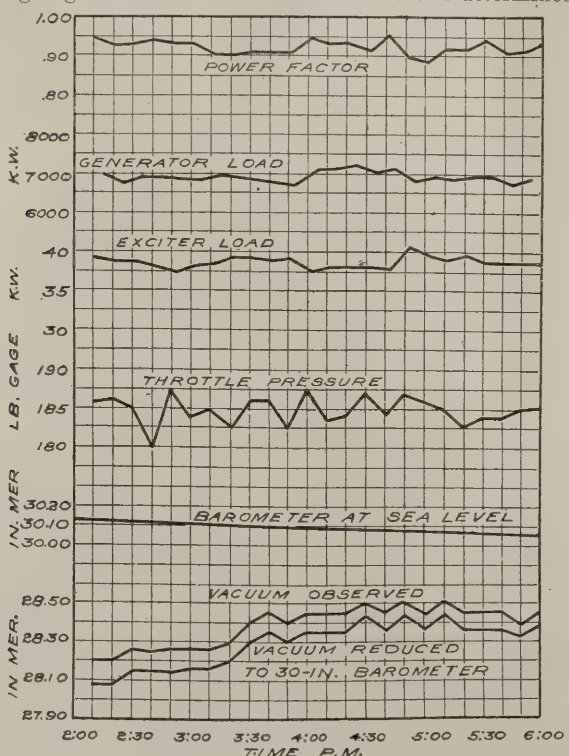


FIG. 2. LOG OF TEST DATA, FIRST TEST.

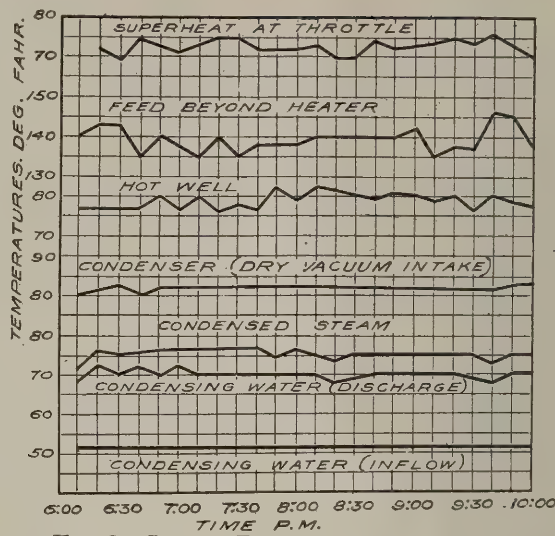


FIG. 3. LOG OF TEST DATA, SECOND TEST.

the load. The level of water in the feed tank and the condition of the weighing tanks at the end of each half-hour period were also noted, thus providing for a closure of the test at any such period. Leakage tests of the condenser and of the wet vacuum pump seal were made before and after the test and a mean of the two values was used as the leakage correction.

All apparatus and instruments employed were carefully calibrated by reference to absolute standards or to others as near to them as possible. The scales employed were tested both before and after the run by the use of 50-lb. weights loaned for the purpose by the Fairbanks Company. All pressure gages were tested by the use of a dead-weight testing apparatus. The indications of the mercury vacuum gage were accepted as accurate without further test. The integrating wattmeters were calibrated before and after the run. All thermometers were compared with standards certified by the United States Bureau of Standards.

The general and economic results for each run as a whole are given below. Figs. 1 to 4 show the data worked up for ten-minute intervals and plotted on a time axis. The actual turbine results were reduced to the conditions speci-

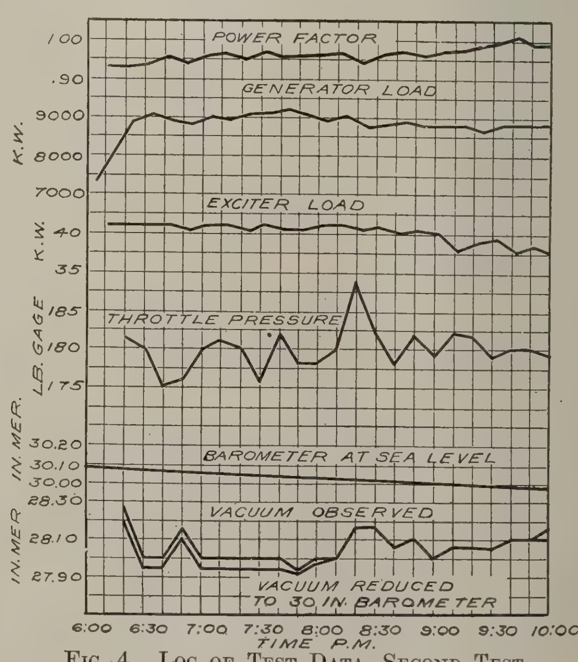


FIG. 4. LOG OF TEST DATA, SECOND TEST.

fied in the contract, by means of the following schedule of corrections:

CONTRACT SPECIFICATIONS.

1 Steam pressure at throttle................175 lb. gage
2 Superheat ....125 deg. fahr.
3 Vacuum .... 28 in.
4 Steam consumption

Generator output K. W.	Lb. per K. W. Hr.
5000	16.75
7000	16.40
9000	16.40

CORRECTIONS.

1 For each 10 lb. pressure...............1 per cent
2 For each 12 1-2 lb. deg. superheat......1 per cent
3 For each inch vacuum................1.08lb. per kw-hr.

GENERAL AND ECONOMIC RESULTS.

1 Time, February 18, 1910	2.10 p. m. to 6.00 p. m.	6.00 p. m. to 10.00 p. m.
2 Total water with all corrections, lb	520,837	650,600
3 Average load, kw	6,922	8,775
4 Water from turbine as weighed (corrected for scales), lb	428,704	562,579
5 Water leakage correction, lb	—2,461	—2,568
6 Corrected water from turbine, lb.	426,243	560,011
7 Water per kw-hr., lb	16.06	15.95
8 Temperature of condenser, deg. F.	78.1	81.9
9 Temperature of condensing water, inflow, deg. F.	52.15	51.0
10 Temperature of condensing water, discharge, deg. F.	66.50	70.0
11 Rise in temperature of condensing water, deg. F.	14.35	19.0
12 Vacuum in condenser, reduced to 30 in. barometer, in. mer	28.30	28.03
13 Exciter output, kw	38.9	40.0

FINAL CORRECTED VALUES.

6.00 p. m. to 10.00 p. m.

Corrections for superheat, per cent	— 4.13
Correction for pressure, per cent	+ 0.48
Correction for superheat and pressure, per cent	— 3.65
Correction for vacuum, lb	+ 0.03
Water rate corrected for vacuum, lb	15.98
Water rate with all corrections, lb	15.42

This information was presented in a paper at the thirty-second annual meeting of American Society at Mechanical Engineers at New York City.

Georgia School of Technology Holds Electric Show.

BY C. V. C. GLOVER.

On Friday evening, January 13, the Senior Class in Electrical Engineering at the Georgia School of Technology, gave an electric show that proved a great success. The show was the first of its kind by any technical school in the South. The idea came to the class through Professor H. P. Wood, head of the Department of Electrical Engineering. The show was first suggested in October and generally discussed until December, during the first part of this month the class met and formally decided to hold an Electrical Show on the thirteenth of January. Officers were elected at this meeting to carry on the necessary business as follows: M. L. Donaldon, business manager; C. V. C. Glover, advertising manager; L. F. Green, treasurer, and W. D. Kellogg, chief engineer. A committee was also appointed to get up a list of practicable exhibits, Prof. H. P. Wood acting as consulting engineer to this committee.

Actual work on the show began after the Christmas holidays. The show was held in the Electric Building and occupied the whole of the second floor and part of the first floor. The show proper was on the second floor, only one exhibit being placed on the first floor. The exhibits were arranged in various rooms, each having a demonstrator who explained in detail the apparatus in his charge.

The main entrance to the Electrical building was headed by a large electric sign reading E. E. Show, January 13, which was made by E. H. Lyon and erected by the class. The stair case leading to the second floor, was decorated with an arch of electric globes, red, white and blue alternating. To the right of this arch a door led into the largest running exhibit of the show where a miniature power plant was shown in operation. Here an International gasoline engine of 6 horse power was belted to a 7 K. W. old style Edison generator, a generator panel was mounted near the dynamo and carried a voltmeter, an ammeter, a field rheostat and a main switch. Twenty-seven incandescent lamps and a flaming arc lamp were run from this plant throughout the evening. C. V. C. Glover had charge of this exhibit.

EXHIBIT ROOM, GEORGIA SCHOOL OF TECHNOLOGY ELECTRICAL SHOW.

Another exhibit attracted attention by the sign, "He eats nails, pitch him one." On a board over a round opening a large mouthed green eyed face was displayed. Around and in front of the mouth were electro magnets to which the nails attached themselves when thrown at the mouth. L. H. Tippnis had charge of the nail eating man and also demonstrated an electric washing machine. Leaving this exhibit, the procession moved up stairs to the show proper. Over the staircase a flaming arc gave forth a brilliant light, and illuminated the entrances to the exhibition rooms. In the electrical laboratory the hydrogen gun was demonstrated. Water was decomposed and the H_2+O resulting exploded by a spark. At a booth near by J. P. Burnuss and H. B. Beckwith demonstrated the electric toasters and passed out toasted bread to the hungry. An exhibit of toys was of interest to the children. Near the toy exhibit was a sign reading, "Three of the illuminants of the Western Hemisphere." These were the candlefish, kerosene oil lamp and incandescent electric lamp. An exhibit of cable and joints for alluminum cable was another display.

An exhibit of transformers was shown by L. C. Benson who performed various experiments. Next to the transformer was suspended on a horse a powerful electro-magnet made in the shops of the school. Nails by the hundred were hung from the magnet demonstrating its purpose. J. S. Gantt demonstrated the welding of iron in a water pail forge. The voltage required was 212 direct current and was obtained by running a motor generator set and connecting the generator in series with the main power plant. The water pail forge was one of the most attractive exhibits shown as the sparking of the iron on the surface of the water was interesting to the spectators. A General Electric Mercury Arc Rectifier, in charge of M. S. Hill, furnished D. C. for the Toasters and Hydrogen Gun and as an illustration of a means of charging storage batteries on an A. C. circuit.

Leaving this exhibit, an electric welder made by the demonstrators, D. H. Woodward and J. Walton, was displayed.

At the next exhibit room, a Frequency Meter, built at the school, armature windings of various types, rheostats, condensers and switches were shown. A small rotary converter built by the students was on exhibit.

The drawing room of the electrical department contained exhibits of light. The Edison three wire system and wattmeter by connections for lighting were shown by E. H. Lyon. He also demonstrated how unbalancing the sides of the system caused variation of light intensity on the sides, also blowing of fuses was shown. Cases containing the evolution of an incandescent lamp and parts of Weston meters were next in line. Then came a long table with booths, each containing a type of light, its cost per hour and its candle power being printed on cards in the respective booths. The candle, kerosene lamp, fish tail gas burners, inverted gas mantle, carbon filament electric lamp and tungsten filament electric lamps composed the types. On a large table further down the room were types of instruments used by the students. Such as voltmeters, ammeters, wattmeters, a current transformer, a kelvin balance, an electro-dynomometer, a potentionometer, a wheatstone bridge and galvanometer. A complete telephone system on central energy supply stations "A" & "B" was demonstrated by C. E. Anderson and Goodman. A party line system and a wireless outfit was also included. The wireless plant had sending and receiving stations of the field type, the antenna being held up by a tetrahedron kite of the Alexander G. Bell type. A large square booth contained Mr. Kollock and Mr. F. S. Adkins who were busy showing cooking and heating apparatus. Storage batteries, telephones for house usage, bell transformers were shown by Messrs. Kollock and Adkins.

A Richmond Vacuum Cleaner was on exhibit and operated by W. D. Kellogg for the ladies who were interested. An X-Ray exhibit run by Messrs. Wright and Stakley, also an exhibit of Geisler tubes were shown.

An exhibit of power plants and generators was shown by lantern slides. The photometer room was open and showed a Lummer Brodhem sight box and base arranged for measuring candle power of electric lamps. Charts were hung on the walls showing the distribution of light with different types of reflectors. The reflectors were hung above the charts. A Sharp-Millar instrument was also on exhibit.

In the Architects drawing room several drawings that had received "Mention" at the "National Institute of Beaux Arts" in New York were on exhibit, also plans for the new shops building. The Perryman exhibit of electrical devices for medicinal use were displayed by Dr. Perryman and proved to be very entertaining.

Through the generosity of W. W. Foster of the Shreded Wheat Biscuit Company and A. C. Allen, steward of the school, a free supper was served in the students dining hall. The co-operation of the W. E. Carter Electric Co.; The Electric Construction Co.; The Westinghouse Electric & Mfg. Co.; The General Electric Co.; Russel-Nichols Electric Co.; M. Morrison, who exhibited a Harmonic Machine, and the F. E. Newcomer Co., made the show a possibility. Valuable assistance was received from Professor Davenport and Professor J. B. Edwards.

A crowd of 500 people completely filled the show rooms from eight o'clock until 10:30, indicating to the management that their purposes in getting up the show were most agreeably accomplished.

Chicago Electrical Show.

The sixth annual show of the Chicago Electrical Trades Exposition Company was held in the Coliseum, Chicago, Ill., January 7 to 21. The interest manifested by the large and enthusiastic attendance at each session is convincing evidence of the popularity of these annual expositions which are held to demonstrate to the public generally, the wonderful progress that is being made in the electrical industry.

Every phase of the industry was represented by the scores of comprehensive exhibits maintained by the most prominent manufacturers in the field. The many applications of electricity in the factory, in the office, in the laboratory, and in the home were shown to the best advantage, and no expense was spared in providing an elaborate setting for the demonstration of this apparatus.

In point of decoration, the show just closed eclipsed anything ever before seen at a trade exhibition. A general idea of the interior decorations may be gained from the accompanying illustration. Looking upward, the spectator saw the drapery of a great pavilion drawn aside to reveal in the center a great expanse of noonday sky. A realistic effect was produced by employing indirect lighting, the lighting units being hidden in the drapery. Pale green and white bunting was drawn from the balcony, which surrounded the entire hall, to the border of the sky-like ceiling.

The booths were divided by posts, each of which supported an Alba glass globe inclosing a 160-watt tungsten filament lamp. This lighting was augmented by high-candlepower tungsten lamps studded in the lattice work which overhung each booth.

A most interesting and educational exhibit, was that of the United States Government. Here were shown models of modern war vessels, various types of army rifles, machine guns, translucent pictures of the engineering features of various Governmental projects, samples of lithographic work as done at Washington, and a standard naval

Exhibit Floor at Coliseum.

wireless station which was connected with an antenna on the roof of the building and received and transmitted messages from neighboring stations. Demonstrations were also given of electrical cooking as recently adopted by the Government for its navy.

Another feature of interest was the demonstration of the Chicago Amateur Wireless Club, composed principally of the students of the technical high schools of Chicago. This was a working exhibit of apparatus constructed by the club members and their ability was demonstrated by the marked efficiency of the wireless sets.

As in former years a number of special days were arranged for. The most prominent of these were Wednesday, January 11, and Friday, January 13. On the former date the Chicago Electrical Club met at the Coliseum and was entertained by a very interesting address by H. H. Cudmore, president of the Brilliant Electric Company, Cleveland, O., on "The Electric Club of Cleveland." This address pertained to the organization management and success of the Cleveland Club, an organization similar to the Chicago Club.

On Friday the Illuminating Engineering Society, Chicago Section, met at the Coliseum and informally discussed the subject of luminous efficiencies. The discussion was led by Mr. Eustice, of the Chicago office of the Nernst Lamp Company.

The Chicago Central Station, the Commonwealth Edison Company, maintained a very comprehensive and interesting exhibit, which occupied the entire Northern section of the Auditorium. This space was constructed into a model street called Commonwealth Avenue. In the exhibit there were six stores, each completely equipped and each showing a different scheme of illumination. In order to carry out the idea more completely each of the stores was not only fitted with a plate-glass window and a display of goods, but before them all ran a sidewalk. Through this method of a practical exhibition the company showed to storekeepers in attendance the value of proper and well-studied window lighting.

Exhibits of apparatus and electrical appliances were given by a number of the more prominent electrical companies, a list of these is given herewith.

Allis-Chalmers Company, Milwaukee, Wis.; Addressograph Company, Chicago; American Ironing Machine Company, Chicago; American Ozone Company, Niagara Falls, N. Y.; American School of Correspondence; American Steel & Wire Company, Chicago; American Telegraph Typewriter Company, New York; Anderson Carriage Company, Detroit; Apex Appliance Company, Chicago; G. W. Armstrong Company, Chicago; Artcraft Institute, Chicago; Automatic Enunciator Company, Chicago; Babcock Electric Carriage Company, Buffalo; Birtman Electric Company, Chicago; Bissel Motor Company, Toledo; Cadillac Electric Manufacturing Company, Cadillac, Mich.; Chicago Electric Meter Company, Chicago; Chicago Fuse Manufacturing Company, Chicago; Chicago Pneumatic Tool Company, Chicago; Crane Company, Chicago; Cutler-Hammer Manufacturing Company, Milwaukee; Dayton Electromobile Company, Dayton, Ohio; J. R. Deane & Company, Chicago; Domestic Equipment Company, Chicago; Driver-Harris Wire Company, Harrison, N. J.; Duntley Manufacturing Company, Chicago; Edison Storage Battery Company, Orange, N. J.; Electric Storage Battery Company, Philadelphia; Electrical Testing Laboratories, New York; Electrical World, New York; Empire Vacuum Company, New York; C. G. Everson & Company, Chicago; Excello Arc Lamp Company, New York; Farrington Auto Company, Chicago; Federal Electric Company, Chicago; Flexlume Sign Company, Buffalo, N. Y.; Fort Wayne Electric Works, Fort Wayne, Ind.; General Electric Company, Schenectady, N. Y.; Hoskins Manufacturing Company, Detroit; Houston Manufacturing Company, Rockford, Ill.; Hughes Electric Heating Company, Chicago; Hurley Machine Company, Chicago; Ideal Electric Company, Chicago; Illinois Appliance Company, Chicago; International Correspondence Schools, Scranton, Pa.; Janette Manufacturing Company, Chicago; Judd Laundry Machine Company, Chicago; Keller Manufacturing Company, Philadelphia; Kimble Electric Company, Chicago; Kinetic Engineering Company, Philadelphia; A. W. Kratz, Chicago; Macbeth-Evans Gas Company, Pittsburg; Machado & Roller, New York; Mailometer Company, Detroit, Mich.; Manhattan Electrical Supply Company, Chicago; McCrum-Howell Company, Chicago; Millar Electric Company, Chicago; Minerallac Electric Company, Chicago; National Carbon Company, Cleveland; National Electric Lamp Association, Cleveland; Henry Newgard & Company, Chicago; Neway Service & Sales Company, Chicago; Ohio Electric Car Company, Toledo; Pelouze Electric Heater Company, Chicago; Perfection Vacuum Cleaner Company, Chicago; Philadelphia Storage Battery Company, Philadelphia; Rider-Ericsson Engine Company, New York; Rosenfield Manufacturing Company, New York; Sefton Manufacturing Company, Chicago; Simplex Electric Heating Company, Cambridge, Mass.; Stamping Washer Works, Chicago; Stolz Electrophone Company, Chicago; Studebaker Automobile Company, South Bend, Ind.; Swedish-American Telephone Company, Chicago; Ralph Temple Automobile Company, Chicago; Thordarson Electric Manufacturing Company, Chicago; Toledo Electric Welder Company, Cincinnati, Ohio; Union Light & Supply Co., Chicago; Van Manufacturing Company, Braddock, Pa.; Vulcan Electric Heating Company, Chicago; Westinghouse Companies, Pittsburg.

N. E. L. A. Convention at New York City.

At the meeting of the executive committee of the N. E. L. A. held January 12, it was voted to hold the next annual convention in New York City during the week of May 29th to June 3d, with four days of business sessions. The meetings will be held in the United Engineering Building at 29 West 39th Street, where the offices of the Association are located, and the three largest auditoriums in the building, seating not less than 1800 persons all told, have already been secured. No hotel has been selected for headquarters, but a hotel committee has been formed with Mr. Frank W. Smith as chairman, which this year will undertake to make definite reservations. The manufacturing members of the Association, in view of the fact that there is another electrical show in New York in October, have voted to dispense this year with the collective exhibit. The attendance at St. Louis was about 2,700, out of a membership of 5,250.

With the new year the National Electric Light Association has taken another leap forward in membership and on January 21, crossed the 6,500 line. This is a gross gain of over 1,500 since the St. Louis convention, and a net gain of about 1,250. The Canadian Electrical Association voted last week to affiliate with this body, and this will also bring a large accession, while new company sections are being formed in Pittsburg, Allegheny City, Scranton, Connellsville, Pa., and other cities. Mr. H. H. Scott, the chairman of the membership committee, estimates that 7,000 members will be enrolled by the end of the month and that the number may easily be 8,000 by the next annual convention in June. The membership fifteen months ago was slightly over 3,000. A number of smaller central stations are included in the new membership.

Ohio Electric Light Association.

The executive committee of the Ohio Electric Light Association held its annual meeting at the Chittenden Hotel in Columbus, Ohio, on January 11. At this meeting Cedar Point, Ohio, was selected as the place for the next annual convention, with headquarters at the Hotel Breakers, the time to be Tuesday, Wednesday, Thursday, and Friday, July 25 to 28, 1911. The excellent entertainment and large attendance at the Convention of 1910 induced the Committee to return to this point for its 1911 Convention. The convention this year will be even more elaborate in the way of program and entertainment than that of 1910, which was the high water mark reached by State electric conventions in the United States.

Twelve subjects will be considered at the July convention, as follows: Report of committees of motor applications, on electrical transmission and on meters. "Ornamental Street Lighting," by O. H. Hutchings, of Dayton Lighting Co.; "Mercury Arc Rectifiers, Their Installation and Care," by J. T. Kermode, of Cleveland Illuminating Co.; "Systematic Central Station Records," by O. B. Reemelin, of the Dayton Lighting Co.; "Motor Driven Refrigeration," by W. C. Anderson, of Canton Electric Co.; "Development of a Central Station in Small Cities," by S. M. Rust, of the Greenville Electric Light & Power Co.; "Pumping Water for Municipalities and for Irrigation by Electricity," by B. H. Gardner, of Dayton Lighting Co.; "The Use of Tungsten Lamps in Sign and Outline Lighting," by W. B. Gowdy, East Liverpool Traction & Light Co.; one paper by W. E. Richards, of the Toledo Railway & Light Co., subject to be announced later. There will also be a report by the secretary of the investigation of insurance rates charged in Ohio, for both fire and liability. This report will also give the money this insurance is costing and the losses for the past five years.

The Association will publish its souvenir program as in the past, which has each year proved a magnificent success, both as a means of creating interest and defraying the expenses of the convention. Three banquets will be given on the three nights of the convention, to all attending, and the entertainment for the ladies will be the best. The committee on general arrangements consists of E. A. Beckstein, Sandusky, Ohio; T. D. Buckwell, Toledo, O.; and W. J. Hanley, Cleveland, O. Further information may be had by writing the secretary, D. L. Gaskill, at Greenville, Ohio.

National District Heating Association.

The Executive Committee of the National District Heating Association at their annual meeting fixed the time and place for the third convention of that Association. The place will be Pittsburg, Pa., and the date June 6, 7, and 8, 1911, with headquarters at the Fort Pitt Hotel.

The hotel management has made special rates for the occasion, and has provided for the meetings and exhibits to be held in the banquet hall of that hotel and which is probably the most magnificent room for such a meeting in the United States.

The program for the convention will be a very attractive one to those engaged in heating, whether isolated or district, as the questions to be considered will be in some measure general to the heating business. The subjects so far announced are as follows: Radiators and their treatment; report of the committee on data, which will include rates and other data pertaining to the heating business; report of the committee on meters; report of the committee on radiation; results of measuring station load by the Venturi and General Electric meters; heating franchises and five other papers, subjects to be announced later.

The entertainment provided will be arranged for both the gentlemen and ladies attending this convention, and the manufacturers and other members of Pittsburg have assured the convention that it will be magnificent in every respect. This convention follows the National Electric Light Convention which will be held in New York City, and it is expected that many of those in attendance at the National convention will attend the National Heating convention upon their return from New York City. Full information will be obtained from the secretary, D. L. Gaskill, Greenville, Ohio.

National Commercial Motor Car Show.

A comprehensive display of motor trucks, delivery wagons and self-propelled road machines for all sorts of industrial purposes is to be held in Chicago during the week of February 6 to 11. It will follow immediately after the annual automobile show and will occupy the same building and be conducted by the same management, under the auspices of the National Association of Automobile Manufacturers.

It is estimated that upwards of 200 different models of work vehicles will be displayed, representing a value of more than half a million dollars. In addition the gallery and second floor of the Annex will be filled with 150 industrial display of parts, fittings and supplies pertaining to the motor car.

Power vehicles suitable for almost every kind of industrial and commercial business will be shown, from tricar parcel carriers for the quick delivery service of laundries, haberdashers, boot and shoe stores, confectioners, and other retailers of light goods, to ponderous motor trucks of five tons load capacity or more. There will be light and heavy delivery wagons, express wagons, baggage wagons, mail transfer wagons, light and heavy trucks from one ton capacity up, with open platform, stake, slat and covered bodies. Special forms for unusual purposes will be displayed, such as self-propelled chemical and hose carts for fire fighting, trucks with power winches operated by the motor that propels the vehicle for loading and unloading heavy pieces of machinery and boxes, crates, and barrels; trucks with self-dumping bodies for handling building materials, ashes, etc.; self-discharging coal trucks; patrol wagons, ambulances, sight-seeing cars and motor stages. The commercial motor vehicle represents a new form of transportation that cannot long be ignored by enterprising business men. It is not a mere substitute for the horse, it is a successor to the animal, and has infinitely greater developed and latent possibilities. It is a combined road vehicle and portable power plant.

Water Power Development Investigation.

The following set of resolutions was adopted at the January 12, meeting of the Executive Committee of the N. E. L. A., urging that a joint commission of Congress be appointed at this session to investigate fully the situation pertaining to the public lands of the United States in connection with the development of water powers:

Whereas, the condition of the laws and regulations relating to the public lands of the United States Government is so complicated, unsatisfactory and unsettled that the financing and commercial development of new enterprises in connection with public lands is rendered practically impossible; and

Whereas, the immediate development of the idle water powers of the Nation is of importance to the whole people in that it brings to immediate use an indestructible natural resource that would be otherwise lost or idle and conserves coal, oil, gas and other fuels that are limited in amount and subject to replacement; and

Whereas, the National Electric Light Association is particularly interested in the situation pertaining to public lands of the United States in connection with the development of water powers; and

Whereas, much of the difference of opinion upon the subject of water powers arises from the difficulty of obtaining a clear comprehension of all the facts;

Now, therefore, be it

Resolved: That this Association does respectfully urge that a competent commission, composed of members of the Senate and the House of Representatives of the United States, together with persons familiar with the financial and other practical aspects of the situation, be appointed with full authority to collect the evidence, and for that purpose to hold full and complete open hearings in different sections of the country; and be it further

Resolved: That this Association does respectfully urge that such commission be appointed at as early a date as possible to the end that its meetings may be held between the adjournment of the present session of Congress and the reassembling of the new Congress in the hope that such commission should report upon such reassembling and Congress be thereby enabled to take prompt action in the enactment of such laws as will permit the development of the natural resources of the country in such a manner as shall render them of the greatest possible use to all of the people.

There are already nearly 1,000 central stations in this country using water powers but under the present conditions that have tied up such development, very few new water power plants can be undertaken, and the result is that for lack of such utilization of such water power, the consumption of coal and other fuel goes on at a rapidly increasing rate. It is to relieve this deadlock that Congress is invited to investigate fully at once, all the aspects of the matter with the idea that a great many communities, particularly in the West, which are seeking to enjoy electric light, power and traction, through the development of unused water power sites, may be enabled to gratify their natural wishes in this respect. The amount of coal, oil, gas, etc., now be consumed which would be conserved by hydroelectric development on the largest scale possible literally transcends belief and is almost incalculable.

Cost of Electricity in England for Heating and Cooking.

Electrical power for heating and cooking is sold by the corporation at the following rates: Up to 3,000 units per three minutes, 4 cents per unit of 1,000 watts; over 3,000 and up to 10,000 units, 3 cents per unit; over 10,000 units, 2 cents per 1,000 watts. An alternative method of charging is that of a fixed quarterly payment of 3 per cent on the ratable value of the house, and a charge of 2 cents per unit on each unit as measured by the meter for lighting, power, or heating. The rates for ordinary lighting are much higher.

The electrical supply for residential purposes for the city of Liverpool is controlled by the electrical engineer of the municipal corporation, to whom communications relative to the sale of electrical heating devices should be addressed. The engineer of the city of Birkenhead controls the electrical plants of that municipality.

As charges for electricity for domestic purposes have recently been reduced to 1 cent per Board of Trade unit, it is thought that there will be a growing demand here for electrical devices. The officials of the Bradford electrical department are especially interested to learn of any new devices for electrical cooking and heating. There is a showroom in the department where electrical devices and apparatus are displayed, which offers an excellent opportunity to American manufacturers to send printed matter in regard to their goods or, better still, samples of their devices, which can be demonstrated to the public. Some American firms now have samples of their products on exhibition.

Electric signs are not much in use here, but this is a branch of business that offers a good field for exploitation.

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.

TRANSMISSION LINE LOSSES.

Editor Southern Electrician:

(190) "I would be glad to know how to determine the loss of energy on a transmission line due to leakage. For a particular case, what would be the leakage loss and also the resistance loss of a direct current system where the drop is about 15 volts. The generating voltage being 125. What complications are introduced for an alternating current line." H. A. F.

LAYOUT OF OFFICE LIGHTING.

Editor Southern Electrician:

(191) "Kindly obtain information from the readers of Southern Electrician, having to do with the layout of lighting systems as to an efficient layout for a room 30 feet by 60 feet. This room is used by clerks using flat top desks and by a bookkeeping department using the usual high desks. The walls are cream color and ceilings 12 feet high. The lights are needed only at those times of the year when it becomes dark before 5:30. It is therefore most desirable to have general illumination rather than drop lights. Kindly indicate sizes of units and spacing." W. L. H.

H. P. OF WATER FALLS AND HYDRO-ELECTRIC EQUIPMENT.

Editor Southern Electrician:

(192) "I would be glad to have you request through your columns, information on estimating roughly the horse power of a water-fall. Also upon what basis an estimate can be made of the cost of a development to utilize the horse power in water available. I would request that the information be condensed as much as possible, giving a formula if possible involving few details, as the estimate required need be only approximate." H. M. P.

EFFICIENCY OF ROTARY CONVERTERS.

Editor Southern Electrician:

(193) "You will favor the writer by obtaining information on the following subject from central station engineers having charge of A. C. installations: Is the efficiency of a rotary converter and the necessary transformers at various loads as good as that of a motor generator set of the same capacity when each must be operated on the same voltage and transforming to the same working voltage. Kindly obtain the features of operation best suited to the rotary converter and at what sizes there is a definite difference in favor of either machine. Are there any losses occurring in motor generator sets not present in the rotary converter." H. L. W.

TELEPHONE TROUBLE.

Editor Southern Electrician:

(194) "The telephone at my residence is supposed to be installed on a common battery system, with selective signal and party line. At the present time there is no party B connected, yet the ringer at my station sounds when our number is not called. The line upon test is said to be clear and the circuit is not particularly noisy. Parties say they have difficulty in calling and getting number, operator giving report that party is busy or won't answer. The instrument is used very little and some one is always present to attend to calls. Where can the trouble be?" D. H. B.

A. C. MOTOR DESIGN.

Editor Southern Electrician:

(195) "Please publish the following request for information: I desire to design a motor to be operated on alternating current 220 volts, 60 cycles on a circuit which has a meter installed marked 5 amperes, current being used for lights. I will require a motor of about one horse power of simple design to drive light lathes, and would rather build it than purchase it, in order to get some experience from the work. Is it possible to build a bi-polar machine with drum armature built up of sheet iron and with a cast iron field magnet, base, etc.? Kindly furnish size of armature diameter and length, number and size of slots, best proportion of field magnets, and size of poles? What should be commutator size how should field and armature be wound and connected, the size of wire and length to use? Would a starting box be necessary and if so would a plain coil with iron wire work? What would be length of wire and size required? How about the fuses of such a small motor on the circuit?" J. M. M.

CONNECTION TO MAGNETO AND COMMON BATTERY LINES.

Editor Southern Electrician:

(196) "I would be glad if you would publish in your columns a circuit by means of which I may connect a single telephone to either a magneto or common battery line using a switch or other means for making the shift. The circuits and induction coils are not of the same size and the general arrangement is different in the two telephones. The common battery instrument is of the type used on the Bell lines." S. O. L.

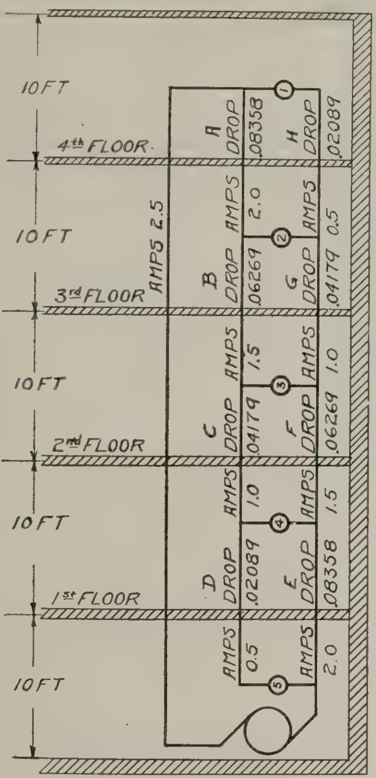
Discussion on Question No. 158.

Editor Southern Electrician:

"I note with pleasure the comments on my answer to Question No. 158 by E. J. Mora in your January issue. The brief answer which I gave to the question was simply an explanation of the equal voltage circuit referred to, more often called the loop circuit or the Wiedemann system of wiring.

"Mr. Mora is perfectly right in questioning my statement interpreted literally, that in such systems each lamp has exactly the same drop, the words, practically the same drop, should have been inserted and further the qualification, on circuits where the lamps are equally spaced.

"It is my belief that in attempting to correct the misleading statement above referred to, he has so exaggerated the actual conditions in such a circuit as he explained that the disadvantages of such circuits are unduly emphasized. For the information of other readers, I have computed the actual drop for the lamps on a circuit such as Mr. Mora gave. It is well known that the loop is usually modified when installed in those places where the lamps are some distance apart by increasing the size of wire according to the scheme presented by Mr. Mora, in which case the system is called the conical loop system.



Loop Lighting Circuit.

"The loop system is a very good way to equalize the loss at each lamp and enable an arrangement such that each lamp is equally distant from the source of supply. The line resistance for each is the same, which in most cases where such system is used composes the largest portion of the drop.

"A practical application of this system for purposes of illustration, is a circuit for the winding stairway of a building. In this case it is desirous to have lamps burn on a separate circuit and all at equal candle power if possible. Referring to Fig. 1, the layout will be readily seen.

"For 5 carbon lamps of 16 candle power in multiple on the circuit, the current demand on the generator is 2.5 amperes. Allowing a voltage drop of one volt, the size of wire required is obtained as follows:

Cir. Mills$=(10.8\times 2d\times n\times c)/v$

d=length wire in feet one side of circuit

n=number of lamps

c=current in amps per lamp

v=volts loss in line

Cir. Mills$=(10.8\times 90\times 5+.5)/1$

$=2430$

=No. 16 B . & S. wire.

"The resistance per 1,000 ft. of No. 16 B. & S. wire is 4.179 ohms. For the 10 feet lengths between lamps, it would be therefore .04179 ohms. Since the line resistance for each lamp is the same the drop of each lamp circuit will only be considered.

LAMPS.	CIRCUIT.	DROP OF LAMP.
1	E F G H	.20895
2	A F G H	.27164
3	A B G H	.29254
4	A B C H	.27164
5	A B C D	.20895

"The largest drop is found at lamp 3, which is a variation of .09 volts over the end lamps or an amount which could scarcely be noticed in the candle power of the lamps. For all practical purposes the voltage drops on such a circuit at each lamp therefore can be said to be equal."

H. F. Patton.

Remarks on Questions Nos. 167 and 179.

Editor Southern Electrician:

"On looking over Mr. G. I. Morgan's answer to question No. 167 in the December issue and Mr. H. H. Boyle's answer to question No. 159 in the October issue, showing connections for testing 3 wire circuits for grounds, I should suggest that a single pole double throw switch, of perhaps 15 amperes capacity, be used in place of the plugs 2 and 3 shown in Mr. Morgan's diagram, for the reason that if plugs 2 and 3 should be inserted at the same time there would be a short circuit the same as if both switches were closed at the same time as shown in Mr. Boyles' diagram. I should suggest connections as shown in diagram No. 1 when using this kind of a ground detector. By using these connections it is impossible to get a short circuit by closing either of the switches.

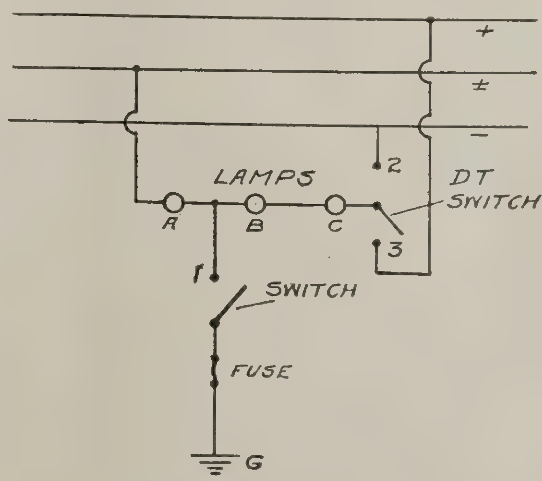


Fig. 1. Ground Detector Diagram.

"To operate, leave switch No. 1 closed throughout test. If on closing, switch No. 1 A burns there is a ground on the positive or negative wire. To determine which, close double throw switch in position 2 and if lamps B and C burn the ground is on the positive wire, if not close switch in position 3 when a ground on the negative wire will be indicated by lamps B and C burning. If the neutral wire is grounded lamp A will not burn but B and C will burn dimly when the double throw switch is closed in either direction.

"This method will only indicate when there is a very heavy ground amounting almost to a short circuit between the defective wire and the ground and for this reason a volt meter test is much more accurate, the simplest connections for which are shown in diagram 2. The volt-meter should have a reading equal to the voltage between the two outside wires or the highest possible voltage that can be thrown on the volt meter. The volt-meter may be mounted in any convenient place. The two flexible cords with plugs or clips a and b attached should be long enough to connect with posts 1, 2, 3 or 4. To operate, connect terminal a or b to post 4 and touch the free terminal to posts 1, 2, and 3. If the volt-meter shows no indication, there is no ground. If the circuit being tested is D. C. and the volt-meter reads backwards, the terminal a or b connected to post 4 should be exchanged.

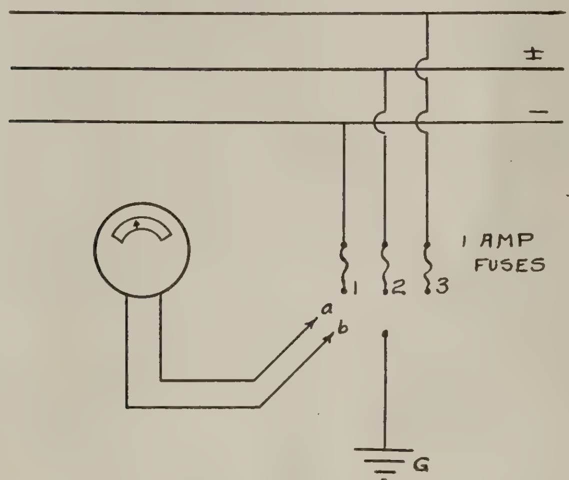


Fig. 2. Voltmeter Ground Detector Diagram.

"Let us assume we are testing a 220 volt 3 wire circuit and there is a ground of practically no resistance on the negative side of the circuit. Then when we touch the free terminal a or b to post 1 the volt-meter will show no reading; when post 2 is touched we shall have a reading of 110 volts and 220 when 3 is touched.

"If the neutral wire is grounded, posts 1 and 3 will show a 110 volt reading while 2 shows nothing. If the positive wire is grounded 1 will show 220 volts, 2—110 volts and 3 nothing. If the ground has a higher resistance the volt-meter readings will be correspondingly less, but there will be some deflection of the voltmeter needle even on a very slight ground. A volt-meter of high resistance will give readings on a ground of higher resistance and is the best to use for these tests.

OPERATION OF ROTARY CONDENSERS.

"In answer to question No. 179 in the December issue, synchronous motors or generators are sometimes called Rotary Condensers when they run light, that is where they are used only to supply wattless currents. They are also called Dynamic Condensers and Synchronous Compensators. They are used to produce wattless currents which compensate for the reactive lagging currents of induction motors and by varying the excitation of their fields the power factor may be varied and brought to unity provided that the condenser is of the proper capacity.

"If the transmission system has a lagging current due to an inductive load such as induction motors, etc., with the resulting low power factor, a synchronous condenser may be installed in the circuit and by over exciting its fields will produce leading currents that will neutralize the lagging currents, give a unity power factor and increase the capacity of the generating and transmission equipment."

H. M. Beal.

Answer to Question No. 181.

Editor Southern Electrician:

"As to the transformer referred to in Question 181 of the December issue of Southern Electrician, after testing it as per your diagram and finding that both coils tested out the same as to volts drop amperes etc., and there being no ground to case, I decided to look elsewhere for my trouble. I finally located it, not in the coils but under the terminal board. During a storm we had just prior to my inquiry about the trouble with the transformer, water was blown in under the porcelain terminal board and whenever the current was turned on arcing would take place from one leg to the other and blow fuses. After thoroughly drying the under side of the terminal board and putting in new mica, I put the transformer in circuit again and it has been in continuous service ever since."

Thomas C. Metcalfe.

Answer to Question No. 184.

Editor Southern Electrician:

"In reading the January number, question No. 184 by "W. E. D." was noted. As a general proposition, the answer to any question may be said to be proportional in exactness as the data submitted. "W. E. D." failed to give some of the pertinent facts necessary to a full and complete answer. Size of motors and efficiencies, transformers and efficiencies, cross section of existing line, hours of operation, cost of current, interest and depreciation are important data in determinations of this nature.

"However, certain assumptions, as below, may be made and tentative results obtained. Let us assume,

Average efficiencies of motors, 86 per cent.
Average power factor, 85 per cent.
Transformer efficiencies, 98 per cent.
Loss in motor wiring, 2 per cent.
Transmission loss (base), 5 per cent.

"Then on the above basis we have as follows:

Power delivered by motors, 186.500 K. W.
Power delivered to motors, 216.800 K. W.
Power delivered at "Cut In," 221.285 K. W.
Power delivered to transformers, 225.801 K. W.

"For illustration, assume that the question is one of transmitting power by either a 2200 volt or a 440 volt line, a distance of one-half mile, and draw conclusions later. First, consider the delivery of 225.801 K. W. to the transformers with a line loss equal to 5 per cent. of the power delivered. Calculations for this call for 35,325 C. M. per conductor, 3 wire and 3 phase. As this is between a No. 5 and a No. 4 B. & S., select a No. 4. Using No. 4 the loss will be 4.23 per cent. of the power delivered, or 9.55 K. W.

"Now in case of the 440 volt line the power would be delivered directly to the "cut in" and this we have found to be, 221.285 K. W. Basing on a loss in this line equal to that of the 2200 volt line plus loss in transformers, we have 14.067 K. W. which is therefore 6.35 per cent. of delivered power. The calculations for this call for 696,873 C. M. per conductor, 3 wire, 3 phase. Select a standard size or 700,000 C. M. The distance being 2640 feet, the total wire in either case will equal 7920 feet. At 15 per cent. per pound, the copper for the 2200 volt line would cost $194.83 and that for the 440 volt line, $3148.20.

"W. E. D." does not state whether the 440 volt line extends back to the generating station as a low tension line. If it does, it certainly is not less than 2640 feet in length and from the above it is seen that at least 700,000 C. M. must be available for the particular factory installation aside from that necessary for other power served by the line. If, on the other hand, this source of 440 volt power is such that "W. E. D." is assured of maintenance of proper potential, he may run the 500 foot distance with No. 0000 cables. In fact this size is the minimum, according to the Code, for his amperage.

"The cost of the No. 0000 would equal $180.00 or $14.83 less than the copper for the 2200 volt line. And it stands to reason that the cost of pole construction on the 500 foot run will be considerably less than for the 2640 foot run. Therefore, with the present light on the matter, it appears that if the existing 440 volt source is ample, up to within the 500 feet mentioned, it is cheaper to tap to it. But if this line needs an increase in copper to properly meet the factory requirements, the 2200 volt line will be better.

"It is hoped that the above is clear and will assist "W. E. D." in his conclusions. The calculations in this matter will be cheerfully furnished to him, either privately or through this column, as you may deem advisable."

J. N. Eley.

Answer to Question No. 157.

Editor Southern Electrician:

"In looking over the Question and Answer section of your paper for September, I notice that Question 157 has not been referred to. I submit therefore protector troubles that I have experienced.

"During last summer I had a singular and unusual trouble to come under my observation. One of our troublemen was sent out on a crossed Common Battery local line, and traced same to the cut-in at the pole nearest the station. Going to the station protector he removed the fuses to ascertain if the trouble was towards the instrument or back in the cut-in. It appeared to be in the cut-in, but when it was disconnected from the line side of the protector, the line was found to be "O. K." Now here was the puzzling feature of the case, and the troubleman was at his "rows end", for the protector was of the type having two parts to the porcelain base, the only connection between the two being the fuses themselves. As the fuses had as mentioned before, been removed, it was evident the seat of the trouble was in the smaller base of the protector. But, again neither of the terminal nuts were touching any metallic substance, as the ends of the block were removed from the board upon which the protector was mounted, by reason of the extra

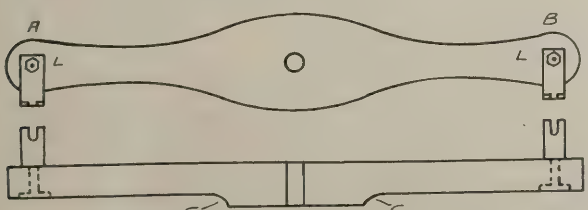


Fig. 1. Protector Porcelain Base.

thickness at C, Fig. 1. Thereupon the block was changed, clearing the trouble, but not fully satisfying the troubleman, who brought it into the office.

"It was taken to the wire-chief's desk where it was connected to the testing circuit of 30 volts, the needle registering a 12 volt cross. Under closest investigation it was found that the real cause of this trouble was that the brass nuts had corroded, under action of the outdoor atmosphere, and the damp solution of same trickled into the holes through the block, where of course it was not glazed, and seeping in the porous porcelain in such a manner that the terminals were connected by a metallic solution, thus explaining the reason of the cross on what was intended for an insulator. An attempt was made to dry out the cross by heating for several days, but without success; the only result being that the voltage of same was slightly reduced.

ANOTHER PROTECTOR TROUBLE.

"A short time after the above trouble one of our troublemen "chased a cross" to the station and when the cut-in was disconnected the line tested clear. But when the cut-in was reconnected and the house wiring disconnected, the

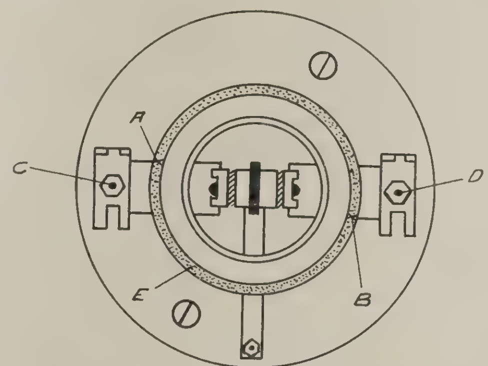


Fig. 2. Another Protector.

trouble was "on" again; this of course located it. The protector was changed and the old one examined closely. The protector was of the carbon block and fuse type, with a brass cap and ring insulated from the line posts, C and D, Fig. 2, by the mica washer E, which in this case was not as large as should be, the ring supporting the cap being in close proximity to the edge of the mica. Now the dampness had caused the brass ring to corrode at the points A, and B, Fig. 2, and connect the line posts through the ring F. This cross read 15½ volts on a 30 volt testing circuit."

L. O. Surles.

Answer to Question No. 185.

Editor Southern Electrician:

"I beg to advise that the author of question 185, has in general the correct idea of the induction generator. When an induction motor is made to operate above synchronism by increasing its speed, the current leads the voltage and we have a leading power factor. When running under these conditions, the primary voltage is not effected materially and the motor has practically the same characteristics as when running below synchronism. An induction motor therefore made to operate under the above conditions is called an induction generator.

"For the benefit of R. C. R. I may add that the advantage of the induction generator is on a circuit carrying an inductive load. It raises the power factor of the circuits due to the fact that its leading current acts against or neutralizes partially the lagging current of the inductive load.

"In regard to its operation as compared with the synchronous motor, as stated by R. C. R., the operation by over-exciting is similar but the induction generator cannot carry a load. This is because the machine is excited from the primary circuit and is a link only in the system on which it is operating and not in the strict sense a generator."

W. S. REID.

Answer to Questions Nos. 177, 184 and 186.

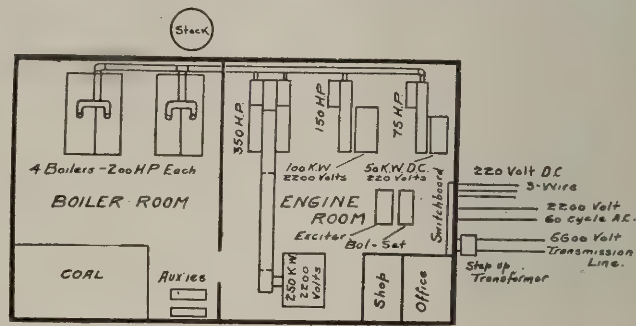
Editor Southern Electrician:

Although the information in question 177 of the December issue was rather brief, I offer the following: The apparatus required for a central station of the size mentioned would depend altogether upon the nature of the load. Assuming that the town is an agricultural center, with a fair sprinkling of manufacturing in the vicinity, I would suggest about 350 K. W. of A. C. and 50 K. W. of D. C. machinery. If the load is largely lighting, two A. C. units should be sufficient for the present, one large enough to carry the evening load alone, if necessary, and the other of a proper size to take the day load without running too light. I would say, one 250 K. W. and one 100 K. W. If the power load is a considerable factor, it would be better to have two larger machines of about equal capacity, and one about half the size of these. This would give additional protection against breakdowns, and permit of using the units fairly well loaded at all times. It would probably be best to generate at 2,200, but if the power load is heavy and some distance away, it would be more economical to step up to about 6,600 or 10,000 for transmission. This is a problem that would have to be figured out, knowing the load and the distance. As for motive power, we can choose steam reciprocating engines, steam turbines, gas engines or oil engines. Here again, local conditions determine the best selection. Where fuel is high, it is of the greater importance to secure the most economical prime mover. For a machine of 200 K. W. or upwards the slow speed Corliss compound condensing engine is the best of the reciprocating type. For the smaller machines, such as 100 K. W. and under, a medium to high speed, compound condensing direct connected unit is compact and efficient.

"The use of steam turbines should also be well considered, as they possess many advantages, among which are low first cost, greater efficiency, small amounts of oil needed, freedom from vibration, and uniformity of rotation, which is especially desirable for operating alternating current generators in parallel. Close regulation is possible, small foundations are required, and condensed steam is free from oil and can be returned to boiler, which is important where bad feed water has to be used. The turbine is also simple, easy to repair, and has a high overload capacity.

"Gas engines should also be considered. They are more efficient than any other type of engine yet produced, except the Diesel oil engine. Gas engines are, however, more complicated than steam, and usually cost more for repairs. They may be regulated fairly closely, but have practically no overload capacity, so that it is necessary to put in a greater aggregate of horseposer than would be the case with steam. Where fuel is high in price, and especially where natural gas can be secured, they are a very valuable type of prime mover. Furthermore, they require no boilers, hence no fireman, and no condensing plant. They require a good deal of water for cooling purposes, but it need not be of good quality.

"In choosing between these various types of engines, we must consider the cost of fuel and the kind available, whether coal, gas, or oil, the cost of land and buildings, space limitations, quantity, quality, and cost of water, price at which power is to be sold, and the load factor.



STATION LAYOUT.

"The sketch shows in a very general way an arrangement for such a plant using steam. There should be about four boilers of 200 H. P. each. Three of these can carry the load, in case one has to be overhauled. The auxiliaries of such a plant such as the boiler feed and circulating pumps are usually run by steam, non-condensing, and the exhaust steam from these used to heat the plant in winter. Since however, these slow speed pumps are very inefficient, there is a tendency to operate these by motors. In this case, a steam pump must also be provided to use in case the main generators are shut down. This will not call for any extra investment, as the boiler feed system should always be in duplicate.

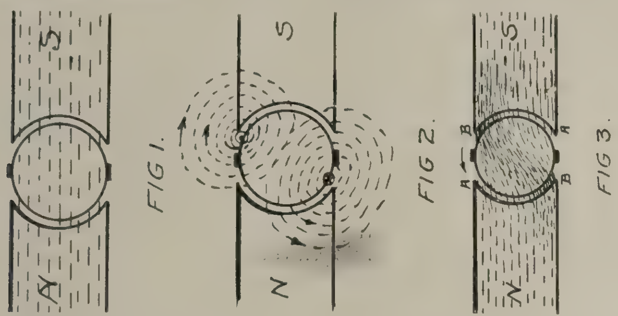
"The A. C. generators will likely have exciters mounted on the shaft. In addition there may be an exciter driven by a small A. C. motor, and switches may be arranged so that the D. C. unit may be temporarily used for exciting. A balancing set should be used in connection with the 220 volt D. C. generator so as to provide for a 3 wire D. C. system, as there will likely be a few small D. C. 110 volt machines to supply.

VOLTAGE FOR SHORT DISTANCES.

"No. 184. Assuming the demand of the factory to be 200 H. P., these motors would take about 440 amperes at 440 volts, or 88 amp. at 2,200 volts. Even with one million circular mil cable the drop at full load would be 22 volts or five per cent. If current cost one cent per K. W. H. this would equal the interest on an inevstment of $4,500, to say nothing of the money tied up in the heavy cable. At the higher voltage a No. 00 wire would carry the load with a drop of only 1.6 per cent. I would therefore recommend the 2,200 volt transmission. Perhaps the 440 volt line could be reconstructed for 2,200 volts, extended to the factory and transformers put in to take care of the present 440 volt business."

COMMUTATION OF INTER-POLE MOTOR.

"No. 186. Fig. 1 shows an armature in a two pole field, the magnetic lines passing straight through. If current is passed through the armature it will create a field of its own, producing a field which opposes in part the main field, and also distorts it. The demagnetizing effect is produced by what are termed back ampere turns, and the distortion by the cross ampere turns. With the armature at rest and the brushes on the neutral position there would be no distortion. With a rotating armature however the field is such as shown in Fig. 2. This field, combined with the main field is shown at Fig. 3, the magnetic field being in-



tensified at BB which are the lagging pole tips, and weakened at AA, the leading pole tips. This distortion produces an increase of the voltage between commutator segments while passing under the brush. With a strong main field this effect is small, but when we weaken the field for purposes of speed control, it becomes very serious, and some means have to be adopted to counteract it. For this purpose the interpoles, which are a modification of the old

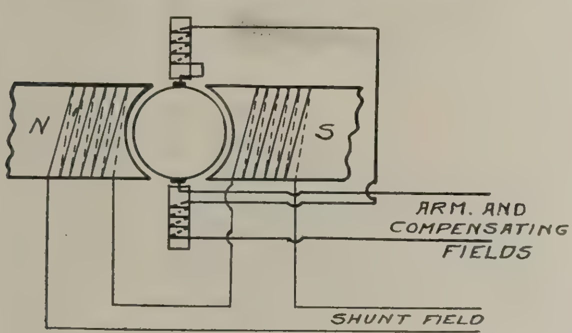


FIG 4.

balancing coils used on the Ryan-Thompson dynamo, are used. These coils are connected in series with the armature and current passing thru the winding neutralizes the cross ampere turns of the armature, correcting the distortion, and enabling the field to be weakened to a point which would not otherwise be possible. The connections of poles are shown in Fig. 4."

A. G. RAKESTRAW.

Answer to Question No. 185.

Editor Southern Electrician:

"In regard to question 185 of the January issue of the SOUTHERN ELECTRICIAN, I wish to say that I have had several months experience operating an inductor generator, which I presume is what R. C. R. is asking about. This machine is a single phase 1,100 volt, or by changing connection can generate 2,200 volt, 110 amp. 133 cycle machine belted to steam engine. The machine is made with one large field coil just the size of the interior of the case and is in the right end of the machine. There is a small field coil, known as the auxiliary which is in the other end, and the rotor is composed of several poles of the same polarity, all positive, the armature coils being connected so as to give the alterations. The magnetic flux from the main field coils flows from the shaft outward and of course there would be a great deal of this flux wasted by going out the shaft and not passing off the poles at the proper place if it were not for the auxilary coil placed around the opposite end of the shaft and connected with the exciter in the reverse direction to the main coil. This throws the would be waste flux, back on to the poles and therefore it is forced to pass off the ends of the poles. The exciter current being connected directly with the two field coils there is no collector ring or brushes to contend with. The machine referred to above was installed in 1906 and is still in operation and seems to be giving fair satisfaction. It gave very little trouble while I was operating the plant but cannot say how it has performed since I left. I hope this will give R. C. R. some desired information." E. M. FOSTER.

Answer to Question No. 171.

Editor Southern Electrician:

"I have noticed and read with interest the remarks of A. G. Rakestraw in the December issue, on Gas vs. Electricity for heating purposes. Since he did not touch upon the comparison of gas and electricity for cooking purposes, I beg to submit something on it. At the present time, the strongest competitor of the gas cook stove is the electric range, and I believe therefore that Mr. Rakestraw's information is incomplete without some reference to the operation of electric and gas stoves applying the heat for cooking and baking.

"With the electric stove energy is sold by the K. W. Hr. read by a meter.

$$1 \text{ K. W. hour} = (1000 \times 33000 \times 60)/(746 \times 778)$$
$$= 3400 \text{ B. T. U. of heat.}$$

"The efficiency of an electric range can be taken as 75 per cent., so that the effective heat for a Kilowatt hour of electrical energy in cooking food is 2560 B. T. U.

"For gas the measurement is also made at the meter. Considering gas to contain 700,000 B. T. U. per 1,000 cubic feet and the efficiency of the gas stove of 15 per cent., we have an effective heat going into the food of 105,000 B. T. U. per 1,000 cubic feet. The efficiency of the gas stove is low on account of the heat consumed by burning the gas and by the ventilating currents.

"Since 105,000 B. T. U. is the effective heat from 1,000 cubic feet of gas, 105,000÷2560=41 K. W. Hrs., the electrical energy equivalent to 1,000 cubic feet of gas. With gas at $1.00 per 1,000 cubic feet, the price of electrical energy would then be 2.42 cents per K. W. Hr.

"When dealing with electrical energy approximately 10 per cent. of the heat in the coal producing it, is delivered to the stove, 75 per cent. of which can be used, or 7.5 per cent. With gas 25 per cent. of the heat in the coal is delivered to the stove, only 15 per cent. of which is effectively used or 3.77 per. cent. It would seen therefore that if 105,000 B. T. U. in the form of gas from coal can be furnished for $1.00, and consumed at so low an efficiency that there is no question but that electrical energy is a competitor on a favorable basis and that the only reason why it has not become generally adopted is that the rates are altogether too high." H. F. BOYLE.

New Apparatus and Appliances.

Hughes Electric Cook Stove.

The day when the electric flatiron was practically the only heating device on the market has passed. A practical electric range is now offered by the Hughes Electric Heating Company of Chicago, which combines the 15 years experience of Geo. A. Hughes as a central station manager, with the long practical experience in electric heating work of T. M. Caven, formerly heating engineer with the General Electric Co., at Pittsfield, Mass.

The designers of the Hughes stove realize that the time has come when the public demand not a stove that would merely toast and do such things as a chafing dish is used for, but that the house wife now requires, so to speak, a universal cooker, giving an abundance of steady heat for all kinds of cooking, baking and other work just as is required of the ordinary kitchen stove. The Hughes stove is strongly made for hard usage, steel body and legs, finished in hard baked black Japan and tastily decorated, easy to keep clean and takes up very little space, it stands in any position and can be moved at will. It insures a maximum of solid comfort, exceptional convenience and real service, and works equally well on either direct or alternating current, and on all commercial voltages up to 220 volts. The heat may be instantly controlled by the operator. One can have a small fire or a large one at will, or both at the same time if desired. The stove is so constructed that by the use of a three heat switch, giving three heats for each burner—low, medium and high. The 1st heat or low consumes 150 watts. 2d heat or medium consumes 300 watts. 3d heat or high consumes 600 watts.

HUGHES ELECTRIC STOVE.

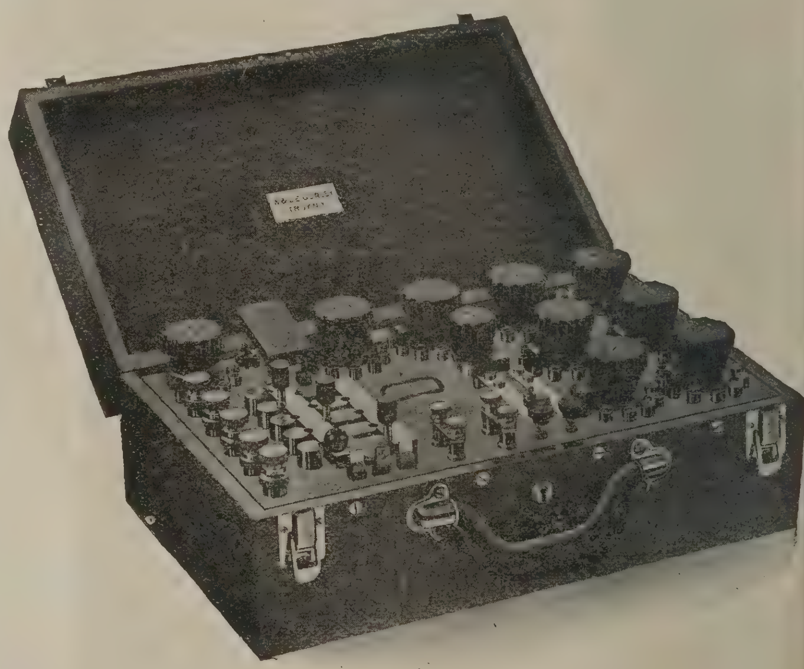
The stove is made in three sizes. One, two or three burners. The one burner is 30 inches high and 14 inches wide. The two burner is 46 inches high and 22 inches wide. Three burner is 46 inches high, 30 inches wide.

A point relative to manufacture that will be of decided interest to the central station man, relates to the heating element proper. The base of the heating element is 8 1-2 inches in diameter and is made of a special composition of the Co.'s manufacture. The wire is a patented alloy and is practically non-oxidizable. It will last indefinitely and is non-corrosive under all conditions of service.

The Hughes Electric Heating Company is also placing on the market a new line of hot plates to meet the demand for a moderate priced stove for all kinds of cooking except baking. The plates resemble the ordinary gas hot plates. The heating units are exactly the same as used in the larger ranges and the plate may be operated on any commercial voltage. The plates are furnished in sizes from one to three burners, trimmed with nickel.

The Friendly Testing Bridge.

The Friendly Testing Bridge is designed and made for the purpose of testing and locating faults on telegraph and telephone lines, electrical conductors, and in electrical apparatus. The bridge is available for the measurement of resistances as a Wheatstone bridge, faults may be located by the Varley or Murray loop methods, or by a new method known as the Friendly Loop.

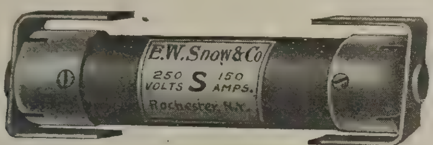


THE FRIENDLY BRIDGE.

The bridge is compact, the construction is solid and substantial, the workmanship is of the highest grade, the resistances are of manganin wound on metal spools and adjusted to an accuracy of 1-10 of one per cent. The metal parts are mounted on a heavy hard rubber top of best quality, the arrangement is convenient for rapid manipulation. Great care has been taken to secure permanency and minimum resistance in the various contacts. A new and ingenious arrangement of the ratio coils has been adopted, permitting unusual ratios, and a new construction for the decade dials maintains low resistance contacts and smoothness of motion with very small wear. This construction allows a continuous motion of rotation in either direction. There are ten units in each decade, an arrangement which makes for quicker manipulation than the usual nine unit decades. The galvanometer is of the moving coil type and is of high sensibility. Provision has been made so that any other galvanometer can be connected, if desired. The cover may be removed entirely and it is provided with dust tight openings, so that the box can be closed and locked without disconnecting the wires leading in. The friendly testing bridge is manufactured by W. & L. E. Gurley, Troy, N. Y.

Refilled Fuses.

A process by which fuses which have been burned out, are refilled and made to serve again, is being successfully used by the E. W. Snow & Co., of Rochester, N. Y. This company advises that it is possible to save by using old fuses, from 30 to 100 per cent. on the actual cost of average size fuses and on some of the larger sizes as high as 150 per cent. All styles of cartridge fuses, large and small, can be refilled and made to do service a second time.



A REFILLED FUSE.

The illustration shown herewith is that of a double knife contact fuse suitable for 250 volts and having a capacity of 150 amperes. This is only one type of fuse which can be refilled by this company, fuse cases of other designs and sizes being refilled with equal efficiency. Where fuses are blown in large quantities, or even in those cases where a few are removed each day, a considerable saving can be effected by collecting these fuses at the end of the month or at some other period of time, refilling them for using again. The process bids fair to be a popular one and it is worth while for those interested to investigate it.

Betts and Betts Sign Flashers.

Flashers are sometimes called upon to make and break circuits carrying a very large load, as in the case of the main circuit on a large sign. There being no inductance in the sign circuit the make is accompanied by a rush of current practically equal to the full load value. During the first instant the current must pass between the brush and the edge of the commutator, and increasing the size does little to protect the commutator edge and the brushes from damage. Due to this action the commutator becomes pitted and ragged on the edge, so that the lamps will flicker unsteadily instead of coming up with a flash to full brilliancy.

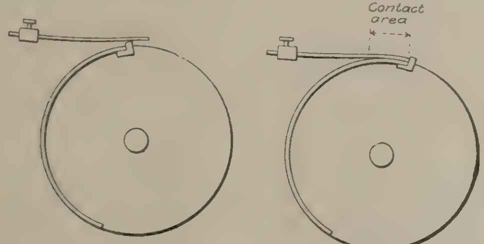


FIG. 1. COMMUTATOR DIAGRAM.

A device has recently been devised by Betts & Betts, New York, which furnishes a simple means of removing the limitation of the initial contact. By providing the leading edge of the commutator with an insulating block, suggestively called the "Noark Picup" as shown in Figs. 1 and 2, the brush is held completely away from contact until it comes to such a position that it will drop directly on the commutator, making the full and maximum contact area available at the first instant. It can readily be seen that this contact area can be so designed as to give the proper current density.

This company also manufactures high speed and combination flashes suitable for use with various designs and for various effects.

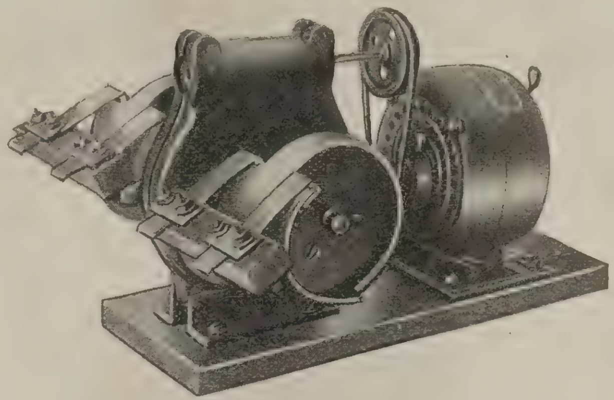


FIG. 2. DOUBLE POLE FLASHER.

An arrangement for giving color effects in electric signs is the color cap, socalled. The color cap is a specially designed cap so arranged that it can be adjusted to an ordinary incandescent lamp and give a color to the light according to the color of the cap. It also acts as a reflector throwing back white light on the background thus diffusing it in a proper manner. It is claimed that the color caps are a great saving over the colored lamps and are also more economical of light in that the intensity is not appreciably lowered. They are used extensively on the large signs of New York City and furnished by Betts & Betts Company.

Alternating Current Speed Regulators and Controllers.

Along with other alternating current devices, the Cutler-Hammer Manufacturing Company of Milwaukee, has recently introduced standard lines of speed regulators and controllers for use with slip ring induction motors. The face plate type speed regulator is illustrated in Fig. 1, and is made in several styles and in sizes of one-fourth to one-

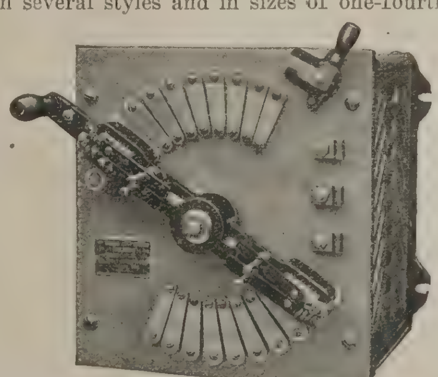


FIG. 1. FACE PLATE TYPE SPEED REGULATOR.

half horse power up to 50 horse power. The resistance is self-contained and is connected when installed, in the secondary circuit. The segments are of hard drawn copper, readily replaced or interchanged without interference with the connections inside. The three sets of resistances are delta connected so that equal amounts are inserted in the three phases of the secondary insuring a balanced condition. This is very important as the maximum output of the motor can be seriously effected by unbalanced current or voltages in the legs of the motor.

Another precaution is using German silver wire for the small regulators. This insures accurate speed control with no speed variations due to heat, the German silver wire having practically a zero temperature coefficient. The standard apparatus is designed to reduce the speed 50 per cent. at full load.

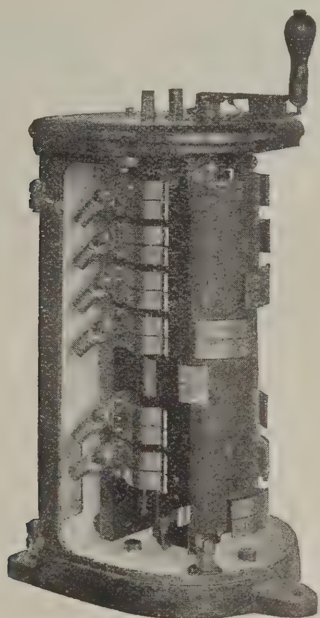


FIG. 2. DRUM TYPE CONTROLLER.

For polyphase motors operating printing presses, machine tools, etc., where it is desired to have convenient speed regulation and a ready means of reversing the motor, the Cutler-Hammer drum type controller, illustrated, Fig. 2 represents an accurate device. The standard controllers are made in capacities of one horsepower to seven and one-half horse power. The speed reduction is secured through resistance placed in the three phases of the secondary or rotor circuit, thus maintaining an electrical balance at all times, permitting of most efficient motor operation. A 60 per cent. speed reduction is possible in standard apparatus, while greater reduction can be provided with slight changes.

New Pendant Switch.

A new pendant switch shown in accompanying cut has recently been placed on the market by the Eclipse Electric Arc Light Company, of 13 East 30th street, New York. The chief object of this switch is to insure an instantaneous make-and-break, and to provide in a simple manner for the locking of a switch blade into contact jaws with one quick clean stroke of the hammer. To accomplish this result, a novel employment of a toggle is used, and a hammer blow is struck at the knuckle of the toggle causing instantaneous movement of the switch blade from one position to the other.

Tandem push buttons are also employed for breaking the toggle. As soon as the toggle has been broken, that is, forced slightly to the right of the dead center position, the tension of the springs causes the toggle knuckle to snap to the right. Another important and essential feature said to be embodied in this switch, is the method in which all strain is removed from the binding screws. It is accomplished by means of two small grips, around which the cord passes before it is connected to the posts or set screws.

Grand Prix for Western Electric Co.

The Bell Telephone Manufacturing Company of Antwerp, Belgium, one of the European houses of the Western Electric Company, was awarded the Grand Prix for its exhibit in the class of Electrical Apparatus and Appliances at the International Exposition recently held at Brussels, Belgium. This company is the pioneer telephone manufacturer of Belgium, having entered the field in 1882, only

WESTERN ELECTRIC EXHIBIT AT BRUSSELS.

six years after the invention of the telephone. It is largely due to the efforts of the Bell Telephone Manufacturing Company and the other European houses of the Western Electric Company that efficient telephone apparatus developed along American lines has become generally used in Europe.

At the exposition this Company occupied a large space in the Belgian section, being located next to the exhibit of the Telegraph and Telephone Department of the Belgian Government, whose requirements it has filled from the beginning. The exhibit, a photograph of which is shown on this page, included many types of apparatus manufactured at the Antwerp factory. Among these were telephone sets of many descriptions, small type switchboards, as well as a large common battery exchange in complete working order with its necessary power plant, frames and racks. Other apparatus required for making up a complete installation of a telephone exchange was shown.

Philips Automatic Grinder for Commutators.

There are two methods now recognized in the truing of commutators. The tool and slid-rest has been long in use and supplemented by the stone and sand paper is familiar to everybody who has anything to do with commutators. The cutting tool possesses certain recognized defects and must therefore be supplemented by a very constant use of stone or sand paper, and it is well known that these only exaggerate flats. Grinding is the only present alternative to the cutting tool. Grinding by means of two revolving surfaces is almost the only way of securing a perfect periphery. In the case of the commutator the mica bars are of necessity ground to an even surface with the copper bars. There is no breaking or tearing of the mica and no dragging of the copper. The cutting wheel runs at such high speed as to make a perfectly clean cut of both mica and copper. It is only necessary to build a cutting wheel that will not fill with copper and that will afford the required cutting efficiency. The only serious objection to grinding that one hears from engineers is the copper and mica dust thrown off in grinding.

The Phillips automatic grinder has demonstrated that it is possible to build a machine that will overcome all the objections to the tool and slid-rest mentioned above. This machine which is easily attached to almost every type of commutator and which is simple in operation, gives the perfect periphery desired and a finish like glass, without the wasteful cutting of the tool. This device trues the commutator at its normal speed, and therefore, leaves it true in service; while the cutting-tool working with the commutator at slow speed will leave it appreciably out of true, in most cases, when in service. The machine is self-contained, that is, it derives the driving power from the commutator itself, by an ingenious device covered by patents. No separate motor is needed to drive it. Particular attention has been given to the dust problem and a dust catcher is provided which meets this objection. This device is made by the Phillips Mfg. Co., 60 Wall St., New York, and shown on the front page of this issue.

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.

COLLINSVILLE. The Peoples Ice & Light Co., has been incorporated with a capital stock of $50,000. The directors are J. H. Middleton, H. D. Bondollar, C. Goodale and C. T. McCarty.

BIRMINGHAM. A steel frame, sixtten-story building, 50 x 125 feet to cost approximately $500,000 is proposed for Birmingham. The building will be the new quarters of the American Trust & Savings Bank on its present site at the corner of 20th St. and First Ave. The building committee consists of W. H. Kettig, J. W. McQueen and Morris Bush.

BIRMINGHAM. A steel frame, sixteen-story building, turing Co., has been incorporated with a capital stock of $10,000. The company will do general merchandizing business in gas and electric fixtures. W. S. Isherwood is president.

MONTGOMERY. It is recently stated that the Citizens Light, Heat and Power Co., of Montgomery have decided to install additional generating units at their plant sufficient to increase the capacity from 1,000 kilowatt to 7,500 kilowatt. It is probable that steam turbines will be installed as prime movers and other auxiliary apparatus.

MONTGOMERY. The Dixie Electric Co. has recently been incorporated with a capital stock of $12,000 by Charles M. Jones, H. Owens and W. H. Crompt. The company proposes to manufacture and handle electrical supplies.

MONTGOMERY. The Montgomery Light and Water Power Co. will increase the capacity of its hydraulic station at Tallassee, Ala., consderably. The station has a present capacity of 3,500 to 4,000 kilowatt and the new units which are to be installed will increase the output to 10,000 kilowatt.

SAYRE. The Sayre Mining & Manufacturing Co. is to erect an electric power plant and make other extensive improvements during the year.

WETUMPKA. The Alabama Electric Co. has been organized for the purpose of building a hydro-electric plant at Wetumpka to furnish industrial power and lighting service to the section. T. J. Carling and H. Horne of Macon, Ga., are interested.

Florida.

FORT LAUDERDALE. It is understood that plans are underway for the construction of an electric light and power plant in the near future. It is said that the necessary capital of $25,000 has been subscribed and that the parties are now looking for a suitable site for the plant.

JACKSONVILLE. The city of Jacksonville took over the lighting business of the Jacksonville Electric Co., on January 18th. This company has recently been granted a franchise to use the streets for the operation of a street car system. It is further understood that arrangements are underway by which the Jacksonville Electric Co., will install a large new generating system and replace its present equipment with additional units.

ST. PETERSBURG. Manager Fuller of the St. Petersburg Investment Co., has made known the extensive improvements which will be made to the plant in the near future.

ST. PETERSBURG. The city has under consideration the construction of an electric light system. Further information can be obtained from the city officials.

Georgia.

ALBANY. At a special meeting of the city council recently held, a definite proposition for the street railway franchise was presented by the citizens who are interested in organizing a street railway company. Those interested in the proposition are C. W. Rawson and S. W. Brown.

AUGUSTA. Recent reports state that the Augusta-Aiken Railway and Electric Co., is to install generating equipment of approximate 3,600 horsepower.

CARTERSVILLE. It is understood that the Municipal Power Plant will add generating units sufficient to carry a commercial day load.

DAHLONEGA. It is understood that the Cedarman Land Co. is to install an electric plant. H. R. Robertson, Candler Bldg., Atlanta, Ga., is secretary of the company.

DALTON. Mayor Crannell has been authorized to secure options for a sight for the removal of the waterworks plant. The waterworks and electric light plant will be located on the same ground and equipment will be installed sufficient for carrying a day load. The plants are expected to be in operation by July 1st.

EAST POINT. The Atlanta Utility Works of East Point is said to be in the market for one 5 and three 10 and 120-horsepower induction motors, 220 volts, 60 cycle. Further information can be obtained from W. W. Rushton, Sec. and Treas. of the company.

FAIRBURN. An election will soon be held to decide upon the issuing of $14,000 in bonds, the proceeds to be used for the installation of an electric light plant.

FORT SCREVEN. It is understood that bids are out for the construction and installation of an electric lighting system for Fort Screven, Ga. Further information can be obtained from the office of the constructing quartermaster.

MACON. The progress on the dam of the Central of Georgia Power Co. which is being constructed near Jackson is progressing rapidly. The dam is estimated to furnish 6,000 horsepower to Macon, operating a large number of mills and manufacturing plants. Power will also be supplied to Griffin, Barnesville, Forsyth and Monticello, and will be used for lighting purposes in all these towns. There will still be sufficient power left to operate an interurban railway line and it is now understood that the railway project will soon be undertaken. Permission has already been secured from the State for laying a line from Macon to Atlanta.

MILLEDGEVILLE.—Bids will be received at the supervising architect's office, treasury department, Washington, D. C., until Feb. 8, 1911, for the construtcion of the U. S. Post Office at Milledgeville, Ga. The equipment to be secured includes the plumbing, gas piping, heating apparatus, electric conduit and wiring.

Kentucky.

BOWLING GREEN. Bids are out for the construction and equipment of the U. S. Post Office and Court House at Bowling Green, Ky. The bids will be received by the supervising architect, treasury department, Washington, D. C., and should cover the plumbing, gas piping, heating apparatus, electric conduit and wiring.

FRANKFORT. A franchise has been granted by the city council to E. M. Wallace, Manager of the Capital Lumber Co. The purpose is to construct and operate an electric light plant at Frankfort, Ky.

LOUISVILLE. The Citizens Telephone Co. has been incorporated with a capital stock of $3,000. E. W. Elliott, J. C. Bruce and J. G. Corman are interested.

LOUISVILLE. At the recent annual meeting of the stockholders of the Kentucky Electric Co. it was voted to reincorporate and increase the capital stock from $600,000 to $3,000,000. The purpose of this arrangement is to make possible additions and extensions to the plant and properties of the company. The contracts for the construction of a new plant will be let at once. R. E. Hughes is president of the company. Engineers of Chicago have been employed to consult with the companies chief engineer L. S. Strang in the construction of the new plant. Steam turbines connected to high voltage generators will be installed and provision made for a steam heating system for the business section.

RICHMOND. The Richmond Electric & Power Co. has increased their capital stock to $90,000. J. H. Dean and Al. D. Hemington are interested in the company.

Louisiana.

ALEXANDRIA. It is understood that the city of Alexandria is contemplating the purchase of the Alexandria Electric Street Railway Co. If this is accomplished the plant will probably be operated in connection with the Municipal Electric Light and Power Plant.

CROWLEY. It is reported that the city is trying to increase the capacity of its power plant by the addition of two engine-driven electric generators of 300 kilowatt capacity each.

OPELOUSAS. According to reports the city will make improvements to electric light plant to install additional equipment. The superintendent, A. R. Masdurio, can give other information.

MANSFIELD. Improvements and extensions to the local system are proposed by the Southern Telephone Co. The expenditures will be approximately $10,000.

SHREVEPORT. The Commercial National Bank has had plans prepared by G. R. Mann and will soon let the contract for the erection of a ten-story bank building to cost approximately $350,000. The building will be equipped for gas and electric lighting.

SHREVEPORT. A committee has been appointed to communicate with engineers and ascertain the cost of a municipal electric plant. W. K. Henderson, of the manufacturers' committee of the chamber of commerce, can give further information.

VIVIAN. The Arkansas Natural Gas Co. is to build in the vicinity of Vivian a power and pumping plant of large capacity. It is proposed to lay supply pipe lines to Little Rock and other places in Arkansas.

Mississippi.

FORT GIBSON. A small power and lighting plant to serve the local community is understood to be the plans of M. E. Melvin.

GULFPORT. It is understood that the Gulfport and Mississippi Coast Traction Co. is to make extensions to their power system.

HAZLEHURST. It is understood that the Hazlehurst Brick Mfg. Co. are to purchase equipment for a power plant.

TUBELO. The city has under consideration the issue of bonds for the purpose of changing the system of the electrical equipmetn from direct to alternating current. The mayor can give any further information.

Missouri.

FORSYTH. An electrical power plant three miles from Forsyth to develop approximately 2,500 H. P. and transmit to Forsyth and Springfield, Mo., are the plans of J. A. Laird, of St. Louis, Mo. The cost of the plant is estimated at $300,000.

GLASCOW. Bond issue of $30,000 has been granted for the construction of an electric light plant sewerage system and water works. City officials can give any information.

LEE SUMMIT. The Lee Summit Light, Power, Ice & Storage Co. has been incorporated with a capital of $20,000 by C. N. Hanks, L. M. Morris, J. H. Cook, and others.

MARIONVILLE. An electric light plant and pumping station for municipal use is under consideration by authorities at this place.

MOBERLY. An electric light plant is contemplated by the city. The engineers in charge are L. G. Knapp & Co., Kansas City.

OREGON. Prices on the following equipment for the municipal water and light plant will be received by the city of Oregon. One direct connected unit of 120 H. P. to 150 H. P. engine and a 2,200 volt 60 cycle alternator; one 150 H. P. high pressure boiler and accessories. N. R. Martin, superintendent of the plant, can give further information.

PALMYRA. The city council has granted a franchise to the Hamilton & Northern Missouri Railway Co. to construct an electric railroad.

SPRINGFIELD. A water power plant on the White River to cost approximately $1,000,000 is the plans of capitalists at Springfield. It is understood that H. M. Smith, C. H. Cole, and J. F. David, of Springfield, and A. J. Zwart, of St. Louis, are interested.

ST. LOUIS. The Ozark Power & Water Co. has been incorporated with a capital stock of $5,000 by R. W. Morrison, C. E. Burg, and Frank Mottbusch.

North Carolina.

CHARLOTTE. D. B. Bradley, formerly with the Globe Electric Co., has severed connections and established in the electrical contracting business. He is prepared for an extensive business in Charlotte.

CHARLOTTE. It is understood that a bill has been presented to the legislature providing for a million dollar bond issue for the erection of an administration building on the capitol square at Raleigh.

DILLISBORO. According to recent reports, C. J. Harris is to operate a leather factory at Dillisboro, which will be equipped for electric driving and for electric lighting.

HICKORY. Connell & Connell, of New York City, have been engaged as chief engineers for the construction of a water power electric plant for the Water Power Electric Co. Louis R. Abel, of New York, is the resident engineer at Hickory. The development is planned to be approximately 10,000 H. P.

JOHNS STATION. A company which is known as John T. John Co., is incorporated with $125,000 capital stock. J. T. Johns, W. A. McCoy, F. A. Kendall, and R. F. Stewart are the incorporators.

PLYMOUTH. The Plymouth Light & Ice Co. has been chartered with a capital stock of $25,000 by A. L. Owens, C. Latham, and C. L. Owens.

RALEIGH. The Sedge Garden Telephone Co., of Kernersville, has been incorporated with a capital of $10,000 by G. A. Smith and others.

RIDGEWAY. The N. C. Virginia Railway Co. has been chartered with a maximum capital stock of $6,000 to construct a six mile railway from Ridgeway to North Carolina State line. E. C. Wing, of New York City, is president, and G. Damarest, of Brooklyn, N. Y., secretary and treasurer.

SMITHFIELD. The city has engaged engineers to plan an electric light plant and sewer system. The present water works system will be improved by the installation of a pumping plant.

Oklahoma.

HOLLIS. Marryman & Prim have prepared plans for Jones & Pendergraft for the erection of a two-story reinforced concrete building to cost $10,000. The building will be equipped for electric lighting.

DUNCAN. During February an election is to be held to vote on a bond issue for a water works system and pumping plant.

MANGUM. A company has been incorporated known as the Mangum Electric Co. for $20,000, the purpose being to install and operate a public service plant.

MOUNTAIN VIEW. The Western Power & Irrigation Co. has been recently incorporated with a capital stock of $500,000 and proposes to develop water power. According to present plans a plant will be erected on the Washita River and a plant of approximately 650 H. P. constructed and equipped. It is understood that T. C. Berryman is president of the company.

OKLAHOMA CITY. The Oklahoma Railway Co. is to install a new turbine unit of 2,000 K. W. capacity in their main generating station. New sub-station equipment will also be added. Recommendations have been approved for the installation of pumping and water distribution systems at Oklahoma City. A bond issue of $125,000 is to be voted on at an early election.

STILLWELL. Bonds have been recently voted to the extent of $5,000 for the construction of an electric light plant for the city. It is understood that the Southwestern Engineering Co., of Oklahoma City, Okla., have been awarded the contract for the construction of the plant.

TULSA. It is understood that steam generating sets of 1,000 K. W. capacity will be installed in the plant soon to be erected by the Tulsa corporation.

South Carolina.

AIKEN. Plans are being drawn for the additional equipment to the water works station at Aiken. It is understood that the equipment will consist of a Corliss engine and two simplex pumps.

CHARLESTON. The city council is having preliminary plans and estimates prepared for a new electric power and pumping plant to serve the city.

GREENSBORO. The Marion Motor Southern Co. has been incorporated by H. L. Hopkins and A. Fair Bros. The company is capitalized at $25,000, and supposed to manufacture motors, power generators of various kinds for carriages, wagons, boats, etc.

GREENVILLE. The Atlantic Electric Co. has recently been organized with a capital of $10,000 by D. A. Henning, Jr., H. L. Fuller and E. C. DeBruhl. It is understood that the purpose of the organization is to carry on an electrical supply business of considerable extent, including a stock of electrical supplies and embracing jobbing retail and construction features.

GREENVILLE. The Gates Hotel Co., with a capital stock of $20,000, has been incorporated. The company will erect a hotel in the city of Greenville. Those interested are A. A. Gates, A. M. Gates, and J. A. McCullough.

KINGSTREE. The municipal authorities at Kingstree have engaged J. N. Johnson, city engineer of Florence, S. C., to estimate cost and submit plans for a water works system.

Tennessee.

BRISTOL. Prof. L. S. Randolph, of the Virginia Polytechnic Institute of Blacksburg, Va., has been retained as engineer to report on a hydro-electric plant in East Tennessee near Bristol.

CHATTANOOGA. The Chattanooga Armature Works has recently completed plans for a large work shop building which will considerably extend the facilities of the company for carrying on their electrical enterprise.

JACKSON. The Citizens Electric Light & Power Co. has been incorporated with a capita lstock of $1,500. The incorporators are T. E. Mercer, M. B. Mulhron, J. M. Justice, and W. Ragland.

MANCHESTER. An electric light plant and water works system is being considered by the city. It is understood that W. P. Hickerson is interested in the project and can give information.

MARYVILLE. A franchise has been granted to the Tellico Power Co., Monroe county, giving it the right to locate lines for the transmission of power from a proposed plant soon to be erected.

MEMPHIS. The Tennessee Traction Co. is making arrangements for the construction of a new electric road. The general manager of the company is G. E. Bushnell.

MEMPHIS. It is understood that a plant is under construction to furnish electrical energy and lighting to the court house. The cost of such a plant will be approximately $10,000, and G. B. Coleman, who is chairman of the committee, can give other information.

Texas.

BATESVILLE. If the plans of the Uvalde and Leon Valley Interurban Railway Co. materialize, an extension of their road to Batesville, a distance of about 25 miles, will be the result. According to present plans the extension will be operated by electrical power and a power plant erected.

CELINA. The Celina Electric Light & Power Co. has been incorporated with a capital stock of $5,000. W. T. Bryan, N. A. Langham, and U. L. Patricks are interested.

CRYSTAL CITY. A furniture factory is to be constructed at this place by E. S. Link. It is understood from the present arrangements that there will be installed at the factory an electric power plant sufficient to furnish not only power for operating the factory, but for irrigation pumping purposes in the section.

FORT WORTH. The city has recently voted an issue of $50,000 in bonds for improvements to the electric light plant. The city engineer, J. D. Trammell, can give other information.

GEORGETOWN. The Electric Light Plant and Water Works has been purchased by the city at $13,000. It is understood that $32,000 approximately will be expended for improvements in the near future. Other information can be obtained from the mayor.

KYLE. A permanent organization has been effected by the stockholders of the Kyle Telephone Co. The directors are G. G. Johnson and R. W. Wood, of San Markus, C. L. Herdenreich, P. Allen, T. F. Harwell, of Kyle. The capital stock will be $5,000 and the charter will be procured at once. The company begins its business with the new plant everything in good condition and a large list of subscribers.

LOMETA. The water and light plant at Lometa, which was owned by E. R. Goodson, has recently been purchased by J. E. Baker, of Killeen, Texas. It is reported that enlargements and extensive improvements will be made.

MARFA. A complete gas engine equipment is to be installed by the Marfa Electric Light & Ice Co.

Virginia.

LYNCHBURG. A new $300,000 hotel is to be built on the present site of the Arlington. The committee having the project in charge is composed of J. W. Craddock, J. P. Pettijohn and James R. Gillian.

MARTINSVILLE. A bond issue of $35,000 has recently been voted by the city for the improvements of the electric light plant and water works.

SMITHFIELD. The city will hold election on February 21st for decision on the issue of $65,000 in bonds for the construction of an electric light and sewerage system.

STAUNTON. It is understood that the Staunton Lighting Co. will install a steam turbine of 500 H. P. and a direct connected generator of 500 K. W. This equipment will add sufficient capacity to enable the plant to carry 25,000, 16 C. P. lamps.

BOOK REVIEWS.

ELEMENTS OF ELECTRICITY. By W. H. Timbie. Published by John Wiley & Sons, New York, N. Y. 556 pages, and 411 illustrations. Bound in cloth, price $2.00.

It is recognized that a thorough grounding in the fundamental principles of electrical theory and measurements is the beginning of an electrical engineer's success. Numerous text books have been placed on the market each intending to serve this purpose. The one which has recently come to hand bearing the above title measures up admirably for the use of the young engineer and especially the student. The material shows careful presentation and a thorough knowledge of the principles underlying the operation of electrical machinery. So clearly are the technical features given that any reader has no difficulty in following the discourse on the subject. While the work is primarily a student's reference, it is equally valuable to practical electrical men. All theories show careful treatment and are made so simple that we heartily recommend the work for general reference on electrical topics.

The subjects covered in this work are as follows: Magnets and Magnetism; Electro Magnets; Ohm's Law; Power Measurements; Measurements of Resistance; Magnetic Field Due to Current; The Generator; The Motor; Applications of Electrical Apparatus; Inductance Capacity; Electrochemistry; Photomometry and Electric Illumination; Electrical Measuring instruments; Alternating Currents.

COMPENDIUM OF APPLIED ELECTRICITY. By Paul E. Low, M. E. Published by David McKay, Philadelphia, Pa. 342 pages and 214 illustrations, price 25 cents.

This small volume is a condensed information bureau on subjects pertaining to the application of electrical energy. It gives a general idea as to the operation of different electrical apparatus showing illustrations and diagrams of the principal features. Due to its size it is a handy reference at any time and a means of investigating perplexing subjects at the time they are met in practical work.

PERSONALS.

L. S. RANDOLPH, Mem. Am. So. C. E., has been retained to report on a large hydro-electric power proposition in East Tennessee in the neighborhood of Bristol.

D. C. & M. B. JACKSON have been retained by the Government of Great Britain to advise the Postmaster-General in regard to the value of the plant of the National Telephone Company, which will be taken over by the Government this year and made a part of the postoffice system. Professor D. C. Jackson sailed on the Lusitania on January 18th, to spend a week in London conferring in regard to the execution of the valuation. He will return by the Kronprinz Wilhelm which is due to arrive in New York February 7th.

GUS LACHS has been appointed sales agent for the Century Electric Company in the State of Texas. Mr. Lachs is well known in this territory and his many friends wish him well in his new capacity. He can be reached at the following address: 1810 Main St., Dallas, Texas.

GEORGE J. BROX, chief engineer of the Manti City Light and Power Company, is now elected city electrician, as the plant has been purchased by the city. Mr. Brox is an able electrical engineer, and has been connected with the Manti plant for ten years.

A. E. BOSLEY, of the American Carbon & Battery Co., East St. Louis, is making an extensive trip through the South, in the interest of the company's line of carbon, graphite products, and wet and dry cells. He will visit the following Southern cities: Nashville, Chattanooga, Atlanta, Macon, Savannah, Jacksonville, Mobile, New Orleans, Montgomery, Birmingham, and Memphis. Any Southern firm interested in the above mentioned products can communicate with the home office at East St. Louis, Ill., and Mr. Bosley will be instructed to call in person.

OBITUARY.

WALTER DeFOREST BROWN, who was secretary and treasurer of the National India Rubber company, was drowned on December 9th while duck hunting. The canoe in which Mr. Brown was, overturned and on account of heavy clothing and the cold water he was unable to save himself. He was 48 years of age and was born in Rehoboth, Mass. After graduating from Bryant & Stratton commercial school Mr. Brown became bookkeeper for Brownell & Field at Providence. About 20 years ago he connected with the National India Rubber Co., and after two years was promoted to secretary, which office he held until about six years ago, when he was elected treasurer of the company also. Mr. Brown is survived by a widow, Mrs. Martha Jones Brown, and a daughter, Miss Viola T. Brown.

INDUSTRIAL ITEMS.

THE WALKER ELECTRIC CO., 329 Broad St., Rome, Ga., has recently opened for business at the above address. Mr. R. M. Walker is manager and a well known electrical engineer, having been connected for years with the Commonwealth Edison Co., Chicago, Ill., in the engineering department. He left this firm to go with the Buckeye Lamp Co., with whom he served a long period in their Chicago office. He came South a few years ago and became identified with the electrical business in Selma, Ala., under the firm name of Reeves-Walker Electric Co. During January, he came to Rome, Ga., and opened what will virtually be a branch of the Reeves-Walker Electric Co., but the name of the firm will be Walker Electric Co. All classes of electrical work, electrical contracting, interior wiring, plant installation, armature winding, and all kinds of repair work will be done and a full line of electrical supplies and fixtures, will be carried.

THE ALLIS CHALMERS CO. announces the removal of its Denver office to 1101-1104 First National Bank Bldg., Denver, Colorado.

ROBBINS & MYERS CO. No doubt a good many people were puzzled as to the meaning of the headlines to the advertisement of The Robbins & Myers Co., on page 82 of the January issue of the SOUTHERN ELECTRICIAN, but the rest of the advertisement gives a clear and impressive announcement of the line manufactured by this well known firm. The second line of the heading should have been "You Cannot Fill," the difference of only two letters changed the entire sense of the lines, by the word "Fill" reading "Tell."

INDEPENDENT ELECTRICAL SUPPLY CO. Through the president of this company, Mr. H. H. Kabot, we are advised that on account of a rapid growth of business, the company has been compelled to move. Since October 1, 1910 the entire eight-story building at 59 Warren St., New York City, has been occupied. A photograph of the new quarters is shown in the advertisement which the firm has in this issue.

CORRECTION.—In the January issue of SOUTHERN ELECTRICIAN on page 43 a description of the direct current compensarc was given, showing an illustration of same. This compensarc is manufactured by the Fort Wayne Electric Works at Fort Wayne, Ind., and the term compensarc is a word which has been coined by that company and applied to their apparatus exclusively. We call attention to the fact that the Fort Wayne Electric Works were not given credit in the article which was published describing their apparatus.

BOOKS AND CATALOGUES.

THE BETTS AND BETTS COMPANY, 302 West 53d St., New York City, are about to issue a bulletin taking up the color caps which they are placing on the market for use in producing colors on electric signs. The bulletin will be printed in five colors and will show signs made by different sign manufacturers all over the country. The company does not manufacture electric signs for outdoor use, but equips them with flashers, color caps, and any special devices. Flasher Bulletin No. 62 is also to be off the press about February 10th. This bulletin will describe the various types of flashers handled by the Betts & Betts Co., and of such a design as to be suitable for producing various effects on different designs of signs. The company advises that they are desirous of making connections with some good agencies throughout the South.

THE WESTERN ELECTRIC COMPANY has just issued Bulletin No. 1006, describing Non-Multiple Toll Switchboards. The apparatus presented in this bulletin is recommended for use as toll boards in either magneto or central battery exchanges. They are recommended for use also as magneto exchange switchboards where a desk type board is desired or a switchboard with a lower key-shelf than is ordinarily provided on local boards.

THE DRIVER-HARRIS WIRE CO., of Harrison, N. J., is distributing booklet H, on resistance materials. This booklet, besides presenting numerous quick reference tables, lists, contains information on two new alloys, "Yankee-Silver" and "Therlo" recently perfected by the company. A copy of the booklet will be sent upon request.

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Orders for any change in advertisements must reach Atlanta previous to the 10th of the month preceding month of issue.

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CONTENTS.

The International Volt.

Since January 1, 1911, a new value has been given the international volt which will be recognized as standard by all countries. This means not only that a basis has been established whereby international uniformity will now be secured both in definitions and specifications but a means is provided for keeping the standards of the different countries in agreement.

The new value of the volt was brought about by the adoption of a new standard value for the Weston cell, changing from e=1.019126 at 20 degrees Centigrade, as previously used in this country, to e=1.01830 at the same temperature. Up to the present time the following values of the Weston cell have been in use in foreign countries: Germany, e=1.0186 at 20 degrees C.; Great Britain e=1.0184 at 20 degrees C. These differences of values have of necessity caused a discrepancy in the value of the volt and ampere in precise measurements.

Since the value of the Weston cell formerly used, was larger in every case than the value now adopted as standard, the new international volt is larger than the old one and all measurements based on the former value must be corrected, the volt 0.08 per cent lower and the watt 0.16 per cent lower. While this change in value appreciably effects only precise measurements where the potentiometer and other delicate instruments are used, there will be a slight change in rating and life of incandescent lamps. In discussing the results of the change in the volt, in his report on the value of the international volt, S. W. Stratton of the Bureau of Standards says, "The watt is altered twice as much as the ampere and volt; that is 0.16 per cent., 50 watts on the old basis being 49.92 watts on the new. A 16 candle power lamp burning at 3.05 watts per candle power on the old basis takes 48.80 watts. On the new basis the same current will be rated as furnishing 48.72 watts and the lamp taking therefore 3.045 watts per candle. The difference here is of course insignificant. A lamp giving 16 candles at 110 volts will on the new basis of voltage measurement give 16 candles at 109.91 volts. If, however, the voltage be made 110 on the new basis the slight increase in current will make the lamp give about 16.08 candles."

The change in the international volt follows as the result of the initial step taken at the International Electrical Congress held at Chicago in 1893. Not all the countries represented at this Congress legislated on the electrical units adopted, and of those which did, no two adopted precisely the same definitions. In all the definitions adopted and in those of the Chicago congress, the ohm and ampere were independently defined, the volt being defined in terms of these two units. While the difference in measurements on this account by various countries have not been large enough to be of commercial importance, yet in precise measurements when electrical instruments made in one country were to be used in another, these differences have often been embarrassing. With the new universal standard, this will all be obviated and values derived by the same methods in one country will be identical to those in any other.

Hydro-Electric Development on Saluda River, Greenville, S. C.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

BY H. M. WILCOX.

IN general there is an inadequate conception of the nature of hydro-electric developments, to which attention has been directed so persistently by the advocates of conservation. It is popularly assumed that it is a comparatively easy matter to dam a stream, set up a few water wheels and sell the resultant electrical power. The numerous examples of misdirected enthusiasm on the subject of water power possibilities have shown very strikingly the fallacy of this belief.

The proper design of a hydro-electric plant is an enterprise requiring a thorough engineering investigation as well as a thorough knowledge of economic and industrial conditions in the territory to be served by the proposed development. Too often large power houses have been erected with too little investigation of the low stages of the river furnishing the power during the dryest seasons. Contracts have been entered into for supplying electricity up to the nominal capacity of the station and then in times of unusual low water it has been impossible to furnish the amount contracted for. In view of these and similar instances a water power development is in some cases looked upon with considerable suspicion. The lessons which the failures should undoubtedly teach are the necessity for careful planning of a plant and a proper design to best make use of the power available, as well as the most careful study of the possible market.

Of all the factors entering into such an enterprise the last mentioned is probably the most important. It is obvious that low costs per developed horse power avail not at all if there is no adequate market for the energy produced. Not only must the present conditions of supply and demand be most intimately studied, but the future possibilities should receive an equal share of attention. When properly conceived in this manner, there are few investments more fundamentally solid than a hydro-electric development.

The inherent value of a well developed water power, is illustrated by the success of a power plant located on the Saluda River about four miles from Greenville, S. C. The site of the dam is near the main line of the Southern Railway between Greenville and Atlanta, Ga., and is well situated with regard to obtaining materials by rail. The river slopes uniformly for some distance at this point while on the east side of the river there is a high bluff with an outcropping ledge. At the other side a field rises gradually from the river edge to about the same elevation, thus affording an excellent situation for a dam of sufficient height to flow out the shoals and fill in the stream for several miles above the site, and providing a basin of sufficient extent for storage purposes.

FIG. 1. HYDRO-ELECTRIC DEVELOPMENT ON SALUDA RIVER.

The country above the site of the dam is broken and the banks of the stream are generally high with small areas of bottom lands so that the facilities for large artificial reservoirs are rather poor. The outline designated as contour 103 on the map, shows the outlines of the storage reservoir created by the dam. This extends upstream about seven miles, the entire area of the watershed being about 300 square miles. Test gaugings were made of the stream flow and comparisons made with the results from hydraulic developments further down the stream. The government measurements show that the rainfall on this upper portion of the river is from 54 to 56 inches proportioned almost equally among the seasons, with a maximum in winter and the dryest season in the fall. The lowest reading of stream flow obtained during these investigations was 313 second feet.

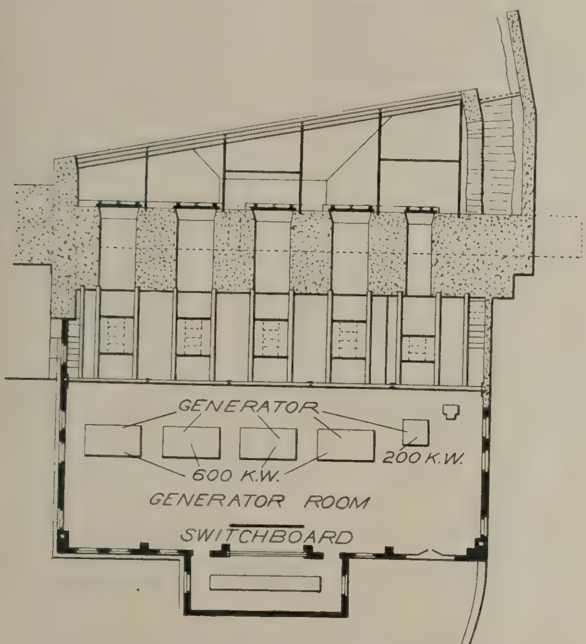


FIG. 2. PLAN OF POWER STATION.

Allowing, however, for a considerable shrinkage of the lowest gaugings and the known developments, it was estimated that the lowest minimum of the dryest year might be expected to run as low as 252 second feet for brief periods.

These figures were based on very careful studies of all available data on the flow of this river, the character of its watershed and by complete surveys and gaugings of the stream. It seemed certain that the figures obtained were conservative and might be relied upon to the fullest extent. As work was about to commence, however, the flow of the Saluda seemed unusually small, even for that season of the year, and it was decided to make supplementary gaugings to be sure that the previous low water estimates were safe to reckon on. It was found that the stream flow was much below any previously recorded dry-season flow. The lowest measured flow of this period proved to be only about one-half of the estimated dryest season flow. The engineers decided, however, that this low stage was so exceptional that it should not be used as a basis for judging the value of the development, but that this value should be estimated on the power available under usual conditions, making allowance, however, for the recurrence of extraordinarily low water by providing sufficient storage capacity to tide over such a period of insufficient flow. The value of this report was subsequently shown during the negotiations for selling the plant. Detailed measurements based on the contour map indicated the formation of a storage pond averaging about 600 feet in width at the level of the crest of the dam for seven miles up-stream. The total surface of the pond amounts to 20,000,000 square feet on the contour line through the crest of the dam and two feet variation in height affects this area only about 1 per cent.

On the basis of a flow of 252 cubic feet per second, the night flow of thirteen hours would amount to 11,793,600 cubic feet; for the storage of which a height of only 6½ inches is required at the dam. Adding in the Sunday flow, it was found that the greatest height to provide for, from the stream flow under usual dry season conditions, would be 18 inches on the dam. The recommended increasing of the available head in unusually dry seasons can be accomplished by the use of flushboards of at least three feet in height.

The power available was figured on a working day of eleven hours, six days per week, and on a basis of ordinary dry season flow, 315 second feet, amounted to 2,144

FIG. 3. GENERAL VIEW OF GENERATOR ROOM.

H. P. delivered in Greenville. On the basis of 252 second feet as the minimum dry season flow, 1,714 H. P. would be available delivered in Greenville. Figuring from the lowest recorded flow 140 second feet the power available would total 1,006 H. P. delivered. This last estimate is of course only to be expected under extraordinary dry conditions and extra storage capacity was recommended by the engineers for this emergency, as already stated.

A masonry dam to give a head of 37 feet was constructed across the river valley so as to take advantage of the high banks, already mentioned, on either side of the river. The natural channel of the river was partially utilized as a race-way from the power house, thus saving a large amount on the cost of the station. The power house itself is at one end of the dam with its roof about on a level with the bank. The building is, however, sufficiently high to avoid any encroachment by high water in the river below at any season. Five S. Morgan Smith water wheels were installed, direct connected to four 600 K. W. and one 200 K. W. Westinghouse generators with horizontal shafts. These machines are located in a single row the length of the operating room.

The main generators are of the revolving field type having 28 poles and generating three-phase alternating current at 60 cycles, 13,000 volts, at 257 R. P. M. The generators are specified to carry 25 per cent overload with an efficiency of not less than 93 per cent under full load and 91 per cent at half load. The 200 K. W. unit is of the same type as the larger machines and runs at 450 revolutions with an overload capacity of 20 per cent. All the cables from the generators are run in conduits under the cement floor which is provided with removable sections for the purpose of examination and repairs to the run-ways.

There are four direct current exciters provided for in the design of this station. For regular service a 70 K. W. unit, direct connected to one of the main water wheels provides excitation for all four of the 600 K. W. generators and also provides station lighting at 125 volts. Two 35 K. W. exciters each capable of supplying two main generators, are belted to the main generator shafts and run at 850 R. P. M. There is a 12 K. W. exciter direct-driven from the shaft of the 200 K. W. A. C. generator. This machine excites the fields of the 200 K. W. machine and also furnishes station lighting when the four main machines are not in use.

On the down-stream side of the power house, a projecting compartment extends up to the roof and carries the high-tension transmission lines and switches with their governing apparatus as well as the generator switches. This is known as the wire tower. On the generator room side of the tower there are two archways in which are located the switchboard, consisting of nine panels in two sections, five panels for A. C. generators and two panels for exciter service, set in one bank, while in the second section in another archway, are the two panels for outgoing feeder control service.

The panels are of blue Vermont marble 24 inches wide, 90 inches high, and 2 inches thick, mounted on a wrought-iron angle frame which is securely fastened to the wall at the back and serves to connect the various panels of the board. The main generator oil switches, which are located in the compartment of the wire tower above the switchboard, are equipped for remote mechanical control by means of a switch lever on the generator panel. These generator switches are all 100 amperes capacity. Each generator panel also contains one 150-ampere double-pole field discharge switch for the direct current bus, the field rheostat as well as the usual ammeters and voltmeters, plugs, fuses, etc. The fifth generator panel is similar to the other four except that the instruments are for smaller capacities. One of the exciter panels contains the controlling and indicating instruments for the two 35 K. W. belted exciters while the second exciter panel carries the instruments for the 75 K. W. and the 12 K. W. exciters. Triple pole knife blade switches are installed on these panels, rheostats for the exciter fields and one main station lighting switch.

There are two 3-phase 3-wire feeders, each being provided with a separate panel on the board. Each feeder is capable of carrying the entire output of the station, or approximately 2,600 K. W. at 13,000 volts, 200 amperes. The oil switches for controlling these feeders are also located in the wire tower and are equipped for distant mechanical operation from the switchboard. Each is of the plunger oil type and of 200 amperes capacity. Each feeder panel carries one 150-ampere polyphase integrating wattmeter to show the power input to each feeder, three 200-ampere A. C. ammeters, one per phase and one A. C. voltmeter. The usual plugs, fuses, connection posts, are provided. The bus bars are of 95 per cent copper and run in separate cells made of soapstone slabs, 1½ inches thick and 12 inches apart. At the top of the wire tower choke coils are installed on each feeder as well as horn lightning arresters. The transmission line is carried across country on poles in a nearly direct line to the city of Greenville, where the stepdown transforming station is located.

The cost of the plant entire, including the sub-station in Greenville and meters, transformers and pole lines to consumers was approximately $375,000. This figure is undoubtedly high for such developments, but the subsequent history of the plant emphasizes the truth of the fact that first cost is of secondary importance compared with the advantage of a proper location. The plant was erected at a point not only favorable to profitable disposal of its product, but also of strategical importance to the development of the water power monopoly of that section—the Southern Power Company. So valuable was its position deemed by the controlling factors of the latter corporation that it had been operating but a few years when it was sold on most satisfactory terms by the original owners. The Southern Power Company is now operating this plant in conjunction with others of their hydro-electric developments in this section of South Carolina. This installation has justified the faith of the engineers in the possibilities of the location for a hydro-electric development and the predicted market in Greenville and its environs had materialized most satisfactorily. Among other results of the completion of this power plant may be mentioned the fact that the street car and lighting systems of Greenville are now provided with their motive power entirely from this plant and several mills are also purchasing power from the company, one in particular having abandoned a steam plant in favor of purchased electricity.

The preliminary survey and examination of the power site for the plant above described, together with a determination of the general characteristics and cost of the development were made by Lockwood Greene & Co., Engineers of Boston, Mass. The success of the development makes it a ready reference for an appreciation of the advantages of hydro-electric power when properly handled.

Alternating Current Engineering.

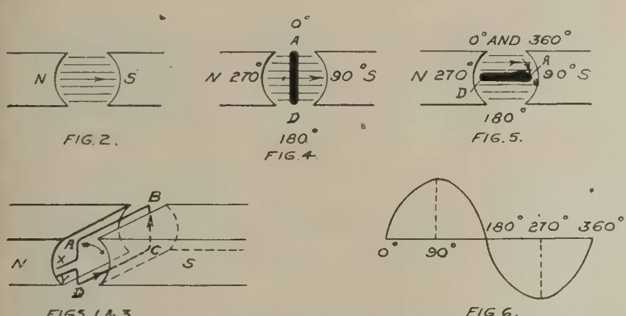
(Contributed Exclusively to SOUTHERN ELECTRICIAN.)

BY WILLIAM R. BOWKER.*

THE object of this serial technical article is to deal in a concise, non-mathematical and condensed manner with alternating current theory, beginning at elementary principles and following along the lines of apparatus, layouts and operation.

A current of electricity may be induced or generated in a metallic wire or conductor by placing it into a certain convenient and practical relative location or position with a magnetic field, that is, a space or condition possessing magnetic properties.

The simplest practical relation that will attain the desired object is shown in Figs. 1, 2 and 3, in which Fig. 1 represents a rectangular coil of wire or metallic conductor, A, B, C, D. Fig. 2 shows a magnetic field energized between the poles of a magnet, one of which is marked N (north) and the other S (south), the magnetic lines of force passing straight across from N to S as shown by the arrowheads.



FIGS. 1 TO 6. FUNDAMENTAL PRINCIPLES OF CURRENT GENERATION.

The fundamental principles of electro-magnetism state, that to generate or induce a current of electricity in a wire or conductor, there must be either: (1) relative movement or change of position between the inducing medium and the induced circuit, or else (2) a relative change of magnetic strength or current strength, one depending upon the other, between the inducing and induced circuits, that is, when they do not move relative to each other.

In practice, both fundamental principles are utilized; the choice being largely determined by what kind of apparatus and appliances are used and the object to be fulfilled.

For the purpose of generating a current of electricity in practice, the relative movement of essential parts is usually adopted. One method is to have a powerful magnet suitably shaped and assembled in the space between two or more pole faces where rotates a coil or coils of wire or conductors suitably arranged, assembled and supported.

*This article is the first of a number which will be published in Southern Electrician covering the entire field of alternating current engineering. Special reference will be made to central station equipments and operating conditions. Mr. Bowker is an electrical engineer of wide experience and was formerly Professor and Head of Electrical Engineering at the University of Southern California, Los Angeles. He presents in these articles the theoretical and practical features of A. C. systems in such a clear manner, that the information will be of general interest to all engineers having to do with electrical apparatus.—Editor.

Referring to Fig. 3, the essentials will be seen, namely, a conductor and field poles in their simplest practical form to generate and deliver an electric current. N. S. represents the outline of two poles of a powerful magnet giving the physical condition of a magnetic field. The direction of this magnetic field, being composed of many thousands of invisible magnetic lines of force, is in this particular instance traveling horizontally in a straight line. If a rectangular coil of wire, A, B, C, D, is now caused to rotate or revolve in this magnetic field there will be generated therein a current of electricity.

The current is generated in the coil by the act of cutting through the magnetic field and the simplest way to conceive of this cutting through an invisible energy field, is to assume that the magnetic field is composed of thousands of silk or cotton threads, and the limbs, A, B, C, D, of the coil to possess a razor edge which in rotating cuts through the threads. This is the mechanical analogy, but there is this great difference between the mechanical analogy, and what in actual reality takes place magnetically. When the mechanical threads are cut transversely across they would need renewing again by some mechanical means at each revolution, while the magnetic field is kept automatically renewed and practically continuous by reason of its physical and scientific nature.

Now the strength of the current of electricity generated will not be equal throughout all the relative angular degree positions of the coil during one revolution, the current generated being weakest when the plane of the coil is at right angles to the plane of the magnetic field, that is, when the limbs, A, B, C, D, are at zero and 180 degree positions. The current is strongest or at its maximum when the plane of the coil is parallel to the plane of the magnetic field or at 90 and 270 degrees.

The position of minimum current is shown in Fig. 4, in which the plane of the magnetic field along N. S. is relatively at right angles to the plane of the coil A, D. The coil A, B, C, D, is now shown edgeways, whereas in Figs. 1 and 3 it is shown in perspective. In this 0 to 180 degrees position, no current is generated, but in rotating towards positions 90 to 270 degrees shown in Fig. 5, the second condition is assumed. That is the plane of magnetic field is parallel to plane of coil A, D, and when the single rectangular coil is in this position the maximum current strength is generated, because in this position the two limbs, A, B, C, D, are cutting transversely across or through a maximum number of magnetic lines of force.

It is well here to draw the attention of the reader to the fact that it is only the limbs A, B and C, D, that actually perform any function in the cutting through the magnetic field and current generation. The end connections, A, D and B, C, are not usefully employed, they do not cut magnetic lines transversely, only slipping through them. They are the back and front metallic connections for the actual generating conductors A, B, and C, D.

In the intermediate angular degree positions between 0 and 180 and 90 to 270, the current strength will increase from a minimum at zero and 180 degrees position to a maximum at 90 and 270 degrees. It will be noticed that while the limb A, B is cutting the magnetic field from top to bottom, the limb C, D, is cutting the lines of force from bottom to top, therefore, it is obvious that the two limbs cutting the magnetic field in opposite directions will have generated in them a current in opposite directions considered relatively; although the current will flow around the coil in one direction considered as a whole.

The currents will be induced and flow in a direction as shown by the arrow, Fig. 3, during one-half revolution of the coil or while the limb A, B is traveling from 0 to 180 degrees, and while C, D, is traveling from 180 to 360 degrees, zero, and 360 degrees being at the same point considered in angular degrees. At the same time the current in limb A, B will start with a minimum value at 0 degrees, gradually increasing to a maximum strength at 90 degrees and decreasing to zero value again at 180 degrees. All the time the current is being generated to travel in one direction during the first half revolution, but with a fluctuating current strength value. Likewise a similar action will take place in limb C, D, only the current will flow in an opposite direction to that in A, B.

During the second half of the revolution the same current variation will take place, but at 180 degrees the direction of current in limb A, B reverses in direction, because after passing this position it now assumes the relative degree position that C, D possessed during its first half revolution. Therefore during one complete revolution of the coil the current reverses in direction in each limb once, that is, at the 0, 360 and 180 degree position.

The relative values of the current strength changes and direction can be graphically illustrated by Fig. 6 in which the circle described by the rotation of the coil A, B, C, D, can be straightened out into a line, and the 0, 90, 180, 270, 360 and intermediate degree locations outlined. Being a minimum at 0, 180 and 360 degrees the curve representing the current strength can be shown by no vertical height either above or below the line, while the vertical heights of the lines above and below this straight datum zero line can be assumed to show current values for the several degree positions, which the rotating coil traverses during its revolution. We have the longest lines at 90 and 270 degrees, and by erecting lines at the intermediate degree positions from 0 to 360, although only two lines at 90 and 270 degrees are here shown and connecting the tops by a curve as shown, we get a graphic illustration of how the current increases and decreases in strength. From 0 to 180 degrees the curve is shown above the datum line, while from 180 to 360 degrees below the line. This indicates the current flowing in opposite directions during one complete revolution of the rectangular coil. This current reversal during each revolution gives us a simple alternating or single-phase current and it can be collected by two brushes pressing on slip-rings located upon the ends X, Y of the rectangular coils.

This description is that of a dynamo in its simplest practical form, and the magnetic field between the pole pieces may be considered as the inducing medium and the rotating coil, the medium in which the current is induced. A dynamo in such a simple form would not be useful for practical purposes, as the fluctuation of current strength would be too great. To overcome this disadvantage and also to generate greater power, we in practice assemble an armature composed of a number of conductors or coils, that is a multiplication of the single coil, which when caused to rotate in the magnetic field generates a current of electricity practically uniform in strength. This current reverses its direction at the 0 and 180 degree positions and flows as an alternating current throughout the external circuit, unless caused to assume a continuous direction by means of suitable brush gear.

The magnetic field may be produced by several methods, but the most practical is to use a field magnet composed of iron or steel, energized by a coil or coils of wire, and known as an electro-magnet.

So much for the elementary principles of single-phase alternating currents. For generating two-phase and three-phase currents, the alternators must be designed with two or three separate windings, so spaced as to come into inductive operation in regular succession. There will thus be two or three independent circuits of equal voltages which may be connected up in either what is technically known as a star or Y and mesh or delta groupings.

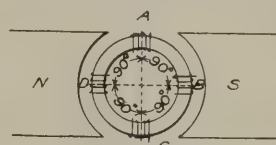


FIG 7

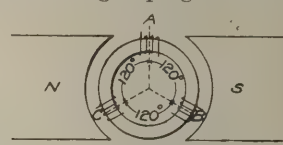


FIG. 8

FIGS. 7 AND 8. THE ESSENTIAL FEATURES OF 2-PHASE AND 3-PHASE CIRCUITS.

To transmit two-phase currents four-line wires may be employed and for three-phase three wires. In Fig. 7, the poles of a field magnet are outlined and an armature core on which is wound four coils, A, B, C, D. By suitably connecting these together we can generate and collect a two-phase current. The center lines of these 4 coils would be as shown set 90 degrees apart.

The elementary principle of three-phase currents is shown in Fig. 8, in which we have three coils, A, B and C, set apart at an angular displacement of 120 degrees, so that when caused to rotate they come into action at regular periodic intervals and generate a three-phase current. These three currents may be connected with three external wires in two different ways. A star or Y grouping and mesh or delta grouping, as shown in Figs. 9 and 10.

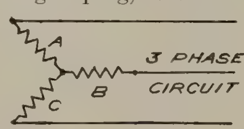


FIG 9

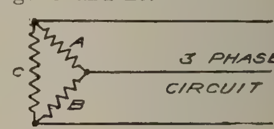
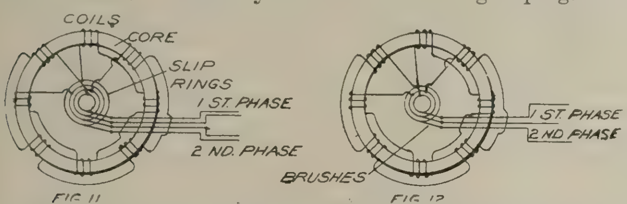


FIG 10.

FIGS. 9 AND 10. STAR AND MESH OR DELTA CONNECTIONS FOR 3-PHASE CIRCUIT.

The methods of construction as shown in Figs. 7 and 8 would not be utilized in practice because the coils as shown, only cover a fractional part of the circumference of the armature core, producing a very irregular or fluctuating voltage and current. We can readily realize however, a practical generator by so constructing as to completely fill up the core with wires, coils or conductors suitably arranged and connected. This essential condition is more nearly realized by the outline diagrams shown in Figs. 11, 12, 13 and 14; in which Figs. 11 and 12 show two methods of collecting currents from a two-phase generator, and Figs 13 and 14 from a three-phase generator.

In Fig. 11 is shown the generating coils and internal connections for a two-phase circuit, in which the currents are collected and distributed externally by means of four slip-rings and four brushes. In Fig. 12 is outlined the coils and connections of a two-phase circuit in which the currents are collected and distributed by aid of three slip-rings and three brushes. In Fig. 13 it will be noticed that the six free ends of the generator coils are connected, two ends on each one of the three slip-rings, forming a triangular or mesh grouping. The first winding on the generator is connected between slip-rings 1 and 2, the second between 2 and 3 and the third between rings 3 and 1. In Fig. 14, the beginning of each winding is connected to one of the collector slip-rings and the other free ends are coupled to a common junction. This system of winding forms what is technically known as the star grouping.



FIGS. 11 AND 12. INTERNAL GENERATOR CONNECTIONS FOR 2-PHASE CIRCUITS.

Referring to Fig. 7, we have an arrangement of two sets of coils at right angles, from which we can collect two alternating currents. In this particular case, when the current generated in the first coil is at a maximum value that is at 90 degrees, the current in the second coil is a minimum value at 0 degrees. At the time that this condition exists, the two currents differ in phase by 90 degrees, or the current generated in phase B coils, lags behind the current generated in phase A coil by a quarter of a period, that is, 90 degrees phase difference. A period is considered 360 degrees and 90 degrees one-quarter of this. In this case they are then said to be in quadrature.

This phase difference is graphically outlined in Fig. 15, and it is simply constructed by superimposing a second curve generated by phase B on the same horizontal datum line, and combining the two on one curve sheet, on which the second curve belonging to phase B is drawn 90 degrees or

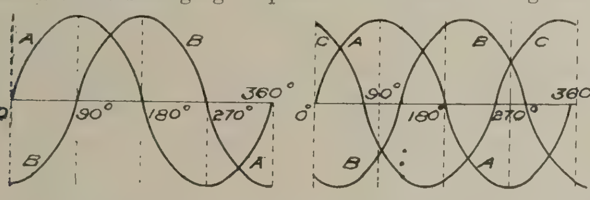


FIG. 15. TWO-PHASE ALTERNATING CURRENT DIFFERING IN PHASE BY 90 DEGREES OR IN QUADRATURE.

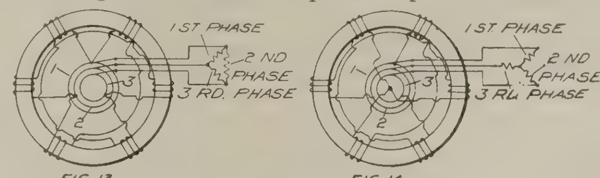
FIG. 16. THREE-PHASE ALTERNATING CURRENT DIFFERING IN PHASE BY 120 DEGREES.

a quarter of a period behind the curve of phase A. It will be noticed that Fig 15, is formed by taking two of the Fig. 6 outlines and superimposing one on the other. A mechanical analogy which very simply illustrates the two-phase quarter period currents, is when we consider a prime mover that possesses two cranks in which one is set at an angle of 90 degrees behind the other.

Referring to Fig. 8, is shown an armature with three coils set at an angular displacement of 120 degrees. Thus we may have three separate circuits each conveying a separate alternating current and the three currents related to each other in such a way that each one differs in phase from the one next it, by one-third of a period or 120 degrees. Such an arrangement is spoken of as a three-phase alternating current circuit and it may be graphically represented by Fig. 16, in which A, B and C represent the current variation in the respective three coils or windings, and their relative phase difference. Both two-phase and three-phase currents are known as polyphase currents.

Up to the present time we have only spoken of the word current, and it is now well to realize that to cause a current of electricity to flow in the generating coils an electromotive force, e. m. f. or electric pressure is required. This dual condition of e. m. f. and current in combination with the one or more other conditions, resistance, inductance, capacity, etc., in a circuit, introduce interesting actions and reactions of which a clear understanding is essential.

Alternating currents do not always keep step with the alternating volts or e. m. f. impressed upon the circuit. Re-



FIGS. 13 AND 14. INTERNAL GENERATOR CONNECTIONS FOR 3-PHASE CIRCUIT, SHOWING DELTA AND STAR CONNECTIONS.

ferring to Fig. 6 the curve shows the variation of e. m. f. or current during one period, and this variation may occur many times in a second, say 25 to 120. This is known as the frequency, sometimes called periodicity.

The currents accompanying these periodic variations of electromotive force are also periodic; they rise to a maximum, fall to zero, reverse, rise to a maximum, fall to zero and so on. The frequency or periodicity of the e. m. f. is that of the current. There is, however, this important difference. Alternating currents do not exactly keep time with the alternating electromotive forces, so that the maximum current value is not attained at the exact time that the instantaneous value of the e. m. f. is a maximum, but occurs a little before or a little after it, according to the nature of the circuit.

It must be carefully noted that the actions and reactions due to capacity and inductance in an alternating current circuit are of the greatest practical importance. If there

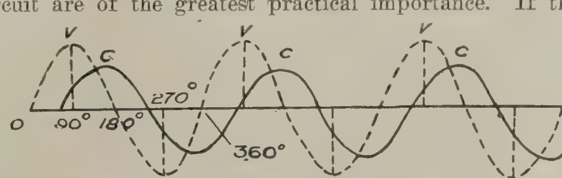


FIG. 17. SHOWING CURRENT LAGGING BEHIND E. M. F.

is inductance in the circuit the current will lag behind the e. m. f., if there is capacity in the circuit the current will lead the e. m. f. If there is an inductive resistance such as a coil of wire included in the circuit it will cause the current to lag, that is, the maximum value of the current will occur later than the maximum value of the e. m. f. producing it, while a condenser which possesses capacity will cause the current to lead, that is, the maximum value of the current will occur before the e. m. f. attains its maximum value.

Inductance has another effect of more importance than any retardation of phase; it produces reactions of electromotive force, choking the current down. While the current is increasing in strength, this reactive effect of inductance tends to prevent it rising. The lag produced by inductance is shown in Fig. 17, in which the dotted curve V, V, V, represents the variation of e. m. f. or voltage; whilst the curve marked C, C, C, represents the variation of current. It will be seen that the maximum value of the current occurs at a later period than the maximum value of the e. m. f.

As before stated there are two properties of a circuit which have certain actions in relation to alternating currents, being the effects of self-induction and capacity. The effect of self-inductance in a circuit, is to decrease and impede or retard the current. Every circuit possesses more or less capacity and is a condenser, the effect of capacity being to increase and accelerate or lead the current in advance of the e. m. f. Therefore an alternating current flowing in a circuit possessing considerable self-inductance will lag or fall behind the impressed e. m. f. causing it. When traversing a circuit having considerable capacity it will be in the lead or travel in front of the impressed e. m. f. causing it.

We can, therefore, by inserting into a circuit possessing self-inductance a condenser of suitable capacity, cause the impedance to be diminished, and the current strength increased. Also, by inserting a piece of apparatus possessing self-inductance such as a choke or impedance coil, we can cause the impedance to be increased and the current strength diminished. Thus it is seen that inductance and capacity produce opposite effects and can be utilized to neutralize each other's actions. By suitably choosing a capacity and inductance of equal amount the current neither lags nor leads and the current is said to be in phase with the e. m. f. producing it. The understanding of these actions and reactions, and the utilizing of different appliances or apparatus to produce certain essential conditions, are of the greatest importance in the practical application of alternating currents.

The next article on this subject will take up inductance and capacity in circuits, also the features essential in the transmission of electrical energy.

Review of Central Station Practice and Developments in England.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

BY CECIL TOONE, AN ELECTRICAL ENGINEER IN ENGLAND.

ADVANCE IN LAMP CONSTRUCTION.

It is unnecessary to descant at length upon the various high efficiency lamps which have recently been introduced, since all these have spread to or originated from, the United States. The two classes of lamp, which have so greatly affected the lighting industry in this country, are flame arcs and, yet more important, metallic filament lamps. The arc lamp load of most stations is relatively small and moreover the user of arc lamps generally desires a maximum of light rather than a minimum energy consumption. Thus it is that the metallic filament lamp, used by large numbers of consumers to whom reduced energy bills are at least as important as increased lighting, has had so great an effect on central station economics.

During the past few years new processes of filament lamp manufacture have been under development and new factories have been opening and expanding, but now that types are more or less standardised, the drawn tungsten "Mazda" filament being among the most successful, numbers of large factories are approaching their full output, competition between makers has become very keen and prices are falling rapidly. Ten per cent reductions have become quite common of late and the price of metallic filament lamps is now only 30 per cent to 50 per cent of that obtaining a few years ago. The reduced prices will doubtless increase the total sale but even so, it seems probable that in the near future that the supply of metallic filament lamps will exceed the demand. Though there is still difficulty in making 200-volt lamps of 20 to 30 candle power or less, the mechanical properties of types on the market are much better than was the case a few years ago and, whereas wholesale purchasers can now be sufficiently independent to refuse responsibility for breakages in transit, the strength of lamps is so much increased that manufacturers do not suffer heavily from the added liability.

The present tendency in metallic filament lamp manufacture is to employ but a single length of filament in each bulb, thus avoiding the numerous joints required in the earlier patterns which had a number of simple U loops in series. This improvement, only made possible by recent advances in the art drawing the wires concerned, tends to uniformity, elasticity and long life of the filament. The "anchors" by which the successive loops of the filament are suspended are usually quite large loops of fine wire instead of the comparatively stiff hooks used for the purpose in earlier lamps. Various methods of flexibly supporting metallic filaments have been tried but the very light mass of the latter is an obvious difficulty. In order that the spring suspension may give an additional resilience it should simply be formed by a prolongation of the filament wire itself, twisted loosely round the leading-in wire a few times before cementing or welding. This short length of "slack" gives the requisite cushioning effect without permitting any serious oscillations such as would likely break the filament more certainly than the direct vibration it is sought to minimize. Other more expensive anti-vibration devices are in use but are seldom more effective than the above, while materially increasing the cost of lamp construction.

In most towns, particularly where very heavy street traffic exists, metallic filament lamps are flexibly suspended from their standards in order to lessen the risk of fracture by vibration. Such flexible supports must be carefully chosen or they may synchronise with and aggravate the primary vibration, thus being actually worse than useless. There is still room for great improvement in anti-vibration suspensions such as will enable the use of metallic filament lamps in mills, engine sheds, and similar places subject to heavy vibration. The desideratum that metallic filament lamps should burn in any position is also imperfectly realized at present.

Metallic filament lamps, particularly of the drawn-wire type, do not deteriorate appreciably by blackening and it is generally English practice to burn them till natural failure occurs. Nevertheless, in certain squirted filaments, in which an organic "binder" is employed during the early stages of manufacture, blackening of the bulb subsequently occurs, probably owing to traces of carbon derived and residual from the organic binding material. It is found that this may be largely avoided by painting various phospham mixtures on the glass stem supporting the filament framework. As drawn filaments will probably be mainly used in future, this difficulty and its remedy are of transient importance.

Flame arcs employ carbons impregnated with various salts of which calcium fluoride is generally the chief constituent. Where this is the case fumes are given off by the arc in considerable quantities and, condensing on neighboring bodies, leave a white deposit which is itself very opaque and very adherent and which, probably by reason of traces of free hydro-fluoric acid in the fumes, actually etches a light frosting on any glasswork on which it collects. Such deposits not only obscure arc lamp globes, as much as 25 to 30 per cent total light being thus lost by early flame arcs even during a 20 hours run, but have been known to etch adjacent shop windows, mirrors, etc., and to damage general goods near-by. Their presence must obviously be injurious to health. In later flame arc lamps this trouble has been avoided by carrying the fumes, by convection, to a deposit trap or chamber; while, in arcs for outside use only, an inner dioptric screen improves the polar distribution of light and incidentally provides the baffle-plate necessary to induce a continuous smart convection current carrying all fumes clear of the outer globe and outside the lamp through appropriate port holes, the inner globe being itself too hot to receive the deposits.

GENERAL ORGANIZATION, TARIFFS AND PRICE PER UNIT OF ELECTRICITY.

Until quite recently, English central stations have been lamentably lacking in even the most simple organization for pushing the sale of their commodity and even now there is much room for improvement in this respect. It must be remembered, however, that the publicity methods and literature which attract the American public would be unfavorably received by the average British householder who prefers a less strenuous and more "by-your-leave" mode of attack.

Most large central stations, whether company or municipally owned, now organize a permanent show room, or periodical special shows, backing this up by an information bureau, the staff of which also attends to the despatch of publicity literature. That special electrical shows are a cheap and effective advertising medium may be gathered from the results of a Wimbledon, London, exhibition; $935 was spent on arranging a display at which close to 25,000 visitors attended, excellent results being secured in subsequent enquiries and business.

Many municipalities find that it pays to illuminate public buildings, bandstands and so on, very lavishly, so as to arouse public interest in electric lighting. The consequent increase in business naturally more than compensates for the apparently extravagant administration of public funds.

Concerning the general scheming of tariffs, the attitude more and more frequently taken up is that of regarding the supply station and its consumers in the light of a co-operative concern in which the consumers pay between them and pro rata, according to the nature and extent of their installations, a certain fixed annual total, ensuring the financial stability of the station, i. e., its ability to run its machinery at a suitable net profit. Then, since the cost of running continuously at full load is little greater than running under a variable load and is proportionately far less, a very small charge per kilowatt hour is made, thus inducing the consumer to use a maximum of current, within the limits to which his fixed annual payment confines him. The overall load factor of the station is thus improved and further reductions in the "fixed" charges become possible. Such a system of charging is fairer though more complex, than a levy per kilowatt hour, independent of the nature of the demand.

An interesting move in another direction has been made by the Southampton Corporation in offering electricity for domestic cooking and heating at 1 cent per kilowatt hour, lighting 5 cents to 7 cents per kilowatt hour, flat rate and with no meter rent. These terms are the most favorable of the kind offered in the United Kingdom and represent a bold attempt to solve the problem of equalizing day loads and extending the utilization of electric supply. It remains to be seen whether the increased demand will adequately compensate for so low a tariff.

Various sliding scales and preferential tariffs are widely employed in this country. Thus battery charging and basement lamps can usually be supplied at reduced rates if the consumer will pay for the installation of suitable means of discriminating such loads from others less favorable to the central station. Hoist motors, on the other hand, are often penalized by a higher rate per unit owing to their "peaky" and intermittent demand. Outside arcs are often granted a preferential rate owing mainly to their long-hour steady demand and partly to the good advertisement they represent; more might certainly be done in this respect to encourage liberal and striking lamp installations in public places. Shops, advertising signs, theaters and churches are also generally supplied at somewhat lower rates than those accorded to the ordinary householder. For very large consumers a popular charging system is such a rate up to such an annual consumption and then a progressively increasing rebate on consumption above this and other successively higher limits. Miscellaneous power and lighting consumers are generally subjected to a certain flat rate per kilowatt hour consumed plus a certain minimum annual charge based on the general nature of their demand. In other cases, the supply of from 5 per cent to 10 per cent of the power demand for lighting purposes, at power rates, is a concession much appreciated.

Gas companies' charges are quite "flat" in most districts, with the exception of an occasional rebate to consumers using large town-gas engines, and the average householder and small power user withstands every effort to explain why such a delightfully simple charging system cannot also be adopted for electricity supply. It appears to be impossible to demonstrate to the layman the difference between the two cases, the gas company, with its large "holders" from which supply may be drawn at any time and to any extent without affecting the cost per 1,000 cubic feet to the company; and the electric station, with its very limited storage cell capacity, usually employed to the full during peak hours and, in any case, costing much to maintain, and the designs of its whole plant controlled by the peak demand.

Until 100 per cent load factor is approached very much more closely than is at present the case, central stations must safeguard themselves and encourage approach to this ideal, by respectively: (1) Charging for each kilowatt hour, what the latter costs to the station a suitable percentage profit. (2) Charging less to bulk-consumers, particularly during light-load hours.

The appropriate charge for any given demand is regulated largely by the existing demand already on the station at that time and the total capacity of the station ma-

TABLE IX FLAT RATES CHARGED FOR LIGHTING.

		Flat Rates—Cents per Kilowatt Hour for Lighting.																	
	16	14	13	12	11	10	9	8	7	6	5	4	3.5	3	2.5	2	1.75	1.5	1.0
1904 Number	7	16	7	60	12	46	27	41	5	11	3	13	----	1	----	1	----	--	--
1904 Per Cent	2.8	6.4	2.8	24.0	4.8	18.4	10.8	16.4	2.0	4.4	1.2	5.2	----	0.4	----	0.4	----	--	--
1910 Number	5	5	5	65	32	70	40	46	16	21	3	11	----	----	----	----	----	--	--
1910 Per Cent	5.6	1.6	1.6	21.1	7.1	2 .7	13.0	15.0	5.2	6.8	0.7	3.6	----	----	----	----	----	--	--

FLAT RATES CHARGED FOR POWER.

		Flat Rates—Cents per Kilowatt Hour for Power.																	
	16	14	13	12	11	10	9	8	7	6	5	4	3.5	3	2.5	2	1.75	1.5	1.0
1904 Number	----	1	----	----	----	1	2	16	3	70	40	63	6	37	15	19	----	1	----
1904 Per Cent	----	0.4	----	----	----	0.4	0.7	5.8	1.1	25.5	14.6	23.0	2.2	13.5	5.5	6.9	----	0.4	----
1910 Number	----	----	----	2	----	3	1	13	4	54	71	69	4	67	21	54	3	13	8
1910 Per Cent	----	----	----	0.5	----	0.8	0.3	3.4	1.0	14.0	18.3	17.8	1.0	17.3	5.4	14.0	0.8	3.4	2.0

The large power user is far more valuable to the central station, kilowatt hour for kilowatt hour, than the small lighting consumer and can therefore be granted cheaper supply. The different tariffs for similar loads in different towns are due to different costs of generation and to variations in the items included under this charge. This is especially noticeable in the charges for "traction" power; in some municipal concerns the bare works-cost of the supply is debited to the tramway department while in other cases

TABLE X. WRIGHT TARIFFS FOR LIGHTING.

Higher Rate cents per kw. hour	Year.	Lower Rate Cents per Kilowatt Hour.								
		10	9	8	7	6	5	4	3	2
18	1904	--	--	--	--	--	--	--	--	--
	1910	--	--	--	--	--	--	--	1	--
16	1904	1	--	3	--	1	--	4	--	2
	1910	--	--	1	--	--	--	2	1	1
15	1904	--	--	1	--	--	--	--	--	--
	1910	--	1	--	--	--	--	--	--	--
14	1904	1	--	25	1	20	8	12	1	1
	1910	--	2	18	--	18	6	13	3	2
13	1904	--	--	--	--	1	--	--	--	--
	1910	--	--	--	--	--	--	--	--	--
12	1904	--	--	5	1	21	3	6	--	2
	1910	--	--	4	1	11	1	6	3	4
11	1904	--	1	--	--	--	--	--	1	--
	1910	--	--	--	--	--	--	--	--	--
10	1904	--	--	--	--	1	--	6	1	--
	1910	--	--	--	--	2	--	2	1	1

a tariff covering generation, distribution and even other services, is in force. In street lighting for instance, the charge per burning hour may cover energy consumption alone or may include the cost of carbons and complete maintenance, see also "Street Lighting."

chines. Thus a consumer can generally obtain energy at nearly "power" rates for all purposes during the day and must then pay nearly "lighting" rates for his power demand during peak hours, or he may pay a flat overall rate at which the station can afford to take good with ill. It is often most satisfactory both to the station and to the consumer, apart from the cost of the more elaborate meter required, to work on a two-rate tariff. This is especially desirable in houses using electrical energy for power, heating

TABLE X WRIGHT TARIFFS FOR POWER.

Higher Rate (cents per kw. hour.)	Year.	Lower Rate Cents per Kilowatt Hour.								
		7	6	4	3	2.5	2	1.875	1.5	1
14	1904	--	1	--	1	--	2	--	--	--
	1910	--	--	--	1	--	--	--	--	--
12	1904	1	--	--	1	--	--	--	--	--
	1910	--	--	--	--	--	--	--	--	--
10	1904	--	--	--	--	--	2	--	--	--
	1910	--	--	--	--	--	--	--	--	--
9	1904	--	1	--	7	--	--	--	--	--
	1910	--	--	--	2	--	--	--	--	--
8	1904	--	--	4	23	--	5	--	--	1
	1910	--	--	1	24	1	6	--	--	--
6	1904	--	--	1	6	1	4	1	--	--
	1910	--	--	1	3	1	1	--	2	--
5	1904	--	--	--	--	--	4	--	--	--
	1910	--	--	--	--	--	3	--	--	--
4	1904	--	--	--	--	1	3	--	--	--
	1910	--	--	--	1	--	3	--	--	--
3	1904	--	--	--	--	--	--	--	--	--
	1910	--	--	--	--	--	--	--	1	--

The most common Wright tariffs are clearly;

14 cents to 8 cents
14 cents to 6 cents } for Lighting, and 8 cents to 3 cents for Power.
12 cents to 6 cents

and cooking purposes and in offices, warehouses and so on, needing artificial light during the day.

Rather than grumble at the complicated tariffs employed by central stations, the consumer should appreciate the accuracy with which the cost of supply can be determined at all hours, thus facilitating a strictly equitable charge for all demands.

During the past six years there has occurred a decided decrease in the selling price of electrical energy both for lighting and power purposes, this being demonstrated by Table 9, analyzing the flat rates charged for power and lighting, respectively, in various British undertakings. The abnormally high rates apply generally to small out-of-the-way stations or to small consumers with high maximum demand while the lowest rates apply to large stations supplying bulk consumers.

Taking an average of these figures it will be seen that the mean flat rates are: In 1904 for lighting = 9.94 cents (mean of 250); for power=4.64 cents (mean of 274); and in 1910 for lighting=9.58 cents (mean of 309); for power =4.02 cents (mean of 387).

This shows a decrease in the mean cost per kilowatt hour of 0.4 cent and 0.6 cent for lighting and power, respectively. A cursory inspection of Table 9 shows that the most common lighting and power rates in "purely lighting" areas were:

	1904.	1910.
Lighting	12 c. per kw. hr.	10 c. per kw. hr.
Power	6 c. per kw. hr.	5 c. per kw. hr.

This again demonstrates the cheaper supply now available. Table 15, in a later section, shows very similar reductions in the price per kilowatt hour of electrical energy supplied on this basis for street lighting purposes.

The familiar Wright system of charging is still in considerable favor in England though, as shown by the following analysis of some 270 stations, it is now used to a decreasing extent in the United Kingdom.

STATIONS USING WRIGHT TARIFF.

	Lighting Supply.	Power Supply
Year 1904	130	70
Year 1910	105	51
Reduction in 6 years	19.2%	27.2%

The data of Table 10, analyzes the actual charges enforced in these districts during the two years concerned, the high rate being usually operative for 1 hour's maximum demand per day and the low rate thereafter, though in some cases the higher scale endures for as short as one-half hour or as long as 2 hours. There is a slight, but decided tendency, towards cheaper supply, which is, however, more readily seen in Table 9.

The most common Wright tariffs are clearly:

14 cents to 8 cents, 14 cents to 6 cents and 12 cents to 6 cents for lighting, and 8 cents to 3 cents for power.

Since the advent of the metallic filament lamp there has been a marked reversion towards the older tariff systems, the salient feature of which was a certain minimum charge per quarter. See also later paragraph.

ELECTRICITY VS. GAS.

It is not proposed to go deeply into this time-honored and hackneyed, though vitally important, controversy, but the following summary representing the undeniable results of the comparison under working conditions in average English houses and streets may be acceptable. Gas burners are far less efficient than electric lamps in absolute luminous return for a given energy expenditure, assuming a fair comparison of types, that is, high pressure incandescent mantles with flame arcs; low pressure incandescent mantles with metallic filament lamps flat flame burners with carbon filament lamps. Energy for energy, however, gas supply is cheaper than electricity, and to this fact alone does gas lighting own its economic advantage in those cases where such can be shown, while, on the other hand, electric lamps are far cheaper in renewal charges.

The net result of these factors in practice is that metallic filament lamps and flame arcs are usually cheaper than corresponding gas burners both for indoor and outdoor lighting. That is, working on a basis of candle power hours and allowing for all direct costs. If such indirect factors as cleanliness, etc., which have certainly a monetary value, be allowed for, electric lighting goes far ahead. The contention that gas lighting gives better diffusion than is obtainable from electric lamps is of course absurd, this being purely a matter of the lamp, reflector and shade arrangement.

Incandescent gas mantles, whether low or high pressure, rapidly deteriorate in candle power and develop blow holes, cracks or various distortions due to shrinkage. The fragility of the mantles far exceeds that of the most delicate metallic filament lamps. High pressure gas mantles are the most serious rivals of flame arcs but, even in this case, the competition for lowest energy cost is very keen and, particularly where electricity for street lighting is cheaper than 6 cents per kilowatt hour, see Table 15, is often unfavorable to gas.

For street lighting purposes under legitimate average conditions, it has been demonstrated that flame arcs cost about half as much to operate as the equivalent high pressure gas system and tungsten lamps far less than half as much as the equivalent low pressure incandescent gas burners.

During recent years English gas companies have much decreased the quality of their gas. Much poorer gas is now legally permissible than was formerly the case; this is naturally desirable since the necessity for high illuminating value disappeared with the substitution of incandescent mantles for flat, flame gas burners. What is mainly required now is a hot non-luminous flame but hygienic considerations must also be regarded. The products of combustion of "legal" gas even, are not appetizing but in small towns, where gas-testing by public authorities is often administered very laxly, the material supplied has a fearful smell and in some cases actually deposits thick yellow sulphurous compounds on stove-bars, kettle bottoms, etc. The writer can testify to this from his own experience. In several such towns electric lighting is extending very rapidly. We wonder why!

Various patent gas plants, air gas, petrol gas and so on, have proved serious competitors of electricity in office and house lighting and where electric motors are employed to drive these apparatuses it has usually been found necessary to penalize the direct competition thus occasioned by charging a heavier rate per kilowatt hour for the motor supply. In large towns this class of consumer has become definitely recognized.

The next article continuing this general heading will take up the tendencies and features of lighting systems.

Principles of Illuminating Engineering.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

BY A. G. RAKESTRAW.

THE question of the proper intensity of the illumination required for various purposes, and the rules for computing these values have been considered in a previous article. Attention will now be given to the problem of securing proper diffusion and contrast, to the end that lighting shall be safe, agreeable and comfortable. This phase of the lighting problem has a distinct physiological aspect, as regards the effect of light upon the human eye and even a hygienic aspect, since the abuse of the eye is coming to be recognized as having no small effect upon the general health.

Apart from the desirability of having pleasant and restful illumination, the ruinous effect which poor lighting is having upon the eyes of school children, factory operatives, office clerks and others who are compelled to use their eyes for considerable periods of time, demands prompt and vigorous attention. The condition under which some of these have to work or study, with insufficient light, or with naked lamps of high brilliancy in direct line of vision, is largely responsible for headaches, nervous troubles, and the increasing use of spectacles. Some authorities claim that decreased vitality and other serious disorders are also results. Furthermore, eye strain with its accompanying headaches and nervous fatigue will produce mental depression and irritability, while proper illumination stimulates the mind, and encourages cheerfulness. In view of these facts, it is obvious that the betterment of lighting conditions is a matter of great importance.

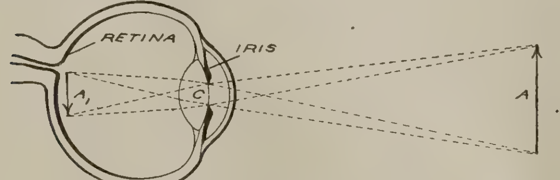


FIG. 1. SECTION OF THE EYE.

Since the eye and its functions will be dealt with largely a moment's study of this organ, of which a diagrammatic section is shown in Fig. 1, will be instructive. Neglecting those parts which are not of present interest, it is seen that the iris or diaphragm with its adjustable opening, serves as a stop to limit the amount of light entering the eye; the crystalline lens, automatically accommodates itself to varying distances, and the sensitive surface of the retina, upon which the image falls and the impression recorded. The retina also by its power of accommodation, assists the eye in discerning objects with widely varying intensity of illumination as great as 10,000 to 1. In fact, the eye is a natural duplicate of a camera but self-adjusting within wide limits in every particular.

In order to secure satisfactory vision, the light which enters the eye whether from the source itself or from some reflecting medium, should not be of too low or too high an intensity, should be properly diffused, steady and of an agreeable color, suitable for the purpose at hand. Diffused light is defined as light coming from all directions, as distinguished from directed light, which originates from a single point. These terms are somewhat relative, as there are all degrees of diffusion, from the piercing rays emitted by the naked carbon arc, to the perfect diffusion of a lightly clouded sky, so that there is no sharp dividing line between the two.

As usually applied to lighting, satisfactory diffusion means the avoidance of glare and obtaining an agreeable proportion of light and shadow. Taking these in order, glare may be defined as undiffused light striking the eyeball with such intensity as to cause discomfort. Of all the offenses against good illumination, it is one of the worst, as well as the most common, and also about the most difficult to obviate.

As it has just been seen, the iris of the eye attempts to keep the image on the retina of a certain intensity. There is, however, a limit to its action, and therefore a limit to the brightness of the surface which may be gazed at without brightness or fatigue. The brightness of a light-giving surface is called the intrinsic brilliancy, and is expressed in candle power per square inch or per square centimeter. In scientific work a unit has been adopted for this quantity, which is termed the phos and which equals one hefner per square centimeter. The following table gives the brilliancy in candle power per square inch for some of the common illuminants, according to determinations of the best authorities.

TYPE OF UNIT.	INTRINSIC BRILLIANCY IN CANDLE POWER PER SQUARE INCH.		
100 candle power filament in 12-inch frosted globe	.25		
Opal shaded lamp	.50	to	2.00
Gas Arc, albaster globe	1.00	to	2.00
Moore vapor tube	1.75	to	2.75
Incandescent lamp, frosted	2.00	to	5.00
Candle	3.00	to	4.00
Open gas flames (varies widely)	3.00	to	8.00
Kerosene lamp	3.00	to	8.00
Mercury vapor lamp	4.00	to	6.00
Gas lamp using mantles	20.00	to	25.00
Acetylene flame	75.00	to	120.00
Enclosed Arc with opal globe	100.00	to	200.00
Incandescent filament, bare	300.00	to	600.00
Nernst filament, bare	800.00	to	1000.00
Tungsten filament	1000.00		
Open arc, without globe	10000.00	and upwards	
Crater of open arc	200000.00		
Sun at Zenith	600000.00		

It may be interesting to compare the above figures with the brightness of a surface in terms of foot candles. Since one candle power equals 12.56 lumens, it will be seen that one candle power per square inch is equivalent to about 1800 foot candles. The statement is usually made in this connection, that the eye can safely look upon a surface of not over 4 to 6 candle power per square inch in brightness. This is only true in a general way, as there are other factors which must be taken into account, such as surface and distance. One might be inclined at first to consider the effect as independent of the surface, as it simply involves additional portions of the retina, but this is not true. A long line of lights will fatigue the eye, where one light will not. This effect is probably due to sympathetic action between different portions of the retina. It is also a matter of common experience that a certain light may dazzle the eye when close at hand, but produce no discomfort whatever when at a distance. It is true, of course, that the atmosphere absorbs part of the light, yet the main reason is that less light flux enters the eye.

Furthermore, it is known from experience that a bright light shining in the eyes at night is blinding, while the same light in daylight is not even noticeable. The reason for this is that in daytime a vastly greater flux of light falling on the eye is accommodated by the iris and retina, and the presence of the other light in the field of vision does not call for any special accommodation, and therefore causes no discomfort. At night, however, the iris is wide open, and the retina sensitive to light of very low intensity, When the bright light is seen, the image on the retina is painfully bright, and the iris contracts accordingly. The eye, however, still attempts to penetrate the shadow, which calls for the opening of the iris. Being subjected to conflicting tendencies, the eye is therefore strained.

The effect of a light source on the eye therefore, depends not only upon the intrinsic brilliancy of the surface, but upon its extent. That is, upon the total amount of light flux which enters. It also depends upon the adjustment of the iris and retina, which in turn depend upon the relative brightness of the general surroundings.

Turning from the physiological considerations, the methods of securing diffusion and the remedy for glare will be considered. Diffusion depends upon the number and position of the light sources and the kind of reflecting surfaces. The most common and distressing instance of glare is the presence of naked lights in the line of vision. In factories it is not uncommon for the workman to have an unshaded lamp burning constantly just in front of him. In churches the front of the auditorium is usually provided with a number of bright lights, which are impossible to avoid and maintain any appearance of attention, and it is no wonder that the occupants of the pews, finding it easier to shut the eyes than to look at the lights, should go to sleep. In assembly rooms, public buildings, hospitals, and other similar buildings, the lights are, as a rule, very poorly arranged in this respect. Besides the glare coming from the lamp direct, what is called streaked light caused by reflection from the polished surface of books and papers, is present. This is even more harmful, since the retina cannot adjust itself to the streaks of varying intensity. It has been stated that there are more eyes ruined from this cause than from any other one, since the nature of the work done under these conditions is such that the operator has to look at this streaked surface almost constantly.

The avoidance of glare is more a matter of how not to arrange the lighting, than how to arrange it. In general, there are three ways by which relief has been sought namely: By keeping the lights out of the line of vision, by concealing them, and by providing with diffusing globes or shades.

Relief from glare is often sought by placing the lights high overhead. The effectiveness of this remedy depends upon the size of the room and the height of the ceiling. It has been stated that in order to keep the light from striking the eyeball when the vision is directed straight ahead, the source shall not bear an angle to the eye greater than 25 degrees to the vertical. The illustration, Fig. 2, shows a room drawn to the scale of 50 feet in length, with a

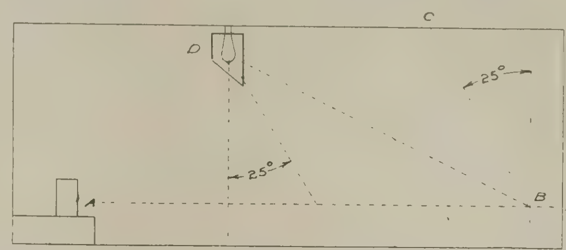


Fig. 2. Location of Source of Light With Reference to Observer.

ceiling 20 feet high. If B is the position of an observer in the rear of the room, it is evident that any ceiling light further front than C, would be within the range of vision, and if any light is hung at a position D, it should be provided with a shade which shall intercept all light thrown backward at a greater angle than 25 degrees. Since the eye is normally directed somewhat downward, I think this figure could safely be increased to 40 or 45 degrees.

The second method, that of concealing the lights altogether, is coming into use rapidly and is called indirect lighting. In its earliest form, shown in Fig. 3, it was called cove lighting, because the lamps were concealed in a cove around the borders of the room. These installations, however, did not prove very satisfactory because limitation of construction usually necessitated placing the lamp on its side, thus restricting the source to the inefficient carbon filament lamp. Furthermore, the cove proved to be an excellent place for dirt and dust to collect and being difficult of access, soon became dusty and caused a great loss of light. Also as will be seen from a study of the figure, many of the light rays have to be reflected several times before they reach the plane of illumination.

Another system of indirect lighting which is meeting with favor is shown in Fig. 4. In this case the tungsten lamp is used, and the light is strongly directed against the ceiling, by specially designed reflectors, and thence to the floor. This system is not limited to incandescents. Fig. 5 shows an inverted arc lamp, in which the body of the lamp is below the arc, thus being particularly adapted for this purpose. Fixtures for the indirect lighting are designed substantially

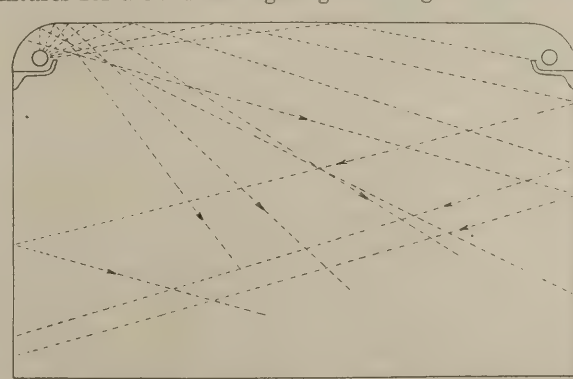
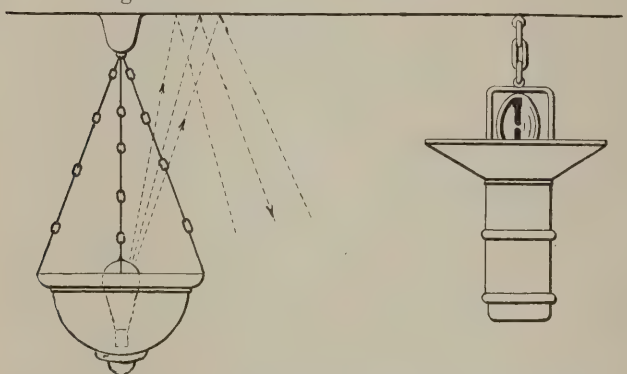


Fig. 3. Illustration of Cove Lighting.

and artistically, and are no longer to be considered as experimental but take their place along with other lines of standard fixtures.

The great advantage of the indirect system is the entire absence of glare, and yet there has been some objection made on the score of too great diffusion. We know that when working for some time under a bright light, we seek relief by turning the eye for a moment to a darker surface. With this system, however, there is very little shadow and in some cases the light is too flat to be pleasant. The appearance of the indirect system to a person entering the room is peculiar. The first impulse on beholding any illuminated surface is to look for the source of light which in this case is not visible. The eye is therefore not satisfied and there remains the impression of something wanting. To remedy this, there has been introduced the semi-indirect system in which the enclosing bowl is made of some material which while strongly reflecting the light, allows a portion of it to be transmitted and thus satisfy the desire to see the source of light.



Figs. 4 and 5. Indirect Lighting Arrangements.

The efficiency of the indirect system is better than would at first appear. The impression on entering a room thus lighted, is that of low intensity and yet when one undertakes to read or write, it is surprising how well one can see. The reason for this is that since there are no bright lights visible, the eye can work with a much wider aperture than otherwise. The energy consumption for a well designed indirect system, while more than for an efficient direct installation, is considerably lower than for the ordinary wasteful installations that we so often see.

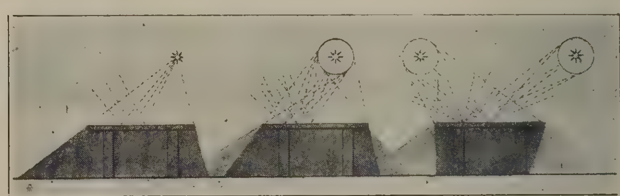
The third method of avoiding glare, which is by the use of diffusing globes, is the method applicable to the largest number of conditions. Contrary to common opinion, simple frosting does not do a great deal of good. The intrinsic brilliancy is less, but the total light falling on the eye is only changed by the amount absorbed in the translucent medium. If the lamp is surrounded by a still denser medium, such as opal glass, the amount absorbed will be greater. The following table shows percentage of light absorbed by different media.

MATERIAL.	PERCENTAGE OF LIGHT ABSORBED
Clear glass	10
Holophane prism ware	12.3
Light alabaster	15
Light sandblasted glass	20 to 25
Opalescent glass	20 to 40
Ground glass	25 to 30
Opal glass	25 to 60
Milky glass	30 to 60

Note: It is claimed that the combined reflection and transmission from the best opal glass may be as high as 97 per cent.

Frosting in connection with diffusing reflectors is of great benefit. The light is directed where it is needed, and a comparatively small amount enters the eye. Several kinds of these reflectors were considered in the last number of this paper.

Closely allied to the question of glare is that of contrast, or the proper relation of light and shadow. If there is too much contrast, the room will have a harsh and unpleasant appearance, the high lights will tire the eye. The eye will also be strained in trying to distinguish objects in the dense shadow. A single brilliant light source such as a naked arc, where the light practically comes from a point, when suspended in a room is an example of this. On the other hand, if the light is too well diffused, coming from all directions, there will be hardly any shadows at all, and the room will appear flat because the eye is accustomed to locate objects largely by light and shadow. Moreover, this is tiring on the eye. The muscles controlling the iris and the crystalline lens need exercise, therefore there should be adjustment of these parts from time to time and a room thus lighted affords no opportunity of so doing. If we sit in a sun parlor on a lightly clouded day, with strong light coming from all sides, we will notice this condition. Daylight coming through windows on one side of a room only is an example of light which is well diffused and yet which gives a good degree of contrast.



Figs. 6, 7 and 8. Shadows Cast by Table Lighted With Different Units.

In Figs. 6, 7 and 8, the shadow cast by a table lighted by one bare lamp, a lamp with a diffusing globe, and two such lamps, is shown. In the first case the change from light to shadow is very abrupt and the eye is under conflicting tendencies in trying to adjust for both. In the second case the transition is more gradual and since the source is shaded, the eye is in better adjustment to pierce the shadow. In the third case, the condition is still better. Not only is the effect of the diffusion to lessen the abruptness of the light and shadow, but the light striking the walls, ceiling, etc., is reflected in different directions and better diffused in general, thus helping to soften the high lights and relieve the dense shadows. The figure shows the direction of the reflection from the table tops. The next article in this series will take up the subject of color.

Reduction factor is the ratio of mean spherical candle-power to mean horizontal. It is usually a fraction and is commonly expressed as a percentage. The reduction factor for the common oval anchored type incandescent lamp is 82.5, so that if the mean horizontal candle-power of such a lamp is 16.0, the mean spherical candle-power would be 82.5 per cent. of 16.0 or 13.2.

Insurance Engineering and Fire Prevention

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

BY W. J. CANADA.

CONSERVATION is attaining some popularity of late, and in no direction has greater progress been made toward the conservation of our natural resources than in the reduction of the fire waste by fire preventative and fire protective measures, originating in the systematic effort of the more or less unpopular underwriters' associations. As communities attain to permanency and stability, interest rates become smaller and abnormal profits from building investments cease. Property values subject to one fire increase. Fire protection rapidly grows in expense, insurance rates become proportionally a greater factor in the profit and loss account and illogically enough, the insurance rate is called into question first, rather than the necessary measures for preventing fires or confining their extent, and so reducing the expense both of insurance tax and of fire department maintenance.

Investigation by the city or plant at this stage, shows that without effective check, building construction has been largely of combustible material disposed in the best designed manner for fire propagation. Architect and builder have failed from the fire resistive standpoint, and the community has failed to keep active fire hazards at a minimum. The natural growth of the city has demanded larger buildings. Size and extent of exposures considered, the so-called brick building, actually frame buildings with brick exterior walls thoroughly pierced by draught producing window openings, constitute a greater conflagration hazard by far than the small and more or less isolated frame buildings with frame exterior walls which preceded. The larger buildings also contain a greater variety and density of fire productive processes and the number of fires to a given city area is increased.

When the causes of fires and their method of propagation are tactfully and thoroughly explained our building methods are found to have been very amateurish. We have built up expense to a degree unheard of abroad, to maintain equipment and men for fighting fires whose inception and spread are entirely unrestricted. The understanding of this condition is fortunately becoming more general among business men and the remedy is self evident; first, fire resistive construction and fire barriers to prevent conflagration; second, regulation of known hazards and definite assignment of responsibility to prevent fire inception. These items should be reversed, but having before us the impossibility of immediately and completely reconstructing our city already built, we must in our new buildings which constitute our ultimate city, pay even more attention to their invulnerability, than to their own occupational hazards.

There is, to be sure, opposition to this reversal of our former illogical city building. There are not wanting men, who regard license to build straw houses and fill them with natural combustibles of every kind, as the true expression of "liberty enlightening the world." A mayor in a city of 1,600 recently stated that he regarded any restriction on building construction or operation as an abridgement of personal liberty. Fortunately there were men of sane judgment in that city. But the spirit of discontent under restriction is the final cause of our average class of building and the average grade of active fire hazards it contains, and we have in the past paid for this license in an annual fire loss ten times as much per capita as that of any other civilized nation under effective restrictions. Each individual in the country directly or indirectly contributes a tax toward this drain and the expense of distributing it, and the national wealth suffers a yearly loss, from the avoidable ash heap, of $250,000,000, besides the enormous and illogical fire fighting expense, and a death list of victims to the idol of mistaken personal liberty.

Combatting the causes and spread of fires is the field of the insurance engineer; to fill the growing demand of cities and building owners for real assurance against fire, instead of insurance against the penalty of pecuniary loss. The work of the insurance engineer covers the investigation and exposition of every feature affecting fire hazard or fire fighting. Even with every hazard removed the probability of fire loss from neighboring breeders exists and must be minimized. When fire is once established in the building, its confinement to the locality of its origin must be guaranteed by construction and fire fighting equipment. Fire fighting is effective only in comparatively small fires which must be assured by minimizing combustible material in construction and storage.

Among the principal active hazards now largely unchecked by municipal restrictions in our cities, but fortunately avoided in many new buildings by well advised owners, are improper disposition of rubbish and ashes, poor flue construction, careless handling of friction matches, gasoline stoves and lamps, stores with inflammable surroundings, coal oil lamps, defective electric wiring.

These causes are given much in the order of importance. The electric wiring hazard in new buildings of many cities has been made entirely negligible, by adoption and enforcement of ordinances requiring iron conduit, the only form of wiring construction comparing in permanency with well erected buildings. Gasoline and coal are among the more serious offenders, but the general use of electricity is reducing fires from these causes also. Among the common mediums for rapid propagation of fires, observable in foreign civilized countries only in exposition construction, or other temporary construction, are unprotected floor openings, ordinary joist floor construction, ordinary stud interior wall construction, and ordinary glass sky-lights. These all operate when fire has once gained headway, as they are usually lined with kindling wood in the shape of lath and rough planking in partitions and floors, wood finish in stairways, elevators and sky-lights, the many miniature flues thus create draft.

The ordinary glass window in wood frame, is a neighborly invitation to surrounding fires to come in and be sociable, and the fact that forty per cent. of our total fire loss originates in other buildings than those damaged, demonstrates the questionable value to the community of the personal liberty which entails such construction as a possibility from its initial cheapness, as our almost universal practice.

The insurance engineer finds the antitoxin for our national disease, the fire waste, in the extermination of carelessness. In reality he is in much the same condition of practice as the physician—gradually undermining his own reason for existence. How very slowly this is done by his influence on fire reductions is a severe reflection on the commercial foresight and solidarity of our citizens. In times past there have not been wanting nations who regarded disease as a God-given affliction, and refuse to better their sanitary conditions. The parallel is perfect as to fire prevention in this country. The fire prevention engineer is therefore usually an insurance engineer, because the nostrum of fire insurance is necessary in the failure of real prevention, and the insurance companies are obliged to at least measure the hazard which they have no authority to effectually prevent by rule.

Given a community or individual sufficiently informed as to the amount of fire waste and the economic necessity for its avoidance, the fire prevention engineer has his field ready and finds his co-laborers far too few. He must be not only thoroughly instructed in the physics of building construction, but physical and chemical properties of the material in both building and stocks, the active heat and flame producers in processes, and careless heating and lighting methods and arrangements. He must also understand the inter-relation of these factors in the fire hazard, balancing the potential hazard which must exist in every variety of disposition of material, and in every operation of our daily life, with construction methods calculated and demonstrated to minimize these hazards.

At the very least he must confine the fire to its smallest possible proportions, under the axiomatic assurance that small fires are easily extinguished by a rug, a pail of water, or a hand chemical, while large ones defy organized attack with the largest volumes of water and the largest pressures possible to handle. His work is to form the basis of construction on which the architect and builder build the structure, adapted to its special purpose and requisite strength and arrangement. Too often the fire prevention engineer, too late to change vital features of construction, must introduce less effective barriers against fire spread, and deal with active but avoidable existing hazards as best he may. Even after the best possible physical conditions are attained in a building, changing stocks, inherent hazards of processes, and most of all our national tradition of irresponsibility and resultant carelessness, will all contribute to maintain a goodly portion of at least incipient fires. The fire prevention engineer must apply himself next to the removal of hazardous occupancies from congested portions of cities, keeping fully in his own mind, and that of his patient, the individual property owner or the public, The fact that the application of good construction methods to one building by no means removes its danger from neighboring buildings with large amounts of quick burning contents, and that with sufficient inflammable stock, a fire originating in one occupancy of a fire resistive building may destroy all stocks throughout the building.

Such occupancies as garages, dry cleaning establishments, hay warehouses or heavy hay stocks, broom factories, chemical stocks, mattress works, moving picture film exchanges, paint and oil stocks, and manufacturing, wood workers are all undesirable occupancies both for a particular building and its neighbors. Ideally they should be isolated so that they are a hazard to themselves alone. Failing in this every feature of hazard should be guarded by supervision and slow burning surroundings in all possible ways.

In the absence of concerted action to combat the fire waste by Federal, State, and uniform municipal regulations and supervision, our cities are today a Babel complete as regards to few building restrictions existing in any one community, the character of occupancies and the guarding of internal hazards and external exposures. One city has one advantageous feature, the next another; none has anything approaching perfection even in its latest buildings. The regulations it has made from time to time are usually the offspring of emotional horror following some purely local catastrophe, resulting from glaring, but previously unremarked fire breeding arrangements. It has taken no lesson from the fire losses of neighboring cities.

The work of the insurance engineer entails educational campaigns, and appeals to the dormant public spirit of unobtrusive good citizenship, as opposed to the rampant public spirit which must be fed by political emolument at every move. The understanding of the individual and a social spirit of economy must be established before even the first tottering steps be made toward consistent progress.

In his effort to secure harmonic advance toward the reduction of fire waste, the engineer has no readily receptive audience. His object is as clearly defined as that of any railway system designer or any promoter of manufacturing plant. But he is far more embarrassed by existing growths both of physical conditions and ideas, and the profit he can hold out to his investor is a negative one, which is a new idea. He can save him on the average from an entire loss and his own property from probability of any large loss. The American habit of taking chances extends to fire also, and must be overcome.

The progress toward fire waste reduction is usually very gradual, marked with more rapidity when unusual calamities have recently occurred. Expediency often necessitates much added expense in fire fighting facilities during the stubborn opposition of real dangers to fire prevention. A hopeful indication is the greater general publicity being given to the problems of fire resistive construction and the causes of fire. The insurance engineer is becoming continually a better known and more utilized factor in most communities. And as one municipality or property improves, aggressive publicity carries the spirit to neighbors. One good example of consistent public improvement along these lines, is the missionary center, and the insurance engineer finds at present a demand which may be expected soon to become more restricted as the municipal law, formerly neglectful, places proper responsibility for the fire waste they cause or to which they contribute on those who design, those who build, and those who occupy its buildings.

Candle hour represents a definite quantity of light just as horsepower hours represents a definite amount of power. A source of 10 candle-power operated for 1½ hours would produce a total of 15 candle hours and operated for 4 hours would produce 40 candle hours.

Economy in Telephone Construction.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)
BY ROY C. FRYER.

CONTINUING this subject from last issue, the features of the survey of a telephone line will be taken up. The superintendent should be equipped for taking notes, and should inspect everything to be sure he is well provided for. He may then proceed to direct the survey. Starting at central, let the forerodsman plant a stake where the first post should stand, and place on it a tag, numbered one. Then let the transitman place his transit in position over this stake, and the forerodsman place a stake at the location of post No. 2, and placing his rod on same, give transitman line. Clamping his transit-head in place, and loosening his needle, the transitman may read the deflection. This the note-keeper should record. Then the needle may be again tightened, for it will be better to run by the deflection. Taking his end of the chain the rodsman may then proceed to place of post three, followed by the transitman to post two. The backrodsman takes his place at post one. When the transit is located at post two, back sight should be taken on post one, the bed of the transit clamped, and the angle turned to post three. If post three is straight ahead, the angle will be zero, or if out of line, the angle will be read right so many degrees, or left so many degrees. This should be recorded also by the bookman, together with the number of the stake.

If at say number 5, the angle is abrupt, or the pole should come in a very low place, the notes may specify "pole tapped for double cross arms." Or if at some other number, say 22, the line should cross that of another line, the notes may specify height of post, etc. This will prevent placing a short pole where a long one is necessary. After a few trials all hands will become accustomed and the work will move more rapidly than expected. When all is finished, a good plat can be made from the notes, and much valuable information will be recorded. The line will be laid out in a much straighter line, and more substantially done by being worked out systematically. In turning very abrupt corners, two poles should be placed closer together than usual and double guyed as shown at Fig. 1. Of course the superintendent will not install poles in place at this time, but he may lay out the diagram as in Fig. 1, by use of the transit and stakes. Stakes for line poles should be numbered only consecutively, while those of the guy-holes and stub guys are lettered. A good plan is to letter single guy stub hole as "a," and a workman on finding a stake marked "a" will know the size and shape of hole to dig. Likewise letter single strain guy stakes "b," double strain as "c" and stub and strain combined, as in guying on opposite side of road from line shown in Fig. 2, letter "a-b" as marked.

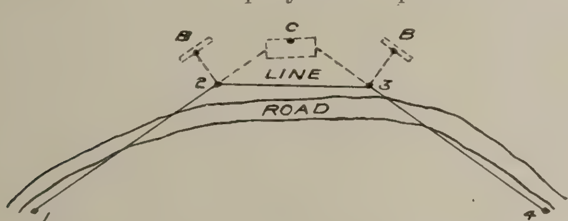


FIG. 1. GUYING FOR ABRUPT CORNERS.

In laying out these measurements, the distance of the guy holes from the pole holes will be governed by the height of the poles in the line. Short poles can be guyed closer than to high ones, considering the angle to be the same in both instances. Considering the angle turned constant, the distance from foot of pole to guy should vary in most cases, directly in proportion to height. There are times, however, when this will not hold good, as in very loose loam. Therefore, in laying out a diagram and plan in guying, guy farther from the pole in light loam than in clay. But be careful and do not make the most common mistake of all in guying too close to the foot of poles.

In climbing steep hills, do not forget head guys. Some may think that this should not be considered in the survey. But these are the writer's reasons. The superintendent in charge should know his business. The man who digs the holes is not expected to know how to guy well. If the plan for guying is not worked out properly, and the superintendent is not present when the corner should happen to be reached, the workman in absence of orders may use his best judgment, which may sometimes fail him, as in a typical instance as follows: The work of digging the guy holes was left to an inexperienced foreman with the result that he placed a hole for a strain guy too near the post. This was on a line handling two busy tolls from a town of 1,500 to the city forty miles distant. All went well until March, when a few warm days were succeeded by a heavy sleet and a quick freeze. Before the ground could freeze deep the taut wires pulled the guy and the corner, 15 miles from town, gave way.

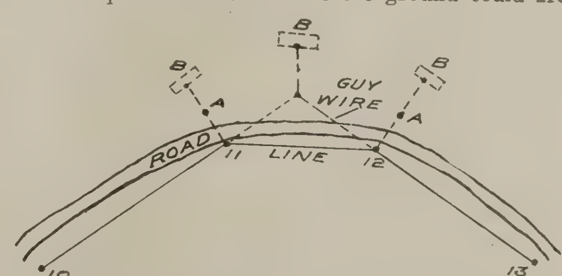


FIG. 2. GUYING ON OPPOSITE SIDE OF ROAD.

Two busy wires were wrecked, and the company lost in toll the wages of an entire gang of men for half a day. With proper care such accidents cannot be prevented, but they can be lessened. It is therefore well to lay out guys as well as lines are layed out. Clay offers a good ground for guying, but it too will soften with the thaws and rains. Rocky country is hard and tedious to the telephone man, but a line well and properly constructed through a rocky country will be a stout line.

INSTALLATION FEATURES.

Having completed and tabulated the survey in all its details, the superintendent will next purchase poles, guys, guy wire, cross-arms, etc., of a height, size and quality suitable for his use. Depending upon the country and shipping facilities, the poles may be chestnut, cedar, or locust. The height will depend upon county regulations. In general, for lines carrying a ten-pin cross-arm 25 to 30 ft. on most high-ways is sufficient.

This of course will have been calculated before and during the survey. Upon arrival of poles, they may be numbered according to the notes to see that every pole is delivered at its proper place. Meanwhile the superintendent will have been engaged in the selection of workmen, selecting those of experience and reliability, for what is more provoking than that one of your hands does not appear.

The superintendent must also ascertain the rate and time of payment of men, make all arrangements and keep accurate time, or see that there is some one to do it. Sometimes it will be of advantage where labor is high to contract piece work, and at other times to pay by the day or hour, unless the labor is governed by unions, and this is seldom the case in rural communities.

One successful telephone man of the writers' acquaintance always said, "Let your slow man shovel, and your fast man dig." This is not much of an axiom, but it may save dollars and cents when properly applied. It will sometimes pay to keep your business entirely to yourself, but if you can interest your men you have gained a good point. You will then be more confident that in your absence the work will be more thoroughly accomplished. Nothing is more pleasing than to see arising between the men a keen competition in the quality of their work. This one point in telephone work calls for all the tact and knowledge of human nature possessed by the superintendent, and when rightfully used will show up later in time saved and in thorough work.

Some Important Features of Patents.

(*Contributed Exclusively to* Southern Electrician.)

BY MAX W. ZABEL.

IN the articles previous to this one on the question of patent claims, various features have been pointed out to indicate the all-important feature of these claims. It has probably been sufficiently emphasized what the claims of a patent control and these matters must be properly understood. A feature to be borne in mind is that an inventor is bound absolutely by what his attorney does during the prosecution of his application in the Patent Office. Consequently, an inventor must use due care to whom the application is intrusted and cheap services should be shunned more in patent work than in any other character of work of which the writer is aware.

The United States Supreme Court has held as follows: "The Court could not distinguish between the patentee and his counsel as to what occurred during the pendency of the application for the patent, and, as to the acceptance of the latter, the patentee must be regarded as bound by the acts of his counsel. That the negligence of an attorney in prosecuting an application is no excuse for defects which may exist in the patent. It will hardly be counted that the mistaken advice of a patent solicitor can override a statute of the United States."

When a certain art has been thoroughly covered, a claim for an apparatus in that art, is more narrowly construed than if the claims covered an entirely new art. If the margin of patentability of the claim is narrow and the applicant because of rejections, amended it to include certain details of construction in order to secure an allowance by the Patent Office, he is bound by the addition of these details in his claims. The claims of a patent cannot be so broad by judicially construing or interpreting them as to cover devices of alleged infringers when this would necessitate including claims which have been rejected by the Patent Office and cancelled by the applicant.

It is thus dangerous to cancel claims or to amend them if a claim should be allowable as originally filed. When a patentee limits his claims after a careful discussion of substantial issues raised in the Patent Office and the invention is of a narrow and doubtful character he must be held by the restrictions thus imposed. Acquiescence in the rejection of a claim on references cited in the Patent Office and the issue of a patent with an amended claim stops the patentee from maintaining that the invention claimed covers the devices shown in the references or that it has the breadth of the claim rejected. Likewise, when a claim is deliberately restricted in its terms, by amendment after it has been rejected by the Patent Office, in order to obtain a patent, the patentee cannot ask the Court to construe such limited claim as if it were the broad rejected claim. The patentee, of course, is entitled to have his patent taken as it reads with due regard to the inventive idea embodied in it, without having it taken in such a way as would virtually restrict it, but the patent must be taken with all its limitations and resort may be had to its course through the Patent Office to determine these limitations.

Rejected features cannot be reasserted nor a broad construction inserted, when a narrow one has been accepted by amendment to meet the objections of the examiner. It might be said of course, that an amendment inadvertently made to a claim and afterwards withdrawn cannot be construed as a limitation. It might also be said that statements, made in written arguments in the record of an application in the Patent Office, do not limit the terms of the claims when the latter have not been correspondingly modified.

When a patent has issued only after repeated rejections, much solicitation and several amendments, it must be confined strictly to the precise language ultimately agreed upon. When an applicant for a patent amends and limits his claims to meet the objections of the Patent Office whether said objections were well founded or not, he is not entitled to a construction of these claims making them as broad as those rejected.

The claims in a patent must be interpreted in view of the original claims made and filed and rejected or amended and a complainant cannot include broadly anything that was rejected by the Patent Office unless finally allowed in the same language. When the Patent Office rejects a claim as not patentable in view of the prior art but suggests that if the limitation "depending," were made at a certain point, the claim would be patentable, and the applicant acquiescing makes the amendment, then the patentability depends on whether there is an invention in making that part "depending."

A very large portion of the above wording is taken verbatim from decisions actually rendered by the Court on this subject and it must necessarily be apparent from this how all important is the procuring of a patent and how a patentee is limited absolutely by what his attorney does while the patent is in the Patent Office, besides being of course limited as to what the claims actually set forth. The very highest degree of technical ability therefore should always be obtained when an invention of any value is concerned, and it might not be out of place to say that for an inventor to listen to the offers of cheap patent services is equivalent to sacrificing a good portion of, if not all, of the value of his patent.

The next article taking up this subject of patents, will deal with some instances of peculiar patent law.

Heat, Light and Power in Buildings.

BY C. M. RIPLEY.

AT A RECENT meeting of the National Association of Building Managers, held at Washington, D C., a paper was presented, entitled "Heat, Light and Power in Buildings," by C. M. Ripley, vice-president of the Engineering Supervision Company at New York City. The information presented in the paper strongly favors the independent power plant and so much data is given showing the operation of such plants, as against operation on central station power, that it is of special interest.

Several types of plants are taken up and we publish an abstract of the paper giving data on each type of plant. For seventeen buildings in New York City the total yearly operating cost for the four items, heat, light, power and engineer's services for repairs, is given. One of the innovations of the paper is that the actual names of most of these buildings are mentioned, giving an opportunity of verifying the statements.

The term "Cost of Electric Plant" refers to the extra engineering investment which the building owner made in

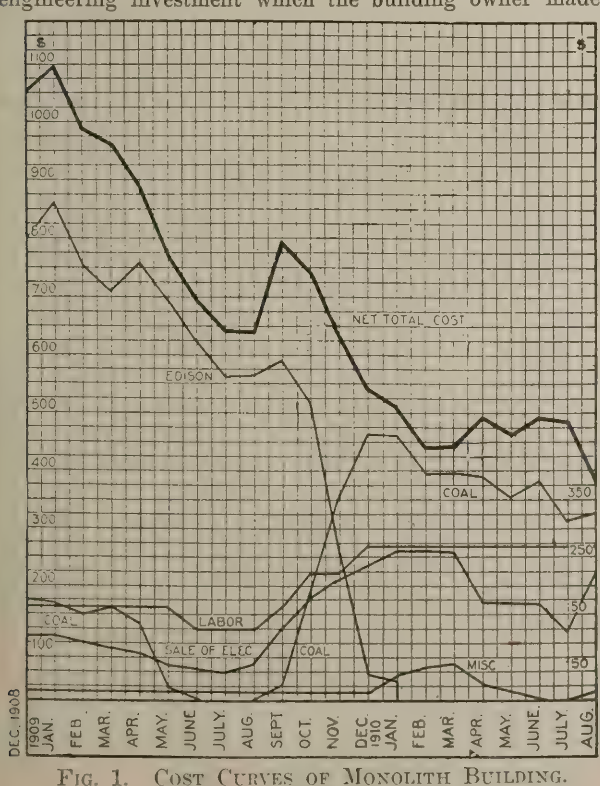


FIG. 1. COST CURVES OF MONOLITH BUILDING.

excess of the cost of a heating plant only. Depreciation is figured at 5 per cent. and interest at 5 per cent. on the original investment. The different types of plants are taken up separately and analyzed.

The Monolith Building curve as shown is instructive, as it shows graphically the detailed operating cost on the building manager's book for the past twenty months. Three different kinds of operation are shown during this period, as follows: From December, 1908, to October, 1909, the building was on Edison service exclusively. From October, 1909, to January, 1910, they were starting up the new electric plant, using some Edison and some of their own electricity. During the remainder of the time they were using their own electricity exclusively. The total net cost is the heavy black line at the top and is obtained by adding all operating expenses for the entire twenty months and subtracting therefrom the entire income from the sale of eletricity to tenants and neighbors. It is this difference month by month that locates the points on this curve. Also on August first of this year they started to supply the New Netherland Bank with electricity, which it is expected will bring in about $1,400 per year increased income, making total cash from tenants and neighbors about $3,600 per year.

The curves show the variations in the different items of expense, month by month, and that a net saving on the building manager's books of between $450 and $600 per month has been effected. A most interesting fact is to be strongly emphasized here, that the saving is paying for the electric plant. Actually the payments on the plant were arranged to be spread over a period of three years and no extra investment was required at all. An important item, and one likely to be overlooked, is that with the electric plant installed the income of $3,600 is contrasted with the meager income from tenants of $879, which was received in the year from December, 1908, to December, 1909, with Edison service. The itemized costs of the main parts of the electric plant are as follows:

3 Ridgway engines and dynamos	$ 5,500
Switchboard	927
Storage battery	3,000
Electric meters	552
Main items	$ 9,979

It is unfortunate that the plant has not been running for a year. But the year's cost on Edison service for the year April, 1908, to March, 1909, was as follows:

No. 1 buck. coal, at $3.35	$1,047
Engineer	1,300
Fireman	350
Ash removal	120
Lamps	209
Edison service	7,905
Repairs	100
Supplies	100
Total	$11,131
Sale of electricity	379
Net total cost	$10,752

It is highly probable that next winter they will stop burning $3.35 coal and change to $2.25 fuel. Tungsten lamps are used throughout. These figures on the Monolith, were possible, through Mr. Vivian Green, one of the owners of the building.

The Acker, Merrall & Condit Building. This is part loft but mainly office building, eleven stories high, on corner plot, 86 x 150. The building contains three electric passenger and two freight elevators. Also a small plant for furnishing the refrigerating required in a ladies' lunch room on the ground floor. Edison service is used exclusively at this time, although a contract has been signed to install a complete plant. The operating cost for the past twelve months is as follows:

Screenings, at $2.22	$3,602
Labor	3,567
Edison service	12,427
Miscellanies	1,520
Total cost on Building Manager's books...	$21,116

The electric consumption is larger than should be, totaling 256,932 kilowatt hours. But the building was not designed for tungsten lighting, and the owners have not seen fit to change the lamps.

The Security Mutual Life Insurance Company Building, at Binghamton, N. Y., six years old. The only difference between unit prices at Binghamton and New York City is that they get coal at $3.00 per ton there, that we would have to pay $3.35 for in New York. So, aside from this difference, amounting to about 10 per cent. of the fuel bill, the conditions can be called the same—really in favor of New York City, because Binghamton is colder than New York City.

This building is on a corner plot 70 x 140, ten stories in height, containing two plunger hydraulic elevators, which

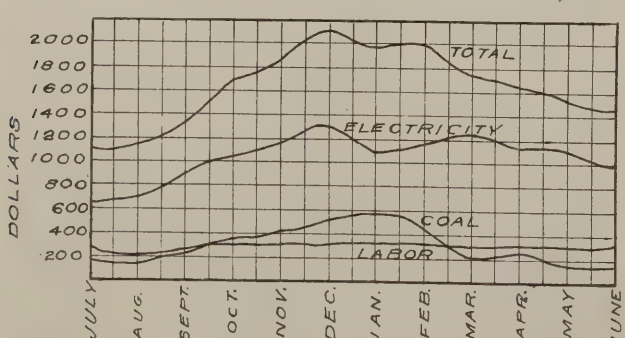


FIG. 2. COST CURVES OF ACKER-MERRALL & CONDIT BUILDING.

made 232,000 trips in 1909; also contains an electric plant which delivers 340,000 kw. hrs. per year. Of this, 255,000 kw. hrs. are for light and 88,800 are for power. A large electric sign using 350 lamps is burned every night. The cost for the year's run of 1909 was as follows:

Coal—No. 1 buckwheat, at $3	$4,062
Wages	3,208
Miscellaneous	800
Total	$8,070
Sale of electricity	600
Net annual cost on Building Manager's books	$7,470
10 per cent. fixed charges added by Treasurer's books	1,500
Total operating cost on Treasurer's books..	$8,970

This plant was designed by Mr. P. R. Moses and he has been in close touch with the engineer, Mr. Asa P. Hyde, to whom I am indebted for the above figures, as well as for the data on the relative efficiency of steam and electric elevator pumps, which follows later. It is estimated by the consulting engineer that it would cost $3,200 per year in coal and labor to run this building in case electricity were bought from the street. If this estimate is correct, then the 340,000 kw. hrs. are made at a cost of 1.6 cents each. For the first six months of this year the operating expense was $4,300, elevator trips 131,908, and the kw. hrs. 180,530. In October, November and December of 1909 the coal bill was $37.00 more than for the same period of 1908, but the Carnegie Library was supplied with electricity, heat and hot water. The Phelps Building was also taken over with the resulting increase in electrical consumption for the three months of 13,350 more kw. hrs. Therefore, the cost of these additional kw. hrs. was 3/10 of a cent each, since the fuel cost was the only cost for producing them. The plant cost less than $15,000. One Skinner engine and two Ridgway engines are direct connected to Westinghouse dynamos supplying current for 2,500 incandescent lamps, one electric pump, a complete printing plant, and a total of 25 motors from 1 to 40 h. p. each.

LOFT BUILDINGS FOR LIGHT MANUFACTURING.

The Langsdorf Building, corner of Spring and Crosby Streets, is 12 stories in height, on a corner plot 100 x 100. The building originally had Edison service. A plant was designed consisting of two units, only one of which was installed at first to demonstrate the facts, which follow: This original installation with means for the additional unit cost about $8,300. It consisted of a Fishkill Corliss engine belted to a C. & C. dynamo of 125 kw. Wing blowers were installed to facilitate the burning of refuse and sawdust from the wood working plant. For the year July, 1909, to June, 1910, the costs were as follows:

ACTUAL COSTS FOR HEAT, LIGHT AND POWER FOR ONE YEAR.

Screenings, at $2.23	$3,179
Labor	2,929
Ash removal, repairs and miscellaneous	950
Total manufacturing cost on Building Manager's books	$7,058
Less sale of electricity	2,835

Net manufacturing cost on Building Manager's books	$4,223
10 per cent. of cost added by Treasurer	830
Total net cost on Treasurer's books	$5,053

The above is the cost of making 180,910 kw. hrs., heating the building, furnishing live steam, repairing elevators, repairing the plant, cost of oil and miscellany, but not including lamps.

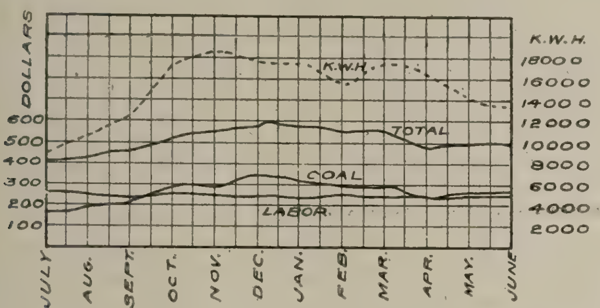


FIG. 3. COST CURVES OF LANSDORF BUILDING.

ESTIMATED COST, IF ELECTRICITY HAD BEEN PURCHASED.

No. 1 buckwheat coal, at $3.35, for heat, hot water and live steam	$1,550
Chief engineer and superintendent	1,200
Fireman, 12 months at $55	660
Edison electricity, 180,910, at 5c	9,045
Care of elevators, repairs, oil and grease	350
Total	$12,805
Less sale of electricity	2,835
Net total cost of buying electricity	$9 970
Actual total cost when making electricity	5,032
Difference in favor of making electricity	$4,938

Here we have an $8,300 investment saving $4,900 per year after it has saved money enough to pay interest on itself and money enough to pay 5 per cent. depreciation; $4,900 per year is almost 60 per cent. per annum on the investment of $8,300. Authorization was given late this summer to complete the plant with the addition of a 150 h. p. Brownell engine and a 60 kw. C. & C. dynamo. These are to be kept in reserve for possible emergency and cost approximately $2,800. This building is a typical heterogeneous New York City loft building and contains a complete printing establishment, making a specialty of night work and delivering on the judge's desk at 9 A. M. the complete testimony and court proceedings of the day before. It also contains woodworking machines, buffing machines, hot tables and glue pots requiring live steam, etc.

Perfectly comparable with the Langsdorf building is a textile building not far from it which is also 12 stories high and also on a corner plot 100 x 100. The superintendent of the building in 1905 reported the following operating cost at the time:

Electricity (in 1905)	$10,056
Coal	1,320
Wages	1,765
Miscellaneous (not including lamps)	400
Total expense on Building Manager's books	$13,541
Income from tenants	———

I am informed that within the past few years the total cost of electricity had been reduced to $9,140, of which about $3,000 is paid for by the tenants at no profit to the landlord. This change in the policy of renting has helped the landlord some, but the total yearly costs is still almost the same. In the year 1901 a proposition was made to install an electric plant in this building. The owner preferred not to make any change, and as a result paid in unnecessary operating expenses the sum of over $45,000, or nine times the difference between his annual operating expenses and the gross operating costs of the Langsdorf Building, which difference is over $5,000 per annum. Even assuming that the Langsdorf tenants get their electricity free, this $45,000 and the interest on a portion of it for the last nine years, eight years, seven years, etc., would have been saved if engines and dynamos costing less than $10,000 had been installed in 1901. The total amount of electricity used in each of these buildings is almost identical, as are their sizes.

A nine-story loft building at 213 Grand Street, New York. This building has 4,244 sq. ft. rentable area per floor and is on a plot equivalent to 50 x 92, irregular. The building has two elevators and a small electric plant, the entire heating and wiring system of the building cost as follows:

Electric wiring for entire building	$ 850
1 Ridgway engine	1,435
1 Sprague dynamo, 75 kw	1,182
125 h. p. Titusville boiler	875
Complete steamfitting, including pumps, radiators, etc.	4,950
Meters and later installations	213
	$ 9,505

Of this amount the electric plant cost about $5,000.

This plant started operating last February and up to September 1st, a period of just seven months, in 1910, during part of which time the building was only partly rented. The costs were as follows:

Screenings, at $2.06	$ 596
Labor (the engine room force operates 1 elevator)	879
Edison electricity	150
Repairs, ash removal and miscellaneous water, etc.	450
Total cost on Building Manager's books	$ 2,075
10 per cent. of plant cost added by Treasurer	500
Total cost on Treasurer's books	$ 2,575

But druing this time the receipt from tenants had been $2,803. This includes two tenants who purchase live steam the year around for manufacturing at $160 per year. Thus, the operating cost, net, for the first seven months has not only been less than nothing for furnishing heat, hot water, public lights and electric power for pumping and for two elevators, but has actually shown a profit of several hundred dollars earned by the engineering department. And do not forget that this profit is in excess of 5 per cent. interest and 5 per cent. more for depreciation. As the electric output increases, this record will become even more favorable.

Foot-candle is the illumination produced by one candlepower on a surface perpendicular to the light rays and at a distance of one foot from the source.

High Tension Power Transmission.

BY J. G. PERTSCH.

THE subject of electrical power transmission is a very extensive one, dealing with the transmission and distribution of electrical energy, as generated by the dynamo, to the receivers which may consist of motors, lamps, electrolytic cells, or other means for conveying this energy into a form suitable for some particular use.

Distribution of power by electrical means is superior to other systems and we find it taking the place of other methods in all but a very few applications. The transmission of the energy from waterfalls to distant points is practically possible only by this means. All over our country are seen striking illustrations of that development by which falling water is generating hundreds of thousands of horsepower for electrical supply to millions of population. In most cases the supply of electrical energy from waterpower has been made possible only by long-distance transmission.

Let us look back and briefly survey the evolution of high-voltage transmission. The predecessor of the electric generator was the voltaic cell, which supplied a direct current. Therefore, since all early apparatus had been constructed to operate from primary batteries, there was, for a long time afterward no demand for alternating current. With the commercial application of arc and incandescent lamps, and later the increased use of stationary and street railway motors, the direct-current generator made great progress in development. Up to this time, alternating-current generators had been slow in development; in fact the use of alternating current was little understood. But as the demand for power increased and the range of distance extended, it became apparent that higher voltages were necessary for transmission. With the invention of the alternating current transformer a suitable device was at hand for transforming the character of an alternating current that is, by changing the pressure, so that it could be most economically transmitted. Along with the development of the transformer and the introduction of alternating current followed a remarkable impetus in the use and development of alternating-current machinery; and today, in almost all high-voltage transmission systems in the United States, alternating-current generators are employed.

It was difficult to break away from the use of direct current entirely and naturally the rotary converter came to be used to transform the alternating-current power into direct-current form, and vice-versa, where desired. However, the present tendency is toward simplicity, and it seems that the rotary converter is going out of use as an unnecessary evil; and modern appliances are being designed for alternating current.

With the development of alternating-current single-phase transmission the next step in advance toward economy was the introduction of polyphase systems—until today we are transmitting hundreds of thousands of horsepower in some cases to a distance of over 100 miles, by the use of high-tension, alternating-current polyphase lines.

From the simple electrical power-transmission circuit consisting of generator, step-up transformer, transmission line, and lowering transformer, there has gradually developed extensive systems, far-reaching and intricate, every element requiring the constant study of the engineer and designer. Generator and transformer design, windings and insulation, switchboard and auxiliaries, transmission-line materials and construction, have all undergone a steady progress in development. Every change made in the system with the advance of higher voltages and longer distances, has resulted in increased difficulties to be surmounted.

Many cities today depend for their lighting, transportation, and the operation of their various industries, upon electric power transmitted over considerable distances. Although absolutely continuous service may not be possible, and unfortunate interruptions of the power supply do occur at times, the number of troubles now experienced can be greatly reduced. The main causes of interruption of the supply of power are open-circuits, grounds, short-circuits and other circuit changes which set up electrical oscillations or surges in the line. These may be traced, directly or indirectly, to storms, lightning, weak insulators, defective pins, destruction of poles, etc. In fact most of the troubles which are met with today that affect the continuity of power service, may be attributed to the line.

The absolute limits of electrical power transmission are fixed by the practicable voltage that may be used. The effects of transmission voltage must be encountered both in the apparatus at generating and receiving stations, and also along the line. For short distances, the alternator may generate a voltage sufficiently high to be supplied directly to the line, making it practicable to dispense with the use of step-up and step-down transformers. But even to attain a pressure as high as 13,000 volts in the armature coils, considerable difficulty in construction is involved because of the relatively large amount of room necessary for insulation. In the longest transmissions with alternating current there is little prospect that the use of step-up transformers at the generating end, and step-down transformers at the receiving end can be dispensed with. Consequently, the highest voltage that may be received or delivered at the terminals of the transmission line is simply the highest pressure which it is practicable to develop by transformers and to transmit by the line. However, under present conditions, the line is that part of the transmission system where an actual limit to the use of higher voltages will first be reached.

The atmosphere about an electric circuit is depended upon to a greater extent for insulation than any other material. It has been found by experiment, however, that the atmosphere will break down much more readily under the disruptive force of electrical strain than solid dielectric materials in the same path. Above a certain electrical pressure then, the atmosphere about the conductors and over the surfaces of the insulating mediums will become conductive, and a leakage of power take place from one wire to another of the same circuit. This phenomenon, which is similar to the familiar brush discharge of electrostatic experiments was studied at some length by Mr. C. P. Steinmetz and he applied to it the term corona.

The factors then, that tend most directly to a limitation in transmission voltage are two: temporary arcing between the several conductors on a pole, a concentrated condition at high current-density; and secondly the less imposing but nevertheless constant passage of energy from one wire to another, the corona or brush discharge, which occurs always when a definite electrical strain exists in the atmosphere next to the high-voltage conductors. Since this latter factor presents a continued loss of energy, it represents the nearest approach to an absolute physical limit of voltage with present line construction.

A careful study was made in 1896 by Mr. R. D. Mershon upon an experimental line near Telluride, Col., to determine the loss of energy due to corona discharge or dielectric conduction from one wire to another of the same circuit. Measurements were made of the energy escaping from wire to wire when separated various distances apart and also with different voltages on the line. It was found that the leakage loss over the surfaces of insulators was very slight, but the loss incident to the passage of energy directly across the intervening air may assume considerable proportions. By curves plotted from the measurements it is clearly indicated that for each given set of line conditions, there exists a critical pressure beyond which the leakage loss between wires increases very rapidly, making such a high-voltage transmission line very wasteful of electric power, and setting an absolute limit to the voltage, and consequently the length of transmission.

But fortunately means to avoid this limit are not difficult. Other experiments have shown that for a given voltage and distance between conductors, the loss of energy from one wire to another diminishes rapidly as the diameter increases. Evidently, conductors of the same circuit may be separated sufficiently to decrease the leakage loss as much as desired. But to carry this increase of distance between conductors very far involves radical changes in the line construction. Then, perhaps, the absolute voltage limit will be set by the proper insulation of generator and transforming devices at the terminals of the line.

As we see the range of high-tension transmission being extended to greater and greater distances by the use of increasingly higher transmission voltages, we naturally ask what will be the ultimate distance to which power will ever be transmitted. Evidently, the final practical limit will be the resultant of economic conditions; and the greatest distance to which electric power will be transmitted will be where the electrical energy ceases to bring a profitable return, at the receiver end of the line, in competition with other sources of energy.—Sibley Journal of Engineering.

The Residence Lighting Rate Problem.

BY R. S. STEWART.

At the annual convention of the Michigan Electric Association held at Port Huron Mr. Stewart presented a paper taking up the successful experiences of small towns in establishing flat rates. On account of the general interest in this subject and the interesting details outlined in the paper, we publish it as follows:

In the early days of electric lighting the problems of determining the proper methods of charging for electric service were comparatively simple. Electric lighting was used almost exclusively for business purposes and the hours of service were long. It was therefore considered equitable to charge customers a fixed monthly sum proportional to the number of lights installed. Later electric lighting was installed in many of the residences and the same method of charging was used. It was soon found, however, that residence customers wished to have a large number of lamps installed but wished to pay for only the maximum number of lamps used at any one time. Electric light companies found that the method of charging a flat rate on the basis of the total number of lamps connected prevented them from obtaining a large amount of residence business. Some companies therefore made a practice of sizing up a residence and charging for an arbitrary number of lamps regardless of the number installed. This was manifestly inequitable and soon lead to complaints of discrimination among customers. Moreover it did not prevent the customers from burning any number of lights they chose and the result was that the customer would pay for a few lamps and have his house brilliantly illuminated by turning on all of his lamps. Other companies charged for all lamps connected but charged a smaller rate for residence lighting than for business lighting. This limited the amount of lighting in residences and deprived the companies of much profitable business. As soon as reliable meters were obtainable at a reasonable price all of the larger companies and many of those in smaller towns discontinued their services on flat rates and charged for electric lighting on the basis of the amount of electricity used. In the course of a few years' experience it was demonstrated that such a system of charging was as inequitable as the old flat rate system, for the man who used his service for long hours paid much more than his share for such service and the man who used his electric service for only a few hours a year was an unprofitable customer under any rate.

The present system of charging for electric consumption are combinations of the old flat rate system based on the maximum demand with meter rates based on the total electric consumption as measured by meter. In order to obtain the maximum demand an extra meter is required and the expense of this meter adds considerably to the cost of electric lighting for the smaller customers. A convenient method of determining the maximum demand with sufficient accuracy without the use of demand meters is to base the maximum demand on the size of the house or on the number of rooms. This method encourages the liberal use of electric lights and the installation of lamps wherever they may be of use. It therefore develops a large amount of business which does not come at the time of the peak load.

The adoption of meter rates was not looked upon very favorably by the customers in the smaller towns and it is very doubtful whether it is the proper method for small companies. As we have noted, the proper charge for electric service is a combination of a fixed charge and a running charge. In a small town, under the fixed charge should be included interest and depreciation on the plant and also all salaries and wages. This leaves practically nothing but the fuel bill for running charges. Even the fuel bill is partly a fixed charge for a certain amount of fuel is required to run the plant at no load. In the larger companies of course wages form part of the running charges for the number of employees varies with the amount of fuel handled. Among the smaller companies we find very many which run plants in which it is necessary to employ only one man to look after the lighting business of the town or village regardless of the total load. These plants are seldom profitable and it is only by obtaining all the business available that they can be made to pay. Meter rates will drive away a certain amount of business and this diminution in the number of customers will necessitate larger meter rates for the rest of the customers. Another important factor in the smaller towns is the fact that electric lighting is much more sparingly used and that there are many persons who would be customers if their bills could be limited to fifty cents or one dollar per month, but who prefer to use oil lamps or gas rather than pay higher rates for electric lighting. When it is considered that from fifty cents to one dollar per month is required to pay for interest and depreciation and maintenance of a meter and the cost of reading the same, it is readily seen that small customers are not profitable to a company which charges for service by meter. Such small services on the other hand on flat rate system brings in a profit proportional to the amount of service. It may also be noted that in these smaller places the number of lamps installed does not exceed very greatly the maximum number connected. Therefore it is feasible to charge a customer on the basis of the number of lamps installed or to put in a current limiting device. This device the customer should pay for.

With a system of flat rate charges, together with an optional meter rate, it is possible to obtain 75 per cent. or more of the total of both business and residence lighting of a small town and the stores will present an appearance, due to their illumination, that is not found in any store where charges on the meter basis are made. It is wise to give all customers the benefit of meter rates if they desire these and the few stores which use meters will serve as examples to the stores which pay for their services on a flat basis. It is interesting to note that a store keeper running on a meter will pay nearly as much for keeping his store bright three evenings a week as a store keeper operating on flat rate will pay for illumination every night during the week.

A typical example will probably illustrate the advantage of flat rates over meter rates for small towns. Take for example a town of 2,500 people with a maximum load of 100 kilowatt, and an investment of $25,000 for power plant, pole lines, etc. The total income may be estimated at $600 per month. Of this income $200 a month will cover charges for fuel, oil and other running charges, the other $400 being fixed charges. Assume that the number of customers will be 250 and that the number of hours use per month of the maximum load will be 100 and that the ratio of the current paid for to current as measured at the station meters will be 2 to 3. The diversity factor will compensate for the lost current and it is therefore safe to estimate the charges on the basis of the readings of the station meters. The total kilowatt hours per month will be 10,000, the fixed cost $4.00 per kilowatt, and the running cost 2 cents per kilowatt hour measured at the station. If a customer makes a contract for two 16-candlepower lamps or 100 watts the cost per month as above estimated would be for 50 hours; fixed 40 cents, running 10 cents and a total cost of 50 cents. Suppose, however, that the customer uses his lights continuously 5 hours per night or 150 hours per month, the total cost would be: fixed 40 cents, running 30 cents and a total of 70 cents.

The flat rate charge of 40 cents average per 16 candlepower per month for store lighting will be profitable. The charge for residence of 25 cents average per 16 candlepower per month is not profitable but pays all expenses. If a customer is paying on the meter basis, at say, 15 cents per kilowatt hour for the first 50 hours and 5 cents per kilowatt hour for all consumption in excess of 50 hours, the total will be 75 cents for the first 50 hours and 25 cents for each subsequent 50 hours, of the use of 100 watts. In addition to this charge the customer should pay at least 25 cents for the extra investment which the central station must make in a meter. This brings the total charge for two lamps for 50 hours to $1.00 per month, and for 150 hours to $1.50 per month. If it is admitted that a meter costs the company 50 cents a month, 50 hours use of 100 watts on meter service will cost the company $1.00 and 150 hours service will cost $1.20. The meter rates that have been assumed therefore show no profit for the small 50-hour customer and only 30 cents profit for the small 150-hour customer. It should be noted that the tendency of every meter customer is to turn off all unnecessary lights and this fact tends to make his lighting unprofitable. As the habits of living in a small town are not so diversified as in a large city the maximum loads of all meter customers will come at the time of the station peak load.

The argument is frequently offered that if the tendency of the meter customer is to turn off lights the tendency of the flat rate customers is to leave them on. This is true to a certain extent. If the lighting company shuts down at midnight and does not encourage the use of switches at convenient locations or of high-grade lamps, customers will leave their lamps burning continuously. If, however, the company gives all night service and notifies all customers that lights used regularly after midnight will have to be paid for at a higher than the standard rate and if the customers are advised that it is to everyone's interest not to use lights extravagantly, the load curve will be much improved. Records of the past year of such a company show an average use of the connected load paid for, of 125 hours per month as measured by the station meters. If this is the record of flat rate lighting, metered lighting will show a smaller use per month and will therefore not be profitable.

One of the main arguments in favor of flat rates is that the average customer prefers to pay a fixed monthly bill rather than to pay a variable bill depending on the reading of some meter concerning which he knows nothing and which he believes to be adjusted in favor of the company. That this is a real argument is illustrated by the experience of a company which recently changed hands. The people in the town thought immediately upon hearing of the change that flat rates were to be abandoned and protests against such a change in rates were almost universal.

When the customers were notified that no such change was contemplated but that the company was perfectly willing to give all those who desired it the meter rates noted above, a friendship to the new company was at once developed. Only a very small percentage of the customers availed themselves of the meter rates and most of these were short hour customers. Several new short hour customers were added to the lines because of these meter rates and the old long hour customers were held.

Experience has demonstrated very conclusively that flat rates with all night service are profitable in a small town if the only carbon lamps sold by the company are Gem Lamps. These should be burned at their lowest voltage so as to give approximately 16 candlepower and the saving of current consumption is 20 per cent. The lamps should be sold at cost price so as to prevent competition from others who are selling ordinary carbon lamps. The white light of the Gem lamp will convince a customer that the light is better than the lamp furnished by others. The Gem lamps will not continue to burn indefinitely after it has lost its light giving power as is the case with many of the old red hairpins used often in flat rate towns. The company should realize that its main function is not to sell current but to furnish light. The ordinary customer will not quibble concerning the current taken by a lamp provided that the light is white and of sufficient amount and that his bill is reasonable.

For residence customers who desire to have a large number of lamps connected, but wish to burn only a few at any one time, current limiting devices should be used. If a customer has this device adjusted for six lamps it does not follow that he is going to leave six lamps burning for he cannot be bothered with the trouble of turning off lamps every time the lights begin to wink and he will pay for more lights than he ordinarily burns to avoid this trouble. The diversity factor, therefore, enters into the problem of flat rate lighting just as in any other system of charging.

Flat rate lighting with tungsten lamps is more satisfactory than any other system of charging in a small town. The customer who buys his tungsten lamps and pays the high price of these, does not wish to buy new lamps except when necessary and he will carefully turn off all lamps which he is not using. This will reduce the number of hours use of the load paid for. It is very satisfactory however to so adjust the rates for tungsten lighting that the price of one new tungsten lamp per year is included in the flat rate. For each tungsten lamp contracted for on the flat rate, a card may be given which will entitle the customer at any time within a year to one new tungsten lamp provided that the old lamps are returned. Complaints of broken filaments in tungsten lamps are thus eliminated. This is not a case of free renewals for the extra lamp is included in the charge for service. Even though the charge per candlepower is less for tungsten lighting than for lighting from carbon lamps the former bills will not be reduced, for most people will prefer to increase their lighting and keep their bills the same rather than to cut down their bills by keeping the lighting the same.

From over a year's experience it has been found that the revenues have been increased considerably and that the maximum peak load has been decreased and that the total consumption of power by the central station has been decreased. Complaints of poor lighting have been eliminated to a large extent because of the smaller drop in the lines and because of the more constant light given from tungsten lamps when the voltage is variable. Much new business has been added which would have been unavailable with any other systems except tungsten lighting on flat rates. Practically every store in town uses electric lighting and there are only two examples of gasolene lighting. These were installed in the times of the former company and in one of these cases, electric lighting is used in the summer time, gasolene lighting being more convenient in the winter because it serves not only as a lighting system, but also as a heating plant. Natural gas is available for lighting with incandescent mantles, but is used rarely in spite of the low cost of gas because of the trouble and expense connected with new mantles and chimneys and purifying systems. Lighting from oil lamps is more expensive than electric lighting with tungsten lamps on flat rate if the two systems are compared on the basis of equal illumination.

The proper charge for flat rate tungsten lighting depends on local circumstances, but a rate of 1¼ cents per month per watt less 10 per cent. for cash should be sufficient to cover all costs and pay for the renewal of one lamp per year for each lamp installed. The cost of 80 candlepower per month or 100 watts per month would be: fixed 150 hours per month the cost would be: fixed cost 40 cents, running cost 30 cents, new lamps 10 cents, or a total of 80 cents. Based on the flat rate charge of 1¼ cents per watt per month less 10 per cent. for cash the revenue from 100 watts would be $1.12½. There would therefore be a profit on all tungsten lighting burning less than 150 hours a month and this number of hours is much in excess of the average number of hours that the peak load is carried.

The main principle which should always be kept in mind in making any change in existing rates in a small town is to obtain more revenue from the present customers by giving the customers more light or better service. It may seem to some, who have not studied the question thoroughly, unjust to charge more per watt for tungsten lighting than for lighting from carbon lamps, but it must be remembered that the fixed cost per kilowatt depends on the existing load and if the load is decreased by the use of tungsten lamps the fixed cost per kilowatt is increased. As the fixed cost is two-thirds of the total cost the charges should be based on fixed rather than running costs. After sufficient additional business has been obtained by tungsten lighting it is proper to reduce rates to encourage still further additions, but this reduction should not be made until it is proved that the revenues will be increased thereby. There is a saturation point in lighting and after this saturation point has been reached further decreases in charges for services will result only in decreased revenue.

Watts per candle unless otherwise stated, is the number of watts required to produce one mean horizontal candle-power and is obtained by dividing the total watts consumed by the lamp, by the mean horizontal candle-power. Care must be taken to state which value of candle-power is used or different values of watts per candle will be obtained for the same lamp at the one efficiency. For example, a 100 watt lamp giving 80 mean horizontal candle-power, the watts per candle would be 100÷80=1.25, while if the mean spherical candle-power were used, the watts per M. S. candle would be 100÷63.2 (mean spherical candle-power) =1.58.

A Large Southern Hydro-Electric Project.

Plans are being perfected by the Georgia Power company which will eventually supply Atlanta with more than 200,000 horsepower of electric current and will insure it the claim of the largest water power center east of the Rocky mountains, Niagara Falls being excepted. With a capital of $10,000,000 behind it, the Georgia Power company has already begun the development of the tremendous power of the Tallulah Falls, which alone will supply a current of more than 100,000-horsepower, an amount almost ten times as large as the power from Bull Sluice, which now runs Atlanta's street cars, operates elevators and factories and supplies most of the current used in this city.

Falls of somewhat smaller size have been secured by the company at Gainesville and Franklin, in Heard county, on the Etowah river, also near Canton, in Cherokee county, and several other points which will furnish an additional supply of 100,000 horsepower. Steel towers will be erected along the 90-mile course to Atlanta from Tallulah Falls and the energy transmitted at 110,000 volts. Over 300 miles of wire will be strung in the northern portion of the state and power used throughout this section of the country for all purposes.

Work has already commenced on the construction of six generators, each capable of developing 15,000-horsepower, at the Tallulah plant. The plans also call for the building of a 100-foot dam just below the big wooden bridge at the falls, and from this point a tunnel a mile and a quarter long will make possible a drop of 600 feet. At this point it is proposed to erect the distribution station with its network of wires which will supply the current for running mills, factories, car systems and light plants for a radius of many miles.

The plant now being operated by the North Georgia Electric company and which supplies a current of 3,000 horse-power at Gainesville, has been secured by the company and with other property on the Chattahoochee it is thought that a much larger power can be developed. The Etowah company's plant, which has also been taken, will furnish more than 30,000 horsepower, and an equal amount is expected from the falls at Franklin, Heard county. These and other powers controlled on the entire upper portion of the Chattahoochee river will enable the company to develop an additional 100,000 horsepower, making a total of more than 200,000. In charge of the engineering work for the company is C. O. Lenze, of 71 Broadway, New York, assisted by C. E. Parson, who is directly in charge of the work now in progress in this territory.

Commercial Section of National Electric Light Association Membership Campaign.

A beautiful sterling silver loving cup, ten inches in height, has been donated by Mr. J. Robert Crouse for presentation to the individual who shall succeed in securing the greatest number of new members for the commercial section of the National Electric Light Association before May 15th, 1911. Mr. Crouse is chairman of the Membership Committee, and its other members are Messrs. Edw. E. Bailey, Napoleon H. Boynton, Charles D. Burleigh, Duncan Campbell, W. R. Collier, I. W. Dixon, I. D. Gibbs, L. D. Mathes and J. C. McQuiston.

Large posters, embellished with a full-sized reproduction of the cup, and giving the conditions of the contest will be sent to the principal central stations and electrical manufacturers of the country, and the committees hope that these posters will stimulate immediate interest in membership among the employees who will read them.

About two hundred men have already been enrolled in the contest, and any one may enter the contest by registering with Mr. Crouse, who will furnish application blanks. Mr. Crouses address is 1823 E. 45th Street, Cleveland, Ohio. The large number of contestants, as many as eight persons from one of the larger Central Stations, has introduced another element of chance by which the smaller central station or manufacturer may carry off the cup. There is a fine, large cup for someone and it is a good, broad game that will be pushed by the contest, therefore, SOUTHERN ELECTRICIAN commends the contest to you.

It is planned to make the various commercial Section committees the national authorities upon the subjects under their jurisdiction. Not only will they render annual reports to the National Electric Light Association convention, but they hold themselves in readiness to assist at any time any member of the section in solving the commercial problems incident to their subject. For example, the committee on decorative street lighting will have at hand all available data upon methods of soliciting and installing special street lighting, various forms of contracts used, examples of unsuccessful methods and the reason for their non-success, and the advantages and disadvantages of various types of equipment. Any member of the commercial section may secure these data from the chairman of that committee, and should there arise any problem not heretofore solved, that problem will be submitted by the chairman to his committeemen for their expert opinions and advice. The value, to one about to undertake a special street lighting campaign, of such a fund of ready information can readily be appreciated. Similar data, advice and co-operation will be offered by each committee, so that there can hardly arise a commercial question which one or another of the committees cannot immediately and finally assist in solving. This service, it must be understood, is rendered only to members of the Commercial Section.

Duplex Telephony.

According to an announcement from Washington, Major Geo. O. Squier has invented a device by which two simultaneous telephonic messages can be transmitted over the same circuit at the same time without interference. While claims are made for this new invention by Major Squier, it is claimed that Frank L. Perry, known in electrical circles as the electrical wave man of Chicago, more than two years ago exhibited at his laboratory an electrical telephonic apparatus and system by means of which two telephonic messages were transmitted simultaneously without interfering with each other over a single wire grounded circuit and also over a single metallic circuit. The claims of Mr. Perry are substantiated by a letter to B. G. Arnold a well known engineer of Chicago, who witnessed the demonstration of the system on November 4, 1908. The claims of Mr. Perry for the priority in the accomplishment of telephonic duplexing are further substantiated it is claimed, by other witnesses of the operation of the system in his laboratory. These witnesses are Dr. C. S. Barker, of Hahnemann Hospital, F. W. Parker and D. M. Carter of the law firm of Parker and Carter, and B. E. Sunny, president of the Chicago Telephone Co. These witnesses heard and saw the successful demonstration of the apparatus in October 1909. From the information now at hand it would seem that duplex telephony was born sometime ago, the announcement recently made being that of its absolute practicability.

Congress of Technology.

What promises to be a very remarkable and striking record of the place of science in modern industry will be presented in the series of papers which will constitute one of the main features of the Congress of Technology to be held in Boston on April 10 to 11 of this year. The first of these dates is the fiftieth anniversary of the chartering of the Massachusetts Institute of Technology, and the primary purpose of the Congress is fittingly to mark that anniversary.

But the interest of the celebration goes far beyond any personal associations with the Institute of Technology. While "Tech," as its friends know it, has been a leader in the application of science in the industries, the progress of that institution and of its graduates marks the enormous development that has taken place in all industries the world over. A large number of Technology graduates who have been conspicuously successful in varied lines of engineering will present papers at the Congress, dealing with various aspects of the country's manifold industrial problems and treating of those problems not only as they exist now but as they promise to take different shape in the future. The whole body of papers will therefore constitute a survey of engineering and industrial science as a whole, from a body of men who speak from first-hand experience with industrial problems all over the country.

The papers, separately, will discuss the conditions and prospects in specific industries and will therefore be of exceptional interest to the great number of men practically engaged in them. No similar discussion of the industries has been attempted on such a scale, and the record promises to be of unique suggestive value to the manufacturers of the country. The meetings will be open to the public.

Convention Features of New England N. E. L. A. Section Omitted.

In view of the fact that the vote of the members of the New England Section was three to one in favor of omitting the program and entertainment features of the annual meeting, scheduled for March 15 and 16, 1911, the executive committee voted to have no papers, no committee reports and no entertainment features. The meeting will be, therefore, purely formal and routine to comply with the By-Laws.

It will be the second annual meeting and will be held in the Auditorium, on the third floor of the Edison Building, 39 Boylston St., Boston, Mass., on March 17, 1911, at 2.30 p. m., for the election of officers, report of the Secretary-Treasurer and such other routine business as may properly come before the meeting.

This arrangement, as the members know, is in line with the consensus of opinion that our spring convention should be dispensed with in order to insure the very largest possible attendance at the big Annual convention of the National Electric Light Association, which will be held in New York City the week of May 29-June 3, 1911.

Minnesota Electrical Association.

The fourth annual convention of the Minnesota Electrical Association will be held at St. Paul, Minn., March 14 to 16, with headquarters at the St. Paul Hotel. From the present indications Central Station Engineers and Manufacturers from all sections of the northwest will be in attendance and the convention be one of profit. An interesting program has been prepared as follows:

Curb Lighting, by Ludwig Kemper, Mgr. Albert Lea Light & Power Co.; Window & Sign Lighting, by Geo. Steinwedell, Commercial Agent St. Paul Gas Light Company; Residence Lighting, by C. E. Van Bergen, Manager Duluth Edison Co., Stillwater; Gas Producer Engines for Central Stations, by A. W. Wagner, Manager Huron Light & Power Co.; Gasoline Competition, by Representative National Lamp Association; Testing Watt Meters, by F. R. Cutcheon, Superintendent Electric Department, St. Paul Gas Light Co.; Engine & Boiler Room Records for Plants up to 256 K. W., by E. Holcombe, Manager Northern Heating & Elec. Co.; Insurance, by Mr. Ritt, St. Paul Bureau of Underwriters; Day Load for Central Stations, by Mr. E. L. Callahan, Manager New Business Department, H. M. Byllesby & Co.; Incandescent Lamp Improvements, by Henry Schroeder, General Electric Co.; Safety In Line Construction, by H. G. Winsor, Chief Inspector Minneapolis Gen. Elec. Co.

Mississippi Electric Association Affiliates With N. E. L. A.

At a meeting of the Mississippi Electric Association which body represents the central station industry of the state, held at Meridian, Mississippi, on January 19, a thorough canvass of the wishes of the members was made and voted to affiliate with the National Electric Light Association. The president, A. B. Patterson and A. H. Jones, secretary and treasurer, were instructed to make the necessary arrangements with the national body for putting this affiliation into effect. The national society has already a number of members in the state and this new union will be particularly beneficial to the smaller companies that hitherto have belonged to the local organization only.

West Virginia Independent Telephone Association.

The West Virginia Independent Telephone Association will hold its fifth annual convention on March 23 and 24, in the city of Clarksburg, W. Va., with headquarters at the Waldo Hotel.

On account of the fact that fire destroyed one of Clarksburg's large hotels, manufacturers are urged to secure accommodations early.

The program layed out for the convention is an especially interesting one and the social features are well provided for. The main feature will be a smoker on the evening of March 23.

Considering the representation at the last convention and the indications thus far, it is expected that the attendance will be the largest in the history of the Association.

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.

A. C. SYSTEMS.

Editor Southern Electrician:

(197) "I would like to see information in the columns of your paper taking up 3-phase A. C. systems balanced and unbalanced. Also information and diagrams for 3 phases from two transformers, the difficulties of grounding secondaries, etc." G. W. H.

POWER FACTOR OF CIRCUIT.

Editor Southern Electrician:

(198) "Kindly obtain information from your readers on the following: Our three-phase, 500 K. W., 2,200 volt, alternator running at 500 R. P. M., often operates at approximately one-half load. Can the power-factor of the alternator be changed by varying the field excitation? What effect does change of load or voltage have on the power-factor of the circuit?" D. A. F.

IMPREGNATION OF COILS.

Editor Southern Electrician:

(199) "Will you kindly give me some general data as to the value of the so-called 'impregnated coils,' comparing same with the other types of insulation employed for fields and armature coils? Also what is the general process of the impregnation? The information from your readers will be highly appreciated." H. E. J.

A. C. GENERATOR FROM D. C. MOTOR.

Editor Southern Electrician:

(200) "I would like to know if any reader of your paper can give directions for changing a direct current motor so that it can be used as an alternating current generator?" H. L. W.

SWITCHING OF TRANSFORMERS.

Editor Southern Electrician:

(201) "As a reader of SOUTHERN ELECTRICIAN, I would like to ask from some other readers who are connected with high tension transmission plants, the following: What methods have you found most satisfactory in switching on and off steps down transformers? The transformers are oil-cooled, 66,000 to 2,200 volts rated at 500 K. W. Should the secondaries be closed and excite from low-tension side, or close primary side first and excite from high-tension side? I have used both methods, but find that when closing secondaries first the ammeter often shows a large current. Please explain this action and give reasons for the proper operation." H. F. B.

DISTRIBUTION SYSTEMS.

Editor Southern Electrician:

(202) "We have a central station of 5,000 K. W. capacity and considering running a transmission to a small town one mile distance. The load will consist of street lighting and a possible office and factory lighting load for 15 buildings averaging 4 stories and approximately 10,000 square feet of basement area. A power load for the factories, 6 in number, is also possible, with an average of 100 horse power. What system of distribution and transmission would be considered most economical and best suited to the demands, direct current, three-wire, or alternating current, single, two or three phase? Our station equipment is 2,200 volt, A. C. with rotary converters." H. A. L.

H. P. OF THREE-PHASE MOTOR.

Editor Southern Electrician:

(203) "Kindly explain how to calculate the horsepower of 3-phase motors for driving a lumber mill equipment. Also please advise how to determine the sizes of wire for connecting up these motors. What kind of wire should be used and should it be laid in conduits along the floor or along ceiling and drop down to motors, which will be located on floor, all direct connected?" H. A. B.

LAMP RENEWALS.

Editor Southern Electrician:

(204) "Kindly publish information from central station readers in the South, as to the policy of furnishing free lamp renewals. In each case give reasons for and against." G. W. H.

Answer to Question No. 174.

Editor Southern Electrician:

"In regard to the calculation of size of wire for an A. C. motor circuit, I offer the following as answer to Question 172, in your November issue, signed W. H. M. We will assume a particular case and follow the necessary steps. Suppose a 25 horse power induction motor is to be installed 300 feet from the transformers and to operate on 110 volts, 60 cycle, 3-phase circuit. Allow 90 per cent efficiency for the motor, an average power-factor of 85 per cent, and a voltage drop of 10 per cent.

"The formula for wire size is then as follows:

$$\text{Circular Mils} = \frac{P \times 746 \times L \times K \times 1.5}{E \times P.F. \times V \times v}$$

Where P = horse power of motor
L = distance to the motor in feet
K = a constant depending on system
E = efficiency
P.F. = power-factor
V = impressed voltage
v = volts drop in wiring

"Substituting values assumed we get:

$$\text{Circular Mils} = \frac{25 \times 746 \times 300 \times 15 \times 1.5}{.90 \times .85 \times 110 \times 11}$$

$= 136000$

$=$ No. 00 wire B. & S. gauge.

"The formula allows for a 50 per cent overload. In regard to the power-factor of lighting and motor loads, in is usual to assume from 85 to 90 per cent."

W. A. BATES.

Answer to Question No. 180.

Editor Southern Electrician:

"In answer to Question No. 180, in the December issue, I wish to state that .001 inch =1 mil and the square of the diameter of a wire in mils is its area in circular mils. The mil foot, that is, a wire 1 foot long and 1 mil in diameter, 1 circular mil in area, is the recognized standard from which is figured the resistance of electrical conductors.

"The resistance of any conductor varies directly as the length and inversely as the sectional area of the conductor. When R=resistance of conductor in ohms

r=resistance per mil foot in ohms

L=length of conductor in feet

d=diameter of conductor

cm=d square or area in circular mils

$$R=(r \times L)/cm."$$

H. M. BEAL.

Answer to Questions Nos. 176 and 165.

Editor Southern Electrician:

"Referring to Question 176 in the December issue, the potentiometer method is the most accurate way of checking the accuracy of direct current instruments. Fig. 1 shows the connections for this test. The Battery B sends a constant current through the resistance R which is subdivided into very small steps. E is a standard cell, such as the Clark or Weston. The double throw switch is thrown up and the resistance contact adjusted until the galvanometer

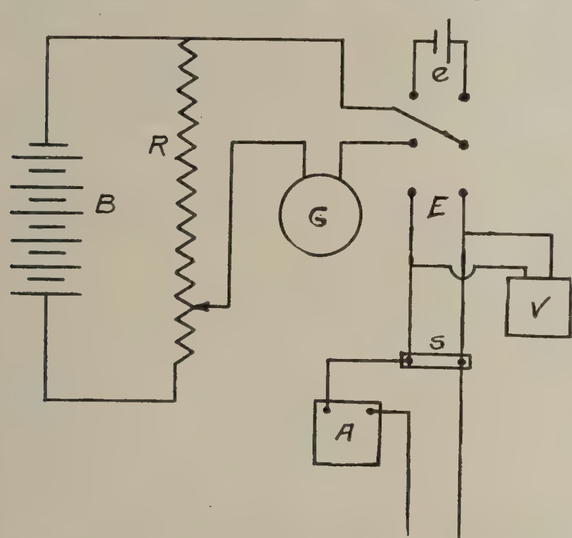


FIG. 1. POTENTIOMETER METHOD OF CHECKING.

shows no deflection. It is then thrown downward and the resistance again adjusted until equilibrium is obtained. The unknown voltage and the known voltage of the standard cell, are in direct proportion to the respective resistance values, and the voltage E may be computed by simple ratio. As shown, this may be used to check a voltmeter V, or the voltage across a shunt S of known resistance, and in this case we may calibrate an ammeter A in the circuit. The voltage of a Clark cell is 1.433 volts at 15°C., but varies with temperature. The voltage of the Weston cell is 1.0185 at from 5° to 26°C.

"Fig 2, shows a simplified diagram of the Leeds and Northrup potentiometer. The resistance R consists of 15 coils of 5 ohms each and at one end of the series is a long length of resistance wire wound on a drum with a movable contact, so that very small increments of resistance may be measured. At the other end T, are a number of small coils used to compensate for temperature changes in the voltage of the standard cell. The current from the battery B is adjusted by the rheostat R to equal exactly .02 amperes by throwing the switch to the left and adjusting to get no

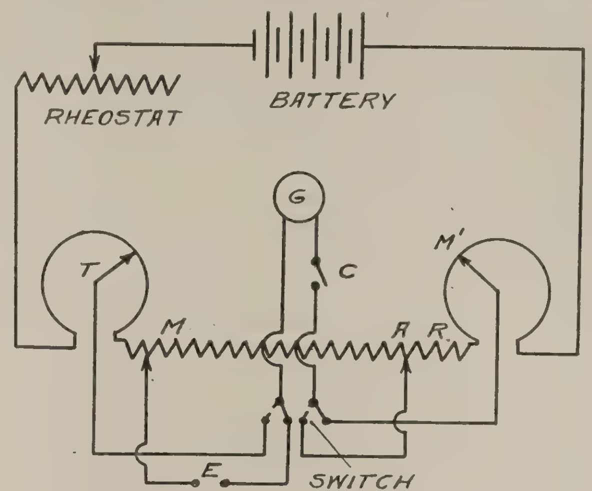
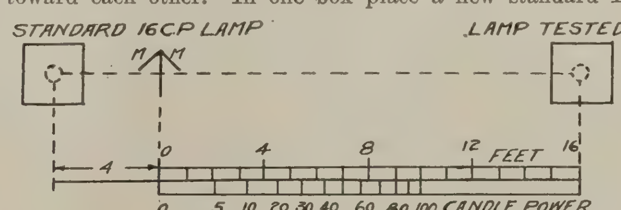


FIG. 2. DIAGRAM FOR LEEDS AND NORTHRUP POTENTIOMETER.

deflection on the galvanometer G. The resistance from A, a fixed point to T, being just enough to give 1.0185 volts with .02 amperes. Then throwing the switch to the right we adjust the contacts M and M' to get zero deflection, when knowing the current and the resistance, the voltage at E is readily computed.

"No. 165. A simple photometer for measuring the candle power of incandescent lamps, can be made by taking two boxes open at one end and painted a dull black on the inside. Mount a socket in the top of each and place these two boxes on a long table in a dark room, with the open ends toward each other. In one box place a new standard 16



A SIMPLE PHOTOMETER.

candle power lamp, in the other the lamp to be measured. Between the two place a paper disc with a round oiled spot in the center. When the same intensity of light is thrown on the two sides of this screen the spot will not be visible. If desired, mirrors M, M, may be arranged so that both sides can be seen at once. The brightness of the two lamps are inversely proportional to the square of their distances from the screen. The simplest way of performing the measurement without calculation is to fix the box with the standard lamp and the screen stationary, and move the other box to get equal illumination. The candle power values may then be painted on a scale, and the instrument rendered direct reading as shown in the sketch. The photometry of arc lamps involves measurement at so many different angles and so much computation that I would not suggest for any one to try it outside of a regular photometric laboratory."

A. G. RAKESTRAW.

Remarks on Question No. 177.

Editor Southern Electrician:

"In Mr. Rakestraw's reply to question No. 177 in the February issue, he recommends a mixed A. C. and D. C. plant. In view of the high state of development of the A. C. motor, the writer considers this entirely unnecessary and undesirable. It makes it necessary to run a small engine at all times to supply the power load, when the power could be supplied by the larger engines more economically. It also renders the power service less reliable by virtue of the fact that if this small unit or the balance set has to be shut down for inspection or repairs, service is interrupted. The D. C. equipment also adds complications throughout the entire engine room equipment.

"A better plan would be to carry the entire power load with the same polyphase A. C. generators that carry the lighting load, running a separate set of 2200 volt feeders if there are any motors of sufficient size to cause undesirable disturbances on lighting feeders. It is becoming general practice to use poly-phase motors in sizes of over 5 H. P. and below this size to use single phase motors.

"Probably the best method of determining necessary plant capacity would be to refer to average capacities. In the state of Ohio the average is 56 watts per capita, while in Iowa it is only 44 watts per capita. Some figure between these two would probably be about right, depending upon the present development and available business in sight. Ordinarily the most economical arrangement of units is in a ratio of 3, 2 and 1, leaving sufficient space for one so that it can later be replaced with a unit of combined capacity of 3 and 2 if the town grows and the business develops to the point where it is needed. With this arrangement 3 should be large enough to carry the entire load, 2 will in all probabilities handle the day load for several years to come and 1 will prove economical between 10 or 11 P. M. and 6 or 7 A. M. Then if 3 should be down for repairs 2 and 1 operating together is capable of handling the peak load.

"All engines should be compound condensing, regardless of cost of coal; as condensing equipment, even where a cooling tower is necessary to furnish condensing water, makes a lower first cost per unit of station capacity than if additional boiler and engine capacity were installed to give same available power, operating non-condensing.

"The high-speed non-releasing type of Corliss engine should be selected for the reason that it can be had to operate at speeds of 150 to 200 R. P. M. as economically as the slow speed Corliss. The first cost will be lower, and it is suited to direct connection to alternators of small size, first cost of a small 100 R. P. M. alternator being prohibitive. The switchboard should be located at the front side of the engine room instead of the end since, if it should ever become necessary to enlarge the engine-room it would necessitate moving the board.

"It has been found economical in most cases in building a new plant to install steam header, exhaust header, feed water-heater and feed pumps 50 to 100 per cent. larger than necessary, as it is cheaper to carry this small additional investment three to five years than at the end of this period to take it all out and replace it with larger equipment."

C. L. CLAY.

Remarks on Question No. 187.

Editor Southern Electrician:

"I note in your February issue the answer to Question 177 by Mr. Rakestraw. This answer in part applies to my Question 187, in the January issue. With your permission I would like to ask Mr. Rakestraw to refer to Question 187 and carry his comparisons a little further so as to cover a comparison of efficiencies and the other items which I mention."

H. A. PARKS.

Answer to Question No. 189.

Editor Southern Electrician:

"In answer to Question 189, January issue, the following is submitted: In any transmission system the distributing and transformer losses should be taken into consideration. 'R. B. C.' may assume a loss of 5 per cent as the average full load for his secondaries and 10 per cent for his transmission line and be entirely within reason. But attention is called to the fact that the losses are dependent upon other features than mere arbitrary selection. Sometimes the 'longest' way round is the shortest way home,' and to brief this matter, the following is submitted for your consideration:

"The maximum load of lamps would equal 81,000 watts and allowing 5 per cent loss in secondaries and taking the average efficiencies of several transformers into consideration, the full load power would be very close to 90 K. W. at the transformer primaries. If it is desired to maintain 110 volts at the transformer and allow 5 volts loss in distribution, 105-volt lamps should be used. Then allowing for average regulation of transformers, the primary voltage would be 2250. A three-wire, three-phase line would be the most economical, the transformers being equally balanced around the phases.

"It is generally conceded that No. 6 B. & S. wire is the minimum size, consistent with mechanical strength and upkeep, for lines of this particular class. The following tabular values are based on Nos. 6, 4, and 3 B. & S. triple-braid W. P. wires spaced equidistantly on 18-inch centers. Delivery of 90 K. W. at 2250 volts at transformers, 60-cycle, 3-wire, 3-phase a distance of two miles.

	No. 6 Wire	No. 4 Wire	No.3 Wire
Per Ct. Loss of Delivered Power	9.51	5.98	4.74
K. W. Loss in Line	8.60	5.38	4.27
Volts Loss in Line	225.53	150.70	124.78
Voltage at Switchboard	2472.53	2400.70	2374.78
Pounds of Wire	3548	5196	6019
Cost of Wire	$532.22	$779.33	$902.88

"From the foregoing the practical points should be clear. The cost of power should be low, water power, and therefore the losses may be higher than for a steam-driven plant. The maximum load from this town will probably last but a short while and the losses for this time are but a fraction of the maximum.

"Without a more intimate knowledge of conditions it appears that No. 6 B. & S. for the transmission line and an average drop of 5 volts in the distributing system would be satisfactory. However, the loss in volts in the line and the consequent loss in power are greater than with larger wires and 'R. C. B.' is in better position to judge what this means to his plant.

J. N. ELEY.

Discussion on Question No. 185.

Editor Southern Electrician:

"I beg to submit the following answer to question 185, in the January issue: The induction generator is an induction motor driven above synchronism as R. C. R. says in his question appearing in January number, but it does not raise the power factor. On the contrary, it requires a certain amount of magnetizing current, just as motors do, which must be furnished by the synchronous machines of the system. It is true that the current of the generator is leading, but we must remember that leading current from a generator is just the reverse to leading current to a motor and so it will not compensate the lagging current to the induction motors although leading current to a synchronous motor will do so. In "Elements of Electrical Engineering" by Dr. Steinmetz we find the following discussion of the induction generator, page 415. 'The induction machine may thus be considered as consuming a lagging reactive magnetizing current at all speeds, and consuming a power current below synchronism, as motor, supplying a power current (that is, consuming a negative power current) above synchronism, as generator. Therefore, induction generators are best suited for circuits which normally carry leading currents, as synchronous motor and synchronous converter circuits, but less suitable for circuits with lagging currents, since in the latter case an additional synchronous machine is required, giving all the lagging currents of the system plus the induction generator exciting currents. Obviously, when running induction generators in parallel with a synchronous alternator no synchronizing is required, but the induction generator takes a load corresponding to the excess of its speed over synchronism, or conversely, if the driving power behind the induction generator is limited, no speed regulation is required, but the induction generator runs at a speed exceeding synchronism by the amount required to consume the driving power.'

"So we see that the induction generator will carry a load if there be a synchronous machine on the circuit capable of supplying the necessary magnetizing (lagging) current, in fact, that is about all it will do, since it has no effect upon the voltage and frequency, which are determined by the synchronous machine.

"Consideration of the above will show that Mr. Reid is altogether in error in his discussion of this question in the February issue, his mistake being evidently due to his failure to distinguish between leading generator current and leading motor current.

"Mr. Foster in his answer describes an entirely different machine, the inductor generator, which is similar in name only. It is really a synchronous machine but differs in details of construction, as will be seen from Mr. Foster's description."

T. G. SEIDELL.

Answer to Question No. 191.

Editor Southern Electrician:

"Referring to Question 191, in the February issue, probably the most satisfactory lighting arrangement for this room would consist of tungsten lamps with Holophane distributing reflectors. We would proceed with the calculation as follows: For ordinary book-keeping work we should have an intensity of from 3 to 5 foot candles. We find that the area of the room is 30 by 60 feet or 1800 square feet, so that to illuminate this space will require from 5400 to 9000 lumens. Now the net efficiency of a lighting installation is expressed in lumen per watt, which is the effective illumination in foot candles on the plane of illumination divided by the watts per square foot. This value may be obtained by calculation, but since there have been many tests made to determine it, we may take advantage of this work and use figures which have been obtained by experience.

"The following table gives some average values for tungsten lamps rated at 1.25 watts per candle.

Clear reflectors, dark or medium walls	4.0
Clear reflectors, very light walls	5.0
Enameled reflectors, dark or medium walls	3.4
Enameled reflectors, very light walls	4.3

"For the example at hand we may take 4.5 lumens per watt as a fair value. We see then that we must expend 1200 to 2000 watts in this room. We must next determine the size and spacing of the units, being limited in the former case by commercial sizes, and in the latter, by symmetry. It is always well to use as large a unit as possible and yet get uniformity, as the first expense and the upkeep are less, and the lamps are more efficient and durable in the larger sizes. In this case we may divide the room into 8 squares each 15 by 15 feet, and place a unit in the middle of each. This would require 8 lamps of 150 to 250 watts each with distributing reflectors. It is likely that for this work the 150 watt lamp would give very satisfactory results. With the distributing reflector the vertical height of the lamp should be about 1-2 the horizontal spacing, and since the spacing is 15 feet the lamps should be 7 feet above the plane of illumination, which means that they should be mounted directly on the ceiling. I believe that this layout will give good results."

A. G. RAKESTRAW.

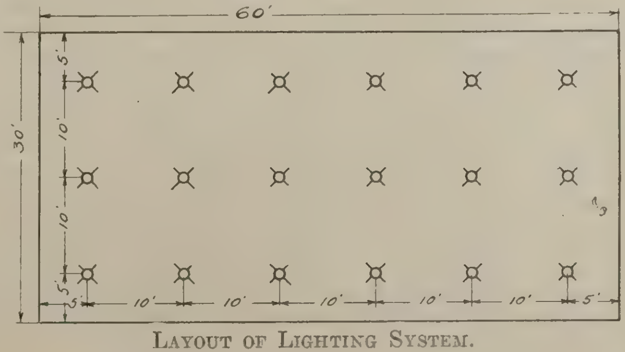
Answer to Question No. 191.

Editor Southern Electrician:

"I beg to submit the following solution to Question No. 191, in the February issue of your magazine. The writer has derived the results by approximate methods but it will be found to give good results. The formula used is the one derived by Prof. Barrows of Armour Institute and published some time ago in one of the electrical magazines, and is stated as follows:

$$\text{No. of lamps} = \frac{\text{Area} \times \text{Foot Candles Intensity}}{\text{Watts of lamp} \times \text{the Constant K}}$$

"K is a constant obtained from actual tests and is known as the lumens per watt or the average intensity produced by one watt per square foot.



LAYOUT OF LIGHTING SYSTEM.

"The illumination necessary for the particular office would be about 4 foot-candles, since the walls are of light color and you would receive a certain amount of reflected light on the tops of the desks. Substituting in the formula:

$$\text{No. of lamps} = \frac{1800 \times 4}{100 \times 4.2} = \frac{7200}{420} = 17.3 \text{ lamps.}$$

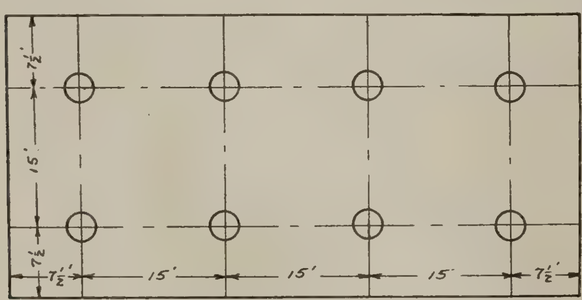
"We would either have to use 17 or 18 lamps. The simplest and most efficient arrangement would be to run three rows of 6 lamps each spaced 10 feet apart, the first unit of each row being 5 feet from the walls of the rooms, as shown in the above sketch. Holophane intensive reflectors, if used, will give good results and should be placed at a height which is four-fifths of their distance apart, in this case being 8 feet above the plane of illumination or from the tops of the desks. The reflectors should be satin finish in order to eliminate as much as possible glare from the bright surfaces of the desks. This will be found in any case to be somewhat annoying. The units may be controlled in a number of ways; either singly by pull chain sockets or in groups of two or three."

E. J. Mora.

Answer to Question No. 191.

Editor Southern Electrician:

"In reply to Question 191, in the February issue of Southern Electrician, I submit the following diagram as a layout for the lighting system mentioned. By referring to the diagram it will be seen that all lights are spaced 15 feet



⊕ = 4 LIGHT FIXTURE —40 WATT LIGHTS

Layout of Lighting System.

from center to center. Four 40-watt Mazda lamps should be used with Holophane extension reflectors. This arrangement, I believe, will give uniform distribution of light suitable for the conditions named. The fixtures should be from three to four feet from the ceiling according to the height of the desks so as to get the lamp at the proper height from the desk tops, which would be about 8 feet in the room considered with ceiling 12 feet high."

Ed. Dumas.

Answer to Question No. 191.

Editor Southern Electrician:

"Question No. 191 signed 'W. L. H.' relative to a proper lighting system for an office room 30 by 60 feet, has been brought to my notice. I desire to submit the following suggestions for the lighting of this room:

"I would recommend that thirty-two ceiling outlets be provided in four rows of eight outlets each; rows to be located 8 feet apart, side outlets being located 3 feet from side walls. Outlets in each row should be located 8 feet apart, end outlets being located 2 feet from end walls. Each outlet should be equipped with one 60-watt bowl-frosted Mazda or Tungsten lamp and Holophane focusing reflector No. F-60 with form H holder. Units should be mounted directly on ceiling.

"Inasmuch as artificial illumination is needed only at those times of the year when it becomes dark before 5:30 p. m., it is necessary to provide a fairly high intensity of illumination, due to the presence of a slight amount of daylight.

"With the spacing which we have recommended a uniform illumination of approximately 4.5 foot-candles intensity will be obtained. This arrangement will allow the movement of furniture from one portion of the room to another without the necessity of placing same with regard to direction of light. Desks may be placed close to wall and no objectionable shadows obtained, inasmuch as light units are provided close to wall."

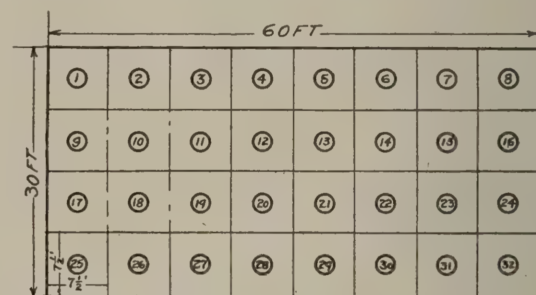
E. B. Rowe.

Answer to Question No. 191.

Editor Southern Electrician:

"Answering question number 191 in the February issue, I recommend as follows: Lay out the ceiling in squares 7 feet 6 inches each way or 32 squares in all and wire to one receptacle in the center of each square. Any kind of receptacle, drop or single light fixture may be used as desired, but in any case the tip of the lamp should be about one foot from the ceiling. Each receptacle or fixture should be fitted with one 60-watt Holophane intensive reflector, or shade, and used with a 60-watt frosted bowl Tungsten lamp.

"The wiring should be done so that the lamps may be controlled by at least two switches and connected so that



Layout of Lighting System

every other lamp is connected to each switch, as follows: Lamps number 1-3-5-7-10-12-14-16-17-19-21-23-26-28-30 and 32 should be controlled by one switch and lamps number 2-4-6-8-9-11-13-15-18-20-22-24-25-27-29 and 31 controlled by the other switch.

"By this arrangement half of the lights may be used at times when a strong light is not needed, a uniform distribution of light maintained and quite a large amount of current saved. The arrangement of the lights shown in the diagram will prove efficient, give an evenly diffused light throughout the office, strong enough for easy work but not strong enough to strain the eyes and will practically eliminate shadows."

H. M. Beal.

Answer to Question No. 186.

Editor Southern Electrician:

"In regard to Question 186, I wish to say: The interpole or commutating pole principle, for eliminating sparking at the commutator has an extensive application, and within the last few years it is used in nearly all types of direct-current apparatus, and slow speed generators, variable speed motors, and railway motors. On no class of motor has the interpole been used to a better advantage than on the variable speed shunt industrial motors, where the speeds vary within a wide range by changing the field excitation, and on the series railway motor, where the speed is also changing continually. But on both of these types the direction of the rotation must be reversible without shifting the brushes.

"In the interpole motor the strength of the interpole magnetization is set for sparkless commutation at full load. At this point the interpole overpowers the field produced by the armature and annuls the voltage generated in the coils which are short-circuited by the brushes. The armature is connected in series with the interpole coils, and the same current passes through both, which eliminates the sparking at all loads up to a heavy overload. The overload limit which can be carried by the motor is fixed by the magnetic saturation of the interpole. A current rush of 2½ times overload at short periods can be carried without flashing. Above this value the sparking will increase and the interpole loses efficiency.

"The theory of the interpole is, that current in the windings of an armature produce a magnetic field which is a maximum within the space between the main field coils. The coils undergoing commutation, whose ends are connected to bars under the brush, has its sides lying in its armature flux, and in the rotation through this flux an active voltage is generated between the bars. Also in addition to this voltage there is another in the same direction, produced by the reversal of the flux induced by the current in the coil undergoing commutation. As the current is reversed in the coil while the bar is passing from under the brush, the magnetic lines which exist around the slot in which the coil lies, are also reversed; this is somewhat like the kick obtained in opening a current-carrying circuit. The voltage produced by armature reaction adds to the slot reacting voltage to form the voltage which produces the sparking.

"Now, if a small pole with coil is place between each of the main poles, and current is sent through the coils so as to oppose the armature magnetization, the field caused by the armature reaction can be completely neutralized in the zone of commutation. And besides this, an additional excitation is needed to drive sufficient flux into the armature to oppose the armature magnetization so as to neutralize the flux around the slot when the current in the armature coil is reversed. These extra turns are known as the overcompensating turns, and enough are added not only to neutralize the reactance voltage, but to add a small voltage under the brush. In the series motor the windings are all connected in series, so that if the iron in the interpole core does not become saturated, the proper adjustment of the interpole which gives sparkless commutation at one current and speed, will give it at all currents and speeds.

"The magnetization of the interpole is generally greater than that of the main field, so that it creates a powerful field between the interpole core and the main field core. This leakage flux tends to saturate the interpole core, so that with thin interpoles the saturation point is reached earlier than with the thick. The reactance flux around the slot in the armature increases in proportion to increase in load, for this circuit has low densities and never reaches saturation. With increasing overloads the point is reached where very little more correcting flux can be forced into the armature by the interpoles, while the reactance voltage steadily increases. The sparking gets stronger and stronger, while at an excessive overload the sparking may be worse than if there were no interpoles at all. When reaching this point the saturation of the interpole practically cuts it out of function, and the armature is left with the interpole partly closing the slot and increasing the reactance flux and voltage.

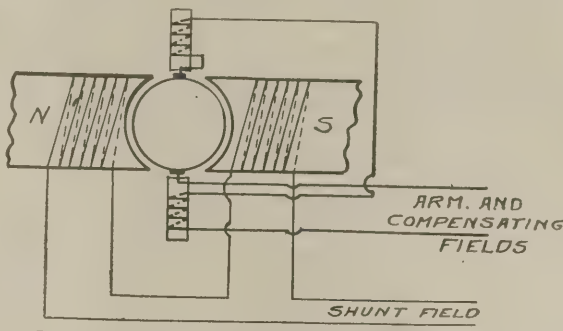


DIAGRAM OF INTER-POLE MOTOR CONNECTIONS.

"The making and breaking of a high voltage on a motor running at high speeds, will produce a great rush of current to its previous running value. As the eddy currents in the solid frame retard the rise of the flux in the main field, they also retard the interpole field. The reactive flux, however, being chiefly in laminated iron, rises in proportion to the armature current, so that less effect is obtained from the interpole with very rapid changes of current than with slow changes. For this reason it is better to slightly over-compensate with a small voltage of favorable sign under the brush, so as to get proper correction for rapid changes of current.

FRANK ZUCH.

Answer to Question No. 175.

Editor Southern Electrician:

"In answer to the trouble experienced by H. E. W. in Question No. 175, I offer the following: In a local battery instrument it may be that the battery has run down to a point where the current is insufficient to properly supply the transmitter. The hook-switch insulation may be broken down and a constant drain on the battery taking place, leaving it unfit for service. This may be determined by leaving the receiver on the hook and disconnecting one terminal of the battery, touch the terminals to the tongue and if current is flowing a slightly acid taste will be evident; otherwise the hook is not to blame.

"The transmitter in either local or common battery instrument may be packed, which will affect the transmission by muffling the sounds very materially; a high resistance resin joint in the set may be the possible cause; a short, even temporarily, in the induction coil, preventing it working at its highest efficiency. These troubles could happen intermittently or the transmitter may not be used in the proper position, that is, the mouthpiece facing horizontally. In a common battery system a loose connection in the circuit anywhere or a dirty switchboard plug might cause the trouble. If H. E. W. will have these points looked into he will probably locate the cause. He asks, "what is the proper distance for best effect in talking in instrument?" Three or four inches is the best under the ordinary conditions in an ordinary tone of voice."

L. O. SURLES.

New Apparatus and Appliances.

A New Rock Drill.

The accompanying illustrations show an electric rock drill developed by the Fort Wayne Electric Works. The drill is the result of several years development and testing under the most severe and unfavorable conditions of actual working operations.

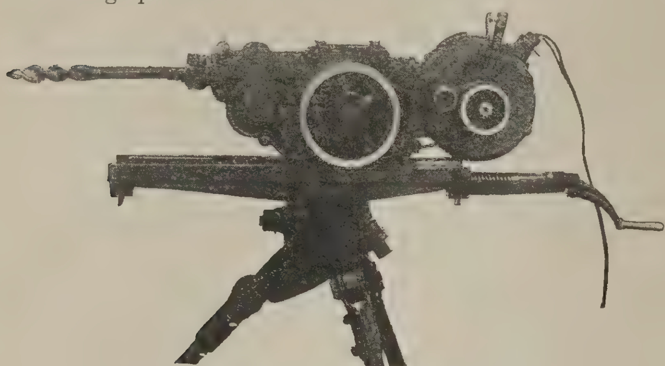


FIG. 1. SHOWING DRILL AND MOTOR.

The drill is of the rotary hammer type, operated by an electric motor which is mounted on the frame of the drill proper. The mechanism of the drill consists of two parts, a revolving helve containing the hammers, and the chuck mechanism for holding and rotating the drill steel. An idler is conveniently arranged in connection with the flexible belt between motor and drill, which provides a means of regulating the speed of the drill. Thus all the advantages of hand drilling are obtained without the disadvantages usually incident to machine drilling.

The drill steel is held in the chuck by means of several spring steel plates. When not striking rock, the blow from the hammer is absorbed by these buffer plates, which also retain the steel in the chuck while "backing out" of deep holes or in broken and uneven ground. The drill casing, striking mechanism, chuck and buffer plates are all simple and very substantial. The floating hammers in the helve are of special steel and are completely cushioned by air chambers so that the jar of the impacts is reduced to a minimum. The drill steel cannot be jammed into a fissure or a cleavage crack as a result of several conditions. Should a fissure be encountered, the buffer head prevents the drill steel from being plunged forward. The drill steel is not reciprocating and before it can be fed far enough into a fissure to wedge, it has hammered for itself a square shoulder or face, due to the rapidity of the blows in connection with the constant and positive rotation of the drill steel. The resultant effect approaches that of boring.

Another feature of the Fort Wayne drill is the simple method employed for the removal of cuttings from the hole being drilled. A special designed steel removes the cuttings by a boring action and does away with the use of hollow drills or water under pressure. Thus the big item of pressure systems, including tanks, hose, water lines, etc., is eliminated, to say nothing of the cost of maintenance and inconvenience incident to such systems. While these drills are ordinarily used in a horizontal position, they can be used in any position and will drill holes at any angle.

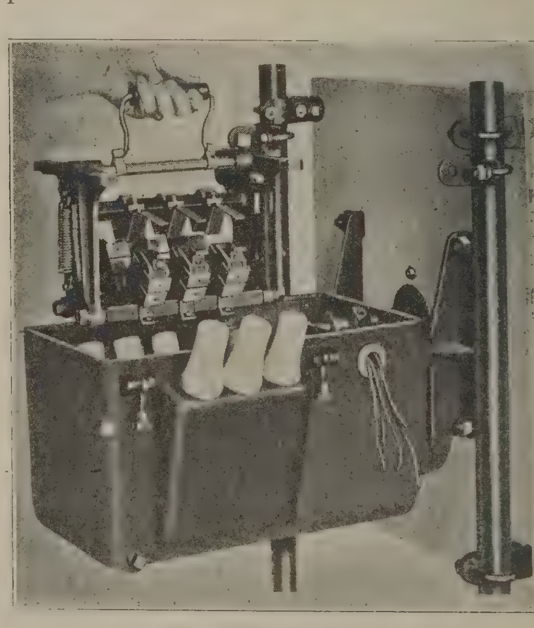
A comparison of tests of the Type "A" drill and air drills shows that the former requires about 1½ to 2 H. P., including transmission loss, while an average air drill requires from 12 to 18 H. P. for the same work. This is due to the design of the drill, the much greater efficiency of the electric motor and the small loss in transmitting power to the drill. The drill can be operated with either AC or DC motor and since the motor is entirely independent of the drill the change from one to the other is easily made.

A New Oil Switch.

The Allis-Chalmers Company has recently brought out a new type of oil switch designed for either switchboard or wall mounting, for pressures of 3300 volts and under, and in capacities up to and including 600 amperes. These switches are of the vertical up break type, a construction which the company has found very desirable because of the fact that maximum depth of oil is secured at the point of rupture of the circuit.

The working parts of the switch, including the stationary and bridging contacts, are made in a unit which is conveniently removable from the tank without disturbing the leads or connections. This is shown in one of the accompanying photographs. An inter-lock is provided so that the switch unit cannot be removed from, or inserted in the tank unless the contacts are in the open position. The contacts are so arranged that a rubbing action takes place when they are brought together, tending to keep them clean and to squeeze out the film of oil between them. Auxiliary removable arcing contacts are provided which break after the main contacts have spread approximately one-fourth inch.

When the automatic tripping feature is applied, three tripping coils, for the three pole automatic switch, are arranged for connection to three series transformers which are furnished with the switch. This construction affords absolute protection under all circumstances. The two pole switches are provided with one series transformer and the four pole switch with two.



ALLIS-CHALMERS OIL SWITCH.

The Allis-Chalmers Company claims many advantages for this switch over the usual type, some of which are as follows: The switch unit can be removed and taken to an adjacent bench where a thorough inspection and all necessary adjustments can be made with good light. The switch units of any one size are absolutely interchangeable so that an extra switch unit can be placed in the case while one which has been in operation is removed, if this procedure is desirable.

With these oil switches the arc is drawn at a point of greater depth of oil than the usual construction permits. This avoids a common fault of throwing oil when the switch is open under a heavy over-load or short circuit and affords a greater breaking capacity with less disturbance. The tripping coils and automatic features of the switch are entirely enclosed and protected within the case while at the same time they are easily accessible for inspection.

Bossert's Octagon Receptacle and Outlet Box.

The accompanying illustration shows a type of outlet box manufactured by the Bossert Company, Utica, N. Y., which takes the place of the round boxes formerly made by this Company. The Octagon Box has a number of advantages over the round box, particularly as regards the fastenings of the conduit with the monitor bushing. From the illustration, it will be seen that the bushing fits up against the flat surface of the box, which is not true of the round box.

OCTAGON RECEPTACLE AND OUTLET BOX.

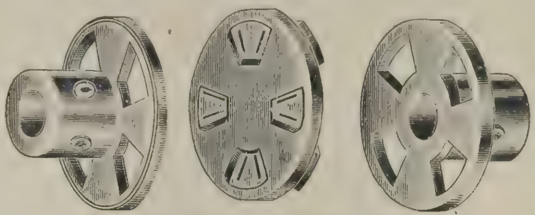
The four knockouts shown can be removed by a blow with a hammer, and on removing a clean, round hole is left the exact size of the conduits, entirely obviating the necessity of filing off ragged edges. This knockout feature was passed upon by the court of appeals in May of last year on the basis of patent No. 571,297 dated Nov. 10, 1896. The Bossert Company carries complete lines in Chicago, New York and San Francisco.

Flexible Insulated Shaft Covering.

The flexible insulated coupling illustrated herewith is designed for the transmission of power from one shaft to another where electrical insulation and a moderate degree of flexibility are desired.

The two outside flanges (Fig. 1) can be either keyseated or set-screwed to the ends of the shafts. The central disk is made of especially selected leather, and has lugs securely cemented and riveted to each side. The disk supplies the insulation and the lugs transmit the power to the outside flanges.

The manufacturer, Charles Bond Company, 520 Arch Street, Philadelphia, Pa., claims that this coupling will transmit more power than any other flexible coupling of equal diameter and that it will sustain uneven strains. It is said to provide an ideal connection between dynamo and gas-engine cranks or similar machinery, and where it is not possible to secure perfect alignment of shafts the coupling will adjust itself to any such inequalities.



PARTS OF INSULATED SHAFT COUPLING.

These couplings can be made in all sizes. They can run in either direction, and are adapted for high speeds.

The Sebsco Screw Anchor.

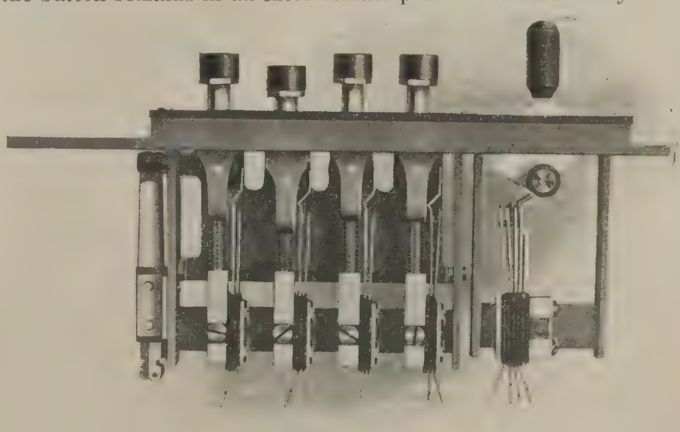
A departure from the usual run of fixture fastening devices is now placed on the market by the Star Expansion Bolt Co., of 147 Cedar Street, New York City, makers of the Star expansion bolts. The Sebco screw anchors are constructed on an entirely different principle from the Star

SEBCO SCREW ANCHOR.

screw anchor, and consist of a lead composition, anchor, corrugated and cut in the form of a star at the screw end, This star adds to the inner expansion and is also a formidable preventative against the fracturing of the two jaws. In the old types a too great expansion would quickly split the jaws. The Sebco also allows a deeper and more even expansion.

New Western Electric Products.

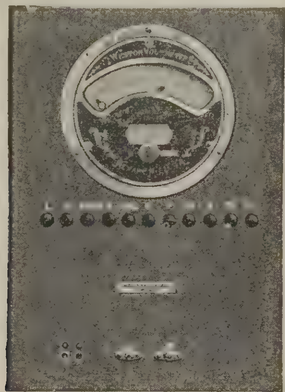
A new type of key designed especially for harmonic ringing and embodying many new features of merit, as well as many features which will be recognized as those found in their horizontal type of key now so extensively used, has been placed on the market by the Western Electric Company. This key, known as the No. 468 type, is of the locking-indicating type. After ringing the subscriber, the button remains in an intermediate position between fully



A NEW FOUR-PARTY KEY.

depressed and normal, thus indicating the last party rung. A distinctive feature is the fact that each group of springs is mounted as a unit. All units are alike and, therefore, interchangeable. In this type of key there is only one pair of talking contacts. The plungers are of the roller type and absolutely noiseless in operation.

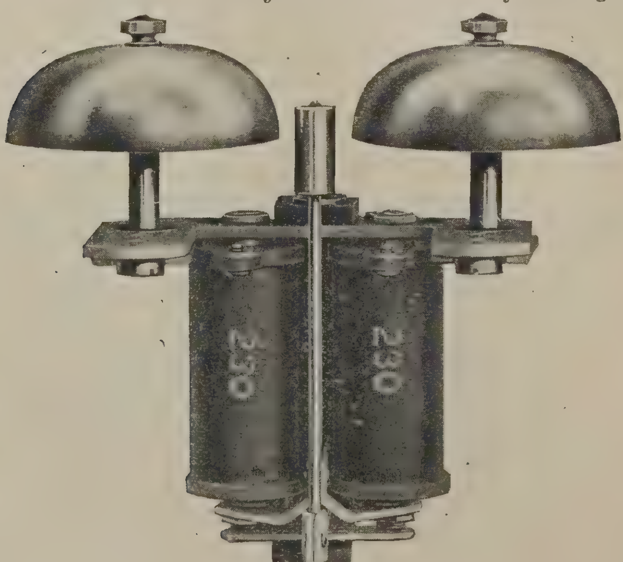
To meet the demand for an inexpensive testing outfit for small telephone exchanges, where a reliable means of testing is absolutely essential but where the outlay for an elaborate wire chief's equipment seems prohibitive, the Western Electric Company has placed on the market a new testing cabinet.



A TESTING CABINET FOR THE SMALL TELEPHONE SWITCHBOARD.

This cabinet, known as the No. 1407, can be used with any switchboard and will do practically the same work as the large and expensive wire chief's desks. It is made in two styles, one for use with magneto switchboards and the other with common battery switchboards. The cabinet is adapted to be fastened to the end of a regular switchboard, or elsewhere, as desired. The volt meter is mounted on the front of a substantially made oak case, directly above the switching keys. The two terminals for connection to a Wheatstone bridge and the terminals for the grounding and testing cords are arranged at the bottom.

The apparatus consists of a testing circuit, an operator's circuit, a ringing circuit with keys and a grounding cord with flexible cord and plug. Both the testing circuit and grounding cord terminate on eight foot cords, and are equipped with No. 47 cord plugs. With these cords it is possible to reach across and get connection with the lines which terminate in the adjacent switchboard. By running a pair of wires from the binding posts on the rear of the cabinet to some convenient place near the main distributing frame and using a flexible cord provided with a test plug fitting the protectors, it is possible to test either the switchboard circuit or the outside line.



A NEW HARMONIC RINGER.

The Western Electric Company has recently placed on the market a new harmonic ringer. This ringer, known as the No. 41 type, operates on the same potential, 140 volts, for four frequencies. This simplifies the harmonic ringing system and eliminates the use of the higher voltages which have been objectionable in low voltage telephone circuits and apparatus.

The construction of this ringer is such that no armature adjustment is required after it leaves the factory. The adjustment of the gongs can be easily and accurately made by means of an eccentric screw. After the adjustment is once made the gongs can be rigidly and permanently set by tightening the screws which lie directly behind the adjusting screw. The very simplicity of the adjustment of this ringer is a unique feature, as the only tool required is an ordinary screw-driver.

Electric Plant of King Alfalfa Mills.

A typical example of the way in which electric power contributes to the development of a new industry, is the installation at the Kingfalfa Mills at Nebraska City, Nebr. Their plant consists of a 300 K. V. A., 440 volt, 600 R. P. M., 3 phase, 60 cycle, alternating current generator of the two-bearing, belt-driven type. This is driven by a 300 H. P., simple, non-condensing Corliss engine, and the power developed is used to drive a disintegrator or alfalfa meal mill and other auxiliary machines, such as blower, dust collector, packer, etc. The alfalfa mill is driven by a 150 H. P. slip-ring type motor, which is belted direct to the mill.

On account of the great weight of the mill and the inertia of the moving parts a high starting torque is required to start and bring it up to speed, which is a severe test on the capacity of both the motor and generating plant. The main motor drive and the generating plant are shown in the accompanying illustrations.

The plant has a capacity of four tons per hour of the finished product, and in a test of several hours continuous operation it has been worked to the capacity of six or seven tons per hour. The entire electrical equipment was manufactured and installed by Fairbanks, Morse & Co., through their Branch office at Omaha, Nebr.

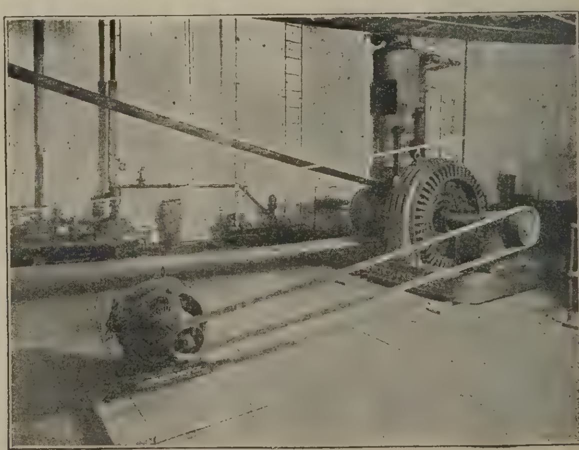


FIG. 1. GENERATING PLANT.

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.

ALBERTVILLE. According to reports the city has under consideration an issue of bonds for the construction of an electric light plant. Further details may be obtained from the city officials.

BIRMINGHAM. A. H. Ford, president of the Birmingham Railway, Light & Power Company, has made a trip to New Orleans where he will confer with engineers of the street railway lines in the South looking to improvements and betterments to the lines in Birmingham.

BIRMINGHAM. It is understood that George Millar is in Birmingham making arrangements to install a "great white way" in the business section of the city.

BIRMINGHAM. It is recently reported that a company has been organized with a capital stock of $250,000 dollars for the construction of a plant for the manufacture of Turbo Rotary Engines. The company will be known as the Veitch-Mathews Engine Co., and the officers are president I. A. Lewis, vice-pres. G. Veitch, treas. E. L. Huey, and secy. J. N. Lobett.

BIRMINGHAM. A large skyscraper is to be built in Birmingham known as the American Trust and Savings Bank Bldg. The building will be 20 stories and located on the corner of first Ave and 20th St. It is understood that W. W. Crawford is interested in the proposition.

CLERA. The electric light plant formerly owned and operated by M. Dein has recently been purchased by E. V. Everettecrin.

DECATUR. It is reported that the city council of Decatur will in a short time put in a number of new street arc lights. The new lights to be put in will be placed in the Western part of the city in a new territory which was recently acquired by annexation.

DOTHAN. Reports state that the city is contemplating the construction of water works and electric light plant to cost approximately $60,000. The engineer is R. R. Pilcher.

EUFAULA. The electric light plant at Eufaula has been destroyed by fire. It is estimated that the loss is about $20,000. According to reports the plant will be rebuilt at once as the city is without lights and all source of power is cut off.

GADSDEN. It is reported that T. M. Gassels is to build a 30 room apartment in Gadsden. Every apartment will have gas, water, electricity, hot water, and everything in modern construction.

LYNCHBURG. It is reported that a new $10,000 hotel is to be erected. J. W. Craddock is said to be interested.

MOBILE. The Mobile Terminal Co., will erect a power house at Alabama Port to supply power for the operation of a large electric dredge.

SPIEGNER. J. Craig Smith, President of the State Convict Montgomery, Ala., will receive bids for electrical supplies including wire, and conduit to connect meter panels of cotton mill and power plant for ten three phase motors. The engineer in charge is Edward B Kay of Tuscaloosa.

Florida.

FORT LAUDERDALE. A company has been incorporated and known as the Fort Lauderdale Light Co., with a capital of $50,000. The president is H. R. Brown.

GAINESVILLE. The city council of the city of Gainesville and the board of public works with the citizens are actively engaged in endeavoring to secure a municipal light plant.

LIVE OAK. The Electric Light Plant has been sold to the Live Oak Electric Light Co., for a consideration of $50,000. The new company is composed of the following: C. A. Burke, H. J. Wood, C. E. Jones, A. L. Humphrey, and J. White of Live Oak, and A. M. Ives of Jacksonville.

JACKSONVILLE. Announcement has been made that the board of bond trustees has decided upon $19,497 as the purchase price for the power and lighting service of the Jacksonville Electric Co., which has recently been taken over.

JACKSONVILLE. The Jacksonville Electric Co., plans the construction of a power plant to cost about $450,000.

TAMPA. The Tampa Electric Co., is to erect the most modern and efficient car barn in the South. The barns will be located on property recently purchased on river front, comprising several acres in the Toland sub-division with access from seventh and eighth streets. They will be capable of accommodating 100 cars at a time.

Georgia.

ATLANTA. On February 1st an extention to the White Way of Atlanta was lighted, 625 globes were added to the already existing white way system, the added lights being placed on Marietta, and Forsyth Streets.

ATLANTA. A Water power sight has been secured and $10,000,000 capital is at hand to furnish 200,000 H. P. to Atlanta and the surrounding territory. According to statements by President C. Elmer Smith of The Georgia Power Co., the necessary plans are to be completed in the next 18 months and power will be ready for consumption by the summer of 1912. The company has acquired power rights at Tallulah Falls which will furnish 100,000 H. P., and other plants will be erected at Gainesville and at Franklin which will furnish the other 100,000 H. P. A large distributing station is to be built at Tallulah Falls where 6 generators each developing 15,000 H. P. will be installed. The engineering work is in charge of C. O. Lenze of New York assisted by C. E. Parson who is directing the operation now in Pittsburg, in this territory. The proposed development will make Atlanta the greatest water power center with the exception of Buffalo and its Niagara Falls, east of the Rocky Mountains.

ATLANTA. It is understood that the authorities are considering the installation of a new private telephone exchange in the new city hall of Atlanta. The city electrician has been instructed to secure estimates on such a system.

ATLANTA. The equipment on the proposed surburban line from Atlanta through Forsyth and Cherokee counties will be a 70 foot, passenger, smoking, and baggage car of 250 H. P. Plans and specifications for these cars are in the hands of the Atlanta and North Western Railroad and it is expected that the cars will be ready when the road is completed and ready for operation. The proposed route for the road is from Atlanta to Bolton, in Bolton county on the Chattahoochee River. From Bolton, the road follows the same river to Roswell and Alpharetta continuing in a Northwesterly direction a short distance into Forsyth county. At this point it separates into two line to the State Tuberculosis Sanatorium passing through branch terminating at Cumming in Forsyth county.

BALDWIN. A modern system of street lighting is being installed at Baldwin. The Wofford Shoals Light & Power Co., will furnish the power. This company has also completed a line to the State Tuberculosis Sanitorium passing through Baldwin.

CANTON. It is understood that plans are under way for the enlargement of the municipal electric light plant at Canton. The Superintendent is J. W. Alford and can give other information.

CLANTON. A new rural telephone line which has recently been organized will be put into operation as soon as possible, connecting with the Valdosta exchange. The Line will run from Valdosta by way of Stephenson to Clanton and connect a number of residences on the route.

COLUMBUS. It is reported that the Central Railway Co., is to install a power equipment for furnishing its own electric light in offices, depots and the shops at Columbus.

COLUMBUS. The Street Railway company is extending its lines above Columbus and erecting overhead wires from Columbus to Goard Rock.

DALTON. P. R. Trammell has been given assurance by the Ocoee Power Company of Chattanooga, that they will run a line from their plant on the Ocoee river into Dalton.

FAIRBURN. It is understood that a bond issue is under contemplation for the construction of a power plant.

GAINESVILLE. The city engineer is preparing plans for a waterworks and sewerage system.

MACON. The large manufacturing and other plants of Macon will be operated by electrical power furnished from the dam at Jackson, through the power house at that place controlled by the Central of Georgia Power Co. The energy is transmitted from the generating station to a sub station at Macon at a voltage of 66,000. Among the large enterprises that will be furnished with power in Macon are the Macon Railway and Light Co., the G. S. and F. shops, The Massee Felton Lumber Co., Acme Brewing Co., Cherokee Fertilizer Co., National Hay, Grain & Storage Co., Roinder Guano Co., and the Brown Wagon Co.

THOMSON. It is reported that the municipal electric plant is to connect a day load service at once. The superintendent is L. J. Porter.

THOMASVILLE. It is reported that the Southern Power Company is seriously considering cutting out Davidson county from their inter-urban and going by way of Winston-Salem.

SAVANNAH. The H. S. Jandon Engineering Co., is preparing plans for a water works system to cost approximately $30,000 for the city of Dalton, Ga. The bids for machinery will be open about March 1st.

WAYCROSS. A street lighting of the city of Waycross has been increased by the installation of 235 lights, making a total of 300 street lights.

Kentucky.

CADIZ. According to reports a concrete and a hydro-electric power plant is to be constructed by A. B. White & Co., at this place.

CLINTON. Reports state that the Clinton Water Power & Light Co., is to install an ice plant.

FRANKFORT. A franchise has been granted to the Capital Lumber Lumber Co., to build an electric power plant for public service at Frankfort. It is understood that transmission lines will be run to nearby towns and substations established. E. M. Wallace is manager of the company and can give other information.

LEXINGTON. The Lexington and Inter-Urban Railway Co., will be reorganized and extensive improvements made to properties including the erection of a new power house estimated to cost about $500,000.

LIVERMORE. An electric light and ice factory is being established at Livermore by the Smith Cooperage Co., of Louisville. At the present time it is understood that the contract for the electrical equipment has not been awarded.

LOUISVILLE. The plant of the Geo. T. Fetter Light Company is practically completed. The total cost of the new plant with the machinery used is about $300,000. It will furnish electricity and will operate a new ice plant and furnish steam for heat and refrigeration.

LOUISVILLE. The property holders have presented a petition asking that the city maintain arc lamps on Silver Street at Spring and Market Streets.

MIDDLESBORO. It is understood that the Nicholson Coal Co., is to install and to operate its equipment by electricity. The plant will also be lighted by electricity. J. C. Cardwell of Louisville is the president of the company.

NICHOLASVILLE. It is reported that the manager of the Municipal Electric Light Plant is contemplating the installation of a new steam equipment including boilers and engines. The manager is E. J. Glass.

PAINTSVILLE. It is reported that a company is being organized to established an electric light plant at Paintsville. C. W. Howard is interested.

RICHMOND. It is understood that the Richmond Electric & Power Co., is to install a generating plant with a capacity of approximately 200 K. W.

SMITHFIELD. It is understood that the Smithfield Milling Co., is contemplating the purchase of equipment for increasing the capacity of their steam power plant.

Louisiana.

NEW IBERIA. It is understood that the Southwestern Power & Traction Co., will construct a power plant in New Iberia and substations will be erected along a proposed railway which will connect New Iberia with Lafayette, La. From the substation lines will lead to various manufacturing plants.

LAFAYETTE. Preparations are being made by the Industrial Institute for the installation of an electric light plant.

MANY. The Many Ice, Water & Light Company, recently organized is planning the construction of a power plant in Many. W. C. Roaten is president, and W. Robinson is general manager.

Mississippi.

McCOMB. The city will construct electric light plant.

NEWTON. Mayor and Board of Aldermen have passed an ordinance providing for issuance of $11,000 of bonds for construction of electric light plant.

MERIDIAN. The Johns Telephone Co., has been organized. The incorporators are H. C. Patrick, J. C. Crain, and others.

TUPELO. This city will soon issue $50,000 bonds, of which $15,000 will be used for improvements to the municipal electric light plant. It is proposed to change the system from direct to alternating current and to install larger engines. W. H. St. John, Superintendent.

North Carolina.

CHARLOTTE. It is understood that the city council has issued bonds for the erection of the Municipal electric light plant and that the work will be pushed.

LAKEVIEW. The Electric Light & Power Co., of Lakeview has been granted a charter with a capital of $25,000. The incorporators are F. R. Danley and J. B. Eastwood of Lakeview and J. R. McQueen of Pine Hurst.

RALEIGH. A company has been incorporated known as the Electric Light & Power Company of Lakeville, with an authorized capital of $25,000. F. R. Danley and J. B. Eastwood both of Lakeville, and J. R. McQueen of Pine Hurst are the incorporators.

SYLVIA. It is understood that Silvia and Dillsboro are soon to have electric lights and other improvements. C. J. Harris is installing an electric plant at Dillsboro, the energy from which will be transmitted to his tannery at Silvia. Energy will also be furnished to light other nearby towns.

WARRENTON. An electric power plant to be constructed to furnish industrial power and lighting are the plans of the company which will be known as the Warrenton Electric Light Co. It is understood that J. W. White is interested.

WHITNEY. It is understood that the Whitney Electric Development Co., has decided to continue the work on the hydro-electric plant estimated to cost $3,000,000.

Oklahoma.

ARDMORE. Plans are under way for the establishment of a hydro-electric plant by E. S. Perry of Coalgate, Okla.

CHEROKEE. It is understood that the city of Cherokee will receive bids through engineers Burns and McDowell of Kansas City, Mo., for the installation of direct connected 75 K. W. 2,360 volts, 60 cycles for the municipal electric light and power plant.

CINITO. Plans are being prepared for the erection of a cotton gin to be operated by electric power. It is understood that L. S. Parker is interested.

GUTHRIE. The Oklahoma Light & Mfg. Co., it is reported has decided to move its plant and offices to Oklahoma City. The company manufactures gas light fixtures and has a capital stock of approximately $25,000.

OKEMAH. A company has been incorporated known as The Canadian Power & Light Co., with a capital of $100,000 to develop a hydro-electric plant on Deep Fork of the Canadian River. A hollow dam and aqueduct with turbines to develop 2,000 H. P. are the plans at the present time. W. H. Dill is the president of the company.

HEAVENER. It is stated that a franchise has been applied for by the Degna-McConnel Coal Co., of Wilburton, Okla., for the purpose of establishing an electric light plant at Heavener.

LAMONT. It is stated that the city is to expend approximately $20,000 for a water works system.

South Carolina.

COLUMBIA. The Springfield Electric Light & Power Company, of Springfield, has been incorporated with a capital stock of $20,000. The incorporators are J. Deane, E. J. Boland, A. D. Smith, J. B. Stroman, and J. Fanning.

COLUMBIA. A company known as the Piedmont and Northern Railway Co., has been organized with $5,000,000 capital to extend the Greenville, Spartanburg and Anderson Railway Co. The following are the incorporators: J. B. Duke, of Summerville, N. J., P. N. Duke of New York City, Samuel McRoberts of New York City. W. S. Lee of Charlotte, N. C., E. A. Smith of Greenville, and L. W. Parker of Greenville. Plans for the new railway combination contemplate a net work of tracks which will bring the towns of the Carolinas in closer relation and utilize the vast natural resources furnished by the mountain streams.

GREENVILLE. The Home Light & Power Co., is now in the process of merging with the Greenville Gas, Electric & Power Co. J. G. Arnold has assumed active charge of the lighting and power properties of Greenville.

NEWBURY. Reports stated that Albert Fillmore or Charlotte, N. C., engineer for the Southern Power Company has petitioned council for the franchise to supply electricity to Newbury.

ROCKHILL. The city has purcahsed the Water and Light Plant from Martin Malony for a consideration of $100,000.

SPARTANBURG. W. H. Erwin, who has bought the interest of J. H. Shores in the Shores-Erwin Electric Co., now is the sole owner of this concern.

SUMTER. It is reported that the plant and interests of the Sumter, Ice, Light & Power Company have been sold to Philadelphia capitalists for a consideration of approximately $150,000.

Tennessee.

CHATTANOOGA. According to reports by the Retail Merchants Association, the "great white way" for Chattanooga is not assured. The lines will extend up and down Market street between sixth and tenth streets and decorative posts supporting five lights be placed every 35 feet on each side of the street.

MEMPHIS. It is understood that the municipal idea for a new lighting plant in Memphis has become active and that probably the bond issue will be $1,000,000 for that purpose.

NASHVILLE. The Chilhowe Water Co., has been incorporated with a capital stock of $10,000. The incorporators are Charles C. Moore, R. P. Johnson, James H. Graham, and James H. Williams.

WOODBURY. An enthusiastic mass meeting of the citizens of Hennon county was recently held to devise a way of securing an inter-urban railway from Nashville. L. B. McFerrin was elected president of the meeting and S. E. Davenport, Secretary.

Texas.

AUSTIN. It is understood that the city authorities are discussing the construction of a new dam across the Colorado River and the installation of a hydro-electric plant to cost about $1,000,000. It is understood also that George G. Moore of Detroit, Mich., is interested.

AUSTIN. The Sumpter Heights Water, Light & Power Co., has been incorporated with a capital stock of $20,000. The incorporators are B. R. Harden and Richard Rogers.

BRYAN. A flour mill is to be established at Bryan by H. K. Lawler and J. T. Lawler of New Orleans, La. It is also reported that this company will furnish electric power and light for the town.

BROWNVILLE. The city council has voted $15,000 to extend the electric light system. The election on this issue will be held on March 14th.

CELBURNE. It is understood that the Gulf, Colorado and Sante Fe Railroad will install an electric light and power plant in connection with its shop at Celburne. W. S. Buck is superintendent of motive power with headquarters at Galveston.

PORT BLISS. An electric lighting system is to be installed by the war department at a cost of approximately $20,000.

COLEMAN. It is understood that bids are out for $20,000 of electric light improvement bonds. The secretary is F. E. Dibrell.

GLEN ROAD. It is understood that Woodford M. Davis, of Dallas has secured a franchise to construct a dam across the Paluxy River to furnish light and power.

HOUSTON. It is understood that J. H. Jones has completed plans for the new 18 story $1,000,000 hotel to be erected on the site occupied by the first capitol of Texas. It is understood also that work will commence on the structure during the coming summer and that it will be finished within a year.

DALLAS. It is understood that the Dallas Electric Co., is to install a new ornamental lighting system for Elm Street. The company is to advance approximately $10,000 in getting ready for the new type of lamps to be used on the circuit and more than $6,000 will be expended in plant equipment. There will be installed 102 lights of the magnetite type and all of the wiring. The poles are to be located on either side of the street and at several of the intersecting streets. They will be set at a distance of 68 feet, to 72 feet apart, the average distance being about 70 feet.

KIRBYVILLE. It is understood that it is practically decided to install electric lights in Kirbyville. J. W. R. Flemming and J. A. Morton, mill operators, propose to move their planer plant to Kirbyville and and furnish electric lights.

Virginia.

FREDERICKSBURG. At a recent meeting of the city council, C. P. Purtwin of Richmond, president of Rappahannock Light & Power Co., made application for electric light franchise.

WARRINGTON. It is understood that Fletcher and Bros., who owned the Electric Light and Ice Plant have sold the property to Geo. J. O'Connell of Washington. Mr. O'Connell will besides improving the service in many ways carry a full line of electrical supplies.

NEWPORT NEWS. The Newport News and Oldpoint Railway and Electric Co., is replacing old equipment by new in their plant. The president, W. J. Paine, reported that no expense will be spared in putting the plant in the best possible condition.

Industrial Items.

SOUTHERN-WESCO SUPPLY CO. Announcement has been made that the capital stock of the Southern-Wesco Supply Company, the electrical jobbing house, of Birmingham, Ala., has been increased from $30,000 to $50,000. J. D. Turner, Jr., formerly of Atlanta, Ga., has sold his interests in Atlanta and has become associated with this company and will in the future be in full charge of the credit department. Mr. Turner has moved his family to Birmingham and will take an active interest in the company at once.

Oscar C. Turner, the president of the company reports that the increase in capital stock is on account of the growth of the business. Mr. Turner stated that when he came to Birmingham a little over a year ago, he felt sure that the people of the South would respond if an electrical supply house were started conducted by southern business men, and competing with other electrical jobbing houses as to quality and price. The Company's success has been entirely satisfactory and they are working toward the best methods for increasing usefulness and taking care of customers in the manner that will be thoroughly satisfactory to them.

The Southern-Wesco Supply Company is a strictly Alabama corporation, all of the gentlemen interested are southern men. They have traveling men covering the states of North and South Carolina, Florida, Georgia, Alabama, Mississippi, Tennessee and a portion of Kentucky. They carry a most complete stock of electrical supplies of all characters and are agents for some of the largest companies in the country. They are also agents for several of the manufacturers of generators, motors, arc lamps, weatherproof wire, meters, transformers etc., and are in position to figure with their customers on everything electrical.

The present officers of the company are:

Oscar C. Turner, president; Rogers V. Scudder, vice-president; Wm. M. Bowles, secretary, and John D. Turner, Jr., treasurer. The company is now occupying the building at the corner of twentieth street and Powell Avenue where they have been for several years.

ECONOMY ELECTRIC SPECIALTY CO. This company is manufacturing and marketing a unique device for attachment to pull sockets to facilitate their operation. The device is made for universal use on Bryant, Hubell and Paiste sockets known as the detachable Horn piece. The following letter by A. A. Earnest, consulting engineer of 103 Park Ave., New York City, speaks well of the device: "I beg to acknowledge receipt of the Economy Switch Operating Device your factory recently sent me. I am quite familiar with this appliance, having used a great number since last November and in every instance have found them entirely satisfactory. They are, as far as I know, the best apparatus of their kind on the market."

WESTERN ELECTRIC COMPANY. January was the first month of the Western Electric Company's new fiscal year, which will correspond with the calendar year hereafter. Earnings were slightly in excess of January, 1910, which is a remarkable showing in the face of the General Electric's report of a decrease of about 15 per cent. as compared with the previous January, and considering that in December, that being the last month of the old fiscal year, every effort was made to "clean up" orders on hand in order to make the carry-over as small as possible.

The larger January showing comes from within and without this country and the increase was very evenly distributed. Western Electric's gross business for the twelve months ended with last November totaled $61,000,000, and for the thirteen months ended with December approximately $68,000,000. This year starts most auspiciously. The company is in strong position in regard to financial resources and will be able to continue its policy of concentration at Hawthorne this year, without incurring further funded obligations.

PERSONALS.

MORTIMER S. ALLEN, who has recently been named manager of the Omaha, Neb., office of the Western Electric company, accompanied by his wife, left Atlanta January 21, for Savannah en route to assume his new duties. For two years Mr. Allen has been telephone sales manager for the Atlanta office of the company, and his promotion comes as a result of his efficient work in this position. No engineer in the South is more familiar with rural telephone problems and the advancement in regard to promoting and developing such systems in the South is in a large measure due to his initiative from the sales end. Mr. Allen was well known by all electrical men in the South and leaves a large number of acquaintances who wish him added success in his new field. Before coming South, Mr. Allen was connected with the Rocky Mountain Bell Telephone Company at Salt Lake City from 1895 to 1905. In January of the latter year he became manager of the Salt Lake City house of the Western Electric Company. The next year he was appointed manager of the San Francisco house and in 1908 he took up his duties as telephone sales manager at Atlanta.

Prior to leaving Atlanta Mr. Allen was banqueted by his many Atlanta friends and business associates. He was banqueted by the officers of the Southern Bell Telephone and Telegraph company and the officers of the Western Electric company entertained him at the Capital City club as an expression of pleasant relations.

Mr. and Mrs. Allen went to Savannah upon leaving Atlanta. Before reaching Omaha they will visit Richmond, Washington, New York and Chicago.

H. B. LOGAN, PRESIDENT OF DOSSERT & COMPANY, is making an extensive trip through the South and West in the interest of the Company's line of solderless connectors, taps, and terminals for electric wires and cables. He will visit the following cities: Atlanta, Chattanooga, Birmingham, New Orleans, Houston, Dallas, St. Louis, Kansas City, Denver, Salt Lake City, Butte, Spokane, Seattle, Portland, San Francisco, Los Angeles. Any firm interested in the above mentioned specialties can communicate with the home office at New York and Mr. Logan will be instructed to call in person.

HAROLD KIRSCHBERG. The resignation of Mr. Kirschberg as illuminating engineer with the Pennsylvania Railroad has been announced. On February 1st he became associated with the Heany Lamp Co., as engineer with offices at 1733 Broadway, New York City.

Alphabetical Index to Advertisers.

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With Which is Combined The Electrical Age.

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CONTENTS.

Electrical Heating.

The applications of electrical heat and the association of these applications with factors affecting central station day load and revenue, is a credit to the past two years of development. Success of present exploitation methods is demonstrating that the time is right for the adoption of the various household and industrial devices on the basis of their convenience and necessity in domestic life and industrial operations. Results from one section confirm those from any other and from all indications this field of application is one of immediate and considerable benefit to all concerned. Elsewhere in this issue we give various opinions on this subject and here call the attention of our central station readers to important features bearing directly upon general conditions.

The residence day load to-day, is comparable with the residence lighting load of some several years ago and the industrial heating load comparable with the industrial motor load of the same period. Recalling the slight activity on the part of consumers in both these fields, at first small, and how new conditions and educational methods have gradually brought excellent results to the central station as well as satisfactory operating conditions for the consumer, present progress of heating devices is gratifying. Just as the use of electric light has spread and caused the demand for efficient lighting, so can it be expected as distribution networks become more and more extensive that the field for the general application of electricity will expand and devices be required for utilizing heat from this source.

Every progressive central station now realizes the possibilities of developing profitable electric heating and cooking loads. The consumption of energy by these devices taken as a whole for any section runs into large figures and involves a varied character of applications. The field may be divided into domestic and industrial, the domestic load taken for any city having decided load curve flattening tendencies, with the industrial factor presenting equally favorable features. The industrial field is large and the nature of the demands resembles a motor load. Electrical heating of tools and appliances has already been developed to a successful point, and while the present applications have been confined to operations where advantages were obvious, the adaptation of the apparatus to the needs of all industries is gradually taking place.

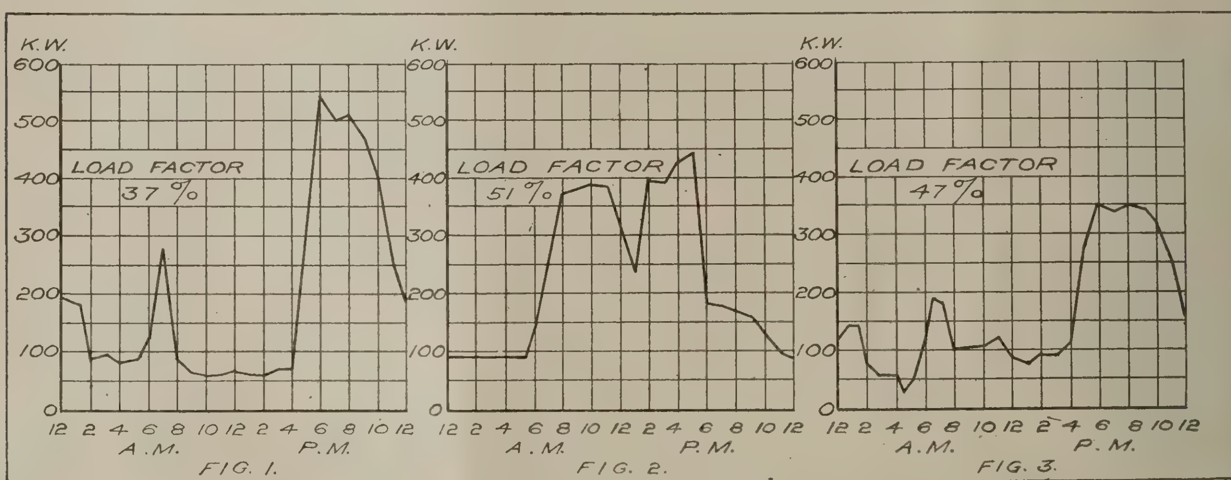
While a favorableness of the day load from current consuming devices is being advanced and the advisability to place rates at such a point as to increase the load to such extent as to be reflected in the load factor of the station, the other side often comes up. To what extent can the average station cater to this load or what is the approximate relation between the maximum possible demand factor and the possibility of causing additional expense in distribution? Without a question the larger number of central stations are so situated that this question is far distant by reason of ample provision in distribution facilities, the use of the devices is therefore to be encouraged rather than feared.

Current Consuming Devices as a Factor in Central Station Revenue.

(Contributed Exclusively to SOUTHERN ELECTRICIAN.)

BY A. G. RAKESTRAW, CENTRAL STATION ENGINEER.

THE original function of the central station was the production of current for lighting purposes only and later to more or less extent for power. Electric heating for industrial purposes has essentially the same characteristics as a motor load, although not usually as fluctuating. Electric light is used, of course, almost entirely at night while most of the power load occurs during the day time, these two loads overlapping to some extent at certain seasons of the year. In most cases the maximum lighting demand is considerably greater than the power demand and therefore the station capacity is that required for the evening lighting peak, in addition to what power or heating load may overlap with it. There are some exceptions, as in the case of plants whose output is utilized for power only, or for electro-chemical or electro-metallurgical purposes. Fig. 1 shows a typical load curve from a plant carrying a purely lighting load, while Fig. 2 shows one used almost altogether for power, Fig. 3 representing a mixed load, probably not far from average central station conditions.



FIGS. 1, 2 AND 3. LOAD CURVES FOR LIGHTING, POWER AND MIXED SERVICE.

We may first consider the development of current consuming devices from the standpoint of the customer. Inventors have been active in the discovery of new appliances for utilizing the electric current, and consumers have been quick to take advantage of them. This useful agent, electricity, may now be used to run the washer or the sewing machine, clean the dust and dirt from carpets and rugs, make coffee or toast bread at the breakfast table, heat the baby's milk, or take the place of the bothersome hot water bottle. The electric iron was soon found to have many points of superiority over the hot, tiresome method of ironing over a gas or coal stove. The electric vibrator, hair drier, and curling iron soon became indispensable adjuncts to the lady's boudoir, while the electrically heated shaving mug is no less appreciated by the man of the house, and the electric fan, one at home and the other at the office, makes possible a breeze universally enjoyed.

In industrial operations small quantities of heat are often produced more conveniently and economically than in any other way. Indeed for some purposes it occupies the field exclusively. We therefore see electrically heated glue pots, soldering irons, press heads for book binders, chocolate dipping kettles, pitch kettles, and many other articles. In nearly every industry these or similar applications of electricity have found a place.

This natural demand for the effectiveness, cleanliness and convenience of electrical appliances, has met in general with more or less active encouragement from central stations. Some of our large operating companies have gone to great expense in fitting up elaborate showrooms, in conducting extensive advertising campaigns, in employing a large force of solicitors, and have used every means to educate the public in regard to these varied applications of electricity. Others have discouraged or simply neglected these opportunities to promote the increased sales of their product. The rapid growth of the central station industry in this country has taxed even the most progressive of the operators to keep pace with it, and naturally we find that many of our moderate and smaller sized plants are under conservative management and not yet alive to their opportunities in this field.

However, it is not sufficient to push the sale of electric devices simply because they consume current, but it is highly desirable that every plant manager should know the effect which each one has upon his fixed expenses and revenue. The matter of central station costs has lately received a great deal of attention in the technical press, and while the last word has doubtless not yet been said, the analysis has been carried to a point where any manager who is at all interested in the matter may determine his fixed and variable charges, and from this deduce some adequate system of rates for service. It has been recognized that both the flat rate and the straight meter rate are unjust, and that an equitable system must take into account both the fixed and variable expenses.

Now, current consuming devices and of course this is true of lamps and motors, as well as the special appliances which we are considering, have two factors which are of interest in this connection, and upon which their value to the central station depends. These are, first, the demand; and second, the revenue. It is usual to entirely neglect the demand of electrical appliances, because as a rule the device is not used during the peak load. There are, of course, exceptions to this. The house wife may have occasion to press a garment for evening wear, at a time when every light in the house is burning, or the coffee percolator may be used at 6 p. m. during the evening meal in December, when every piece of station machinery is taxed to the utmost, but these are admittedly exceptional cases, and for this reason the demand factor has been neglected. This approximation, while not strictly true, does not present any serious features as long as the appliance load is low as compared with the capacity of the station, but when for instance, an extra unit has to be started every Tuesday morning to take care of the ironing load, the demand factor becomes of consequence. If such a thing were possible that the station capacity should be determined by the appliance load, rather than by the lighting load, the neglect of the demand factor in this case would place the whole calculation of rates upon an unsound basis and result in heavy loss of revenue.

There is one factor that has contributed in no small degree to the pertinence of this discussion and that is the advent of the high efficiency lamp. While it is both futile and selfish to discourage anything which results in the higher efficiency of light production, or anything else, for that matter, yet it has forced upon us the consideration of a rational apportionment of station costs. Not only has the demand factor of heating and other appliances become of importance, due to the increase in the number and size of the articles themselves, but also due to the increased demand of the more efficient light sources. Since we have no assurance that there will not be further increase in lamp efficiency, we cannot tell but that, with more and larger auxiliary devices coming into use, we may have to reckon with the appliance demand as being of equal importance with the lighting demand. This is not said to discourage any central station from promoting the sale of appliances but to point out the necessity of considering the factors of demand and revenue in distributing them and in determining an adequate basis of charges for the service rendered.

From what has been said we may conclude that appliances having a large demand and small revenue are not in general, desirable additions to the connected load, while those of small demand and large revenue are to be sought after. There are, it is true, exceptions to this rule and there are ways whereby we may overcome some disadvantages which might otherwise occur due to the use of some devices, but in general the above rule will hold good.

A current consuming device may be of advantage to the central station in one of four ways. First, it may bring a profit from the sale; second, an income from rental; third, a revenue from current consumed; or fourth, influence in extending the use of electricity. We will now discuss some of the classes of appliances and show how each may be of benefit. We will not attempt to take up every kind of domestic device, but will simply consider a few typical groups.

The most widely used household appliance is without doubt the electric iron. In this connection it occupies a class by itself. It is typical of the kind of device which possesses a high demand factor with comparatively low revenue. The demand exceeds one-half K. W. while the current consumed is usually not over 5 to 10 K. W. H. per month. If this high demand should come on the lighting peak, it would make this class of apparatus extremely unprofitable. This, fortunately, is not usually the case, and we may consider the electric iron as being a valuable addition to our load. It is cheap in price, not much trouble to place and being rugged in construction, is usually a source of satisfaction after being put in service. It is also of considerable value in influencing the use of current.

The usual method of connecting the iron in circuit, that is on the risidence meter, is however open to the objection as before stated, namely, that the revenue produced may not cover the fixed charges due to the demand. There is, however, one method by which this disadvantage may be overcome, and that is by the use of a double pole, double throw switch connected so that the iron and house lighting cannot both be used at the same time, as shown in Fig. 4. The usual price at which this service is rendered is from 50 cents to $1.00 per month.

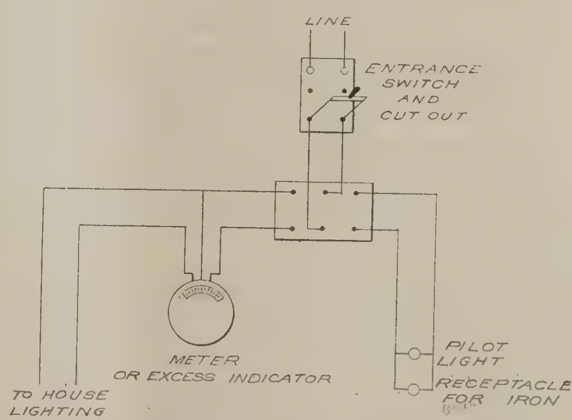


Fig. 4. Circuit Layout for Lighting and Heating Service.

The value of household cooking and heating apparatus varies greatly with the price and kind of available fuel. Electric cooking undoubtedly has many advantages in point of convenience, cleanliness and ease of operation, but it is as yet more costly than the other means of producing heat. The devices most commonly used are the toaster, coffee percolator, and chafing dish and they are in considerable demand by well appointed homes, as they add grace and elegance to the dining table. The revenue from these is quite small, and the demand practically negligible as their use is confined to the homes of well-to-do consumers. They are, however, valuable as illustrating the luxury of electric service.

In the same class we may consider a number of small household devices such as the milk warmer, cigar lighter, curling iron, corn popper, vibrator, hair drier, etc. These are only used occasionally and their current consumption is negligible. The greatest benefit derived from their use is that each is a practical demonstrator of the convenience of electric service, and as such should be advertised and their use encouraged by the central station. The profit from the sale of these articles is no mean item. If sold at proper prices it will pay for advertising and go a long way toward keeping up the expenses of the office and show rooms.

Heating devices of 100 per cent. load factor, such as the fireless cookers which are now being put upon the market, belong to an entirely different class. They have a low demand factor and produce a comparatively high revenue, for instance one such piece of apparatus now being introduced takes 50 watts continuously for 24 hours per day, and the maximum demand during the period of operation is 100 watts, therefore consuming about 36 K. W. H. per month. While this class of apparatus is as yet comparatively new, there is no doubt but that it has a wide range of application which is worth consideration by the central station.

The portable vacuum cleaner, sewing machine motor driven and the electrically operated washing machine, form a group of machines whose demand is not high and which do not produce considerable amount of revenue. The vacuum cleaner used once a week will consume possibly 1200 watt hours, the sewing machine in steady use about 400 watt hours per day, and the washing machine from 300 to 500 watt hours per week, and yet all three of these are extremely valuable to the central station for the reason that once used they become indispensible, and since they require electricity to operate them they make permanent customers. Furthermore they have been found to be good paying investments on account of the high quality of the service rendered at moderate cost and for this reason attract many persons who would not otherwise use electricity at all. After a woman once cleans house by a vacuum cleaner it is impossible to persuade her to do it any other way. There is also considerable profit in the sale of this class of machinery.

Another very valuable class of apparatus is that of household refrigerating machinery. There are in every town a number of fine residences in which considerable sums of money are spent for ice. A motor driven refrigerating plant is cleaner, more sanitary and much more convenient and can be operated for the amount formerly spent for ice. It produces a good revenue to the central station with low demand and creates universal satisfaction. While the number of persons who can afford a machine of this description is somewhat limited yet the field so far has hardly been touched.

Turning our attention to commercial apparatus, we will consider only a few of the many varied uses to which electricity may be put. The meat chopper and coffee grinder in the small retail store have a very good effect and are the means of inducing many merchants to use electric light. The dough mixer and the ice cream freezer have somewhat higher demand but since the hours of use are very short, do not produce much revenue. The load, however, is generally off the peak. The glue pot and the soldering iron for industrial plants may aggregate considerable consumption and are a desirable load.

Laundry irons are great consumers of current, but must be taken on a low rate to be attractive and this is often not sufficient to cover the fixed charges. The best way to charge for this service is to make a fixed charge in proportion to the demand and add a low meter rate for current consumed and thus encourage long hour use.

Commercial operations in general afford an unlimited field for current consuming devices which we cannot consider in this article. In general these devices will be found to be profitable, but if possible we should keep the heavy industrial heating demand off of the lighting peak, or see that a charge is made which will be adequate to cover the investment.

We may now consider the methods which have been found successful and the organization which is desirable for the purpose of putting these appliances upon the market. In general, we may say that there are three ways of calling the attention of the public to the advantages of electrical devices. These are, advertisement, display, and solicitation, all of which must be combined in some proportion in conducting a successful campaign.

In advertising, the daily paper will be found a great help. A large amount of space is not necessary, except at certain seasons, or in the opening of a special campaign, and yet enough should be used to keep the subject in the mind of the reading public. Street car ads are excellent as the subject matter has a chance to impress itself upon the mind and will in time be sure to produce results. The manufacturers of electrical apparatus are only too glad to co-operate in this work, loaning cuts and furnishing street car cards and also doing extensive advertising on their own account.

The bill board should not be neglected, but care should be taken to put out only such displays as are in good taste. Electrical signs, especially those operated by flashers, are always centers of attraction and aid in the campaign of education. Circulars sent by mail are valuable in some cases but not in others. I favor circularizing to a select list, accompanied by a personal letter in imitation of typewriting and in a sealed envelope. The expense will be no more than that of scattering circulars broadcast and the results will be much greater.

As to display, it is necessary to fit up a show room in some central location. The size of the room is not as important as the location and general attractiveness. It should be in charge of some competent person who is not only able to describe and demonstrate the apparatus, but who can also take applications for electric service and give intelligent answers to persons presenting complaints of any kind. It is desirable to have the bills payable at this place as well, as this will bring a large number of customers into the show room at least once a month. The effect of an attractive display of useful articles often repeated will be sure to produce results sooner or later.

In regard to the character of the display, seek for quality rather than quantity, and above all use originality. Seek to display the article, if not in actual use, at least arranged as if for use. An electric iron on an ironing board, resting on a garment, with a dish of water placed as if for moistening, will produce more effect than a dozen irons simply scattered around indiscriminately. For a good window display, get a table and chairs, which any furniture dealer in town will be glad to lend, drape with a handsome cloth and dishes, and arrange a percolator, toaster, chafing dish, with some slices of toasted bread, just as it would actually appear. Other effective displays will readily suggest themselves. It is not necessary to show more than one or two articles of each kind. Keep the most of your stock carefully packed away where it will not get specked or tarnished. Add a few figures, or portables, to give an air of elegance to the display than for sale. Demonstrations are often effective, but should be used rather sparingly, as they are expensive. About Christmas time they are especially of benefit.

Solicitation is the most effective way of placing appliances on the market. Advertisement and display often prepare the way, but it frequently takes personal solicitation to close the sale. In a company of any size, it is effective to have an organized appliance department, although this is largely a matter of detail. My preference is for permanent solicitors, who are trained for this work, however, I have known good results to be secured by temporary employees. As to remuneration, men temporarily employed are usually put on a commission basis, which I consider to have some disadvantages. Where articles are put out on trial, and advances are made for each one put in a house, it encourages the solicitors to misrepresent the conditions in order to have the article accepted on trial. The result of such work is that a large percentage of the appliances are delivered and collected unnecessarily, to say nothing of the effect on the customer of having been deceived in the matter. Therefore I believe the best method is to use permanent salaried solicitors for this work, or else to pay on a combination salary and commission basis, each man to do his own investigating, and be paid on the basis of actual sales only.

There is no reason why solicitation cannot be carried on the year round. The men may start out in the spring and cover the territory for irons, in the meanwhile casually talking up sewing machine motors, vacuum cleaners and washing machines and getting a line on prospects. When the iron canvass is over, there should be enough of these, with what others are worked up later, to keep the men busy nearly all the year. In regard to special campaigns, they are often a help, but they can never take the place of careful house to house work by a force of trained men.

Certain articles, such as those just mentioned may be advantageously left on trial. It is usual to allow from two weeks to thirty days trial. It is even a good proposition to leave irons out all summer if they are being used, as the current consumed will pay well for the expense of delivery and collection and repairs, but it is not wise to leave articles on trial which are easily damaged or otherwise rendered unsaleable. It is considerable expense to deliver and set up washing machines, but if care is used in putting them out they are sure to stay. Of twenty machines put out on trial in a town of 25,000 of which the writer knows, there was not one returned.

In regard to the price at which appliances should be sold, there has been a good deal of discussion, some claiming that it is advisable to sell at cost, or even below, and to get the returns from current consumed, and others taking the opposite view. I believe that all articles should be sold at a profit. They should be sold at list price, or only slightly under, and I believe that nearly as many will be put out as at the cut rate. Furthermore, cutting the price to cost is sure to incur the emnity of the local electrical contractors and this it is never wise to do.

There is one other source of revenue from electrical appliances and this is the income from the rental. At present the most valuable piece of apparatus along this line is the vacuum cleaner, which may be made to yield a good profit. A fair rental value for the small domestic machines is two dollars per day, including delivery and collection. Estimating the expense of handling the machine at 50 cents, this leaves a profit of $1.50 per day. Another article which may be rented during the summer months is the desk fan. These readily bring from $1.50 to $2.00 per month.

It appears then, that if the sale of electrical appliances is encouraged and sales are made at a fair profit, together with receipts from the rental of fans and vacuum cleaners, that the commercial department may be made in time self-supporting, and further produce a large volume of business in the way of lighting contracts, at no expense to the management.

Prevention of Overcrowded Street Cars.

There is almost entire absence of excessive overcrowding of street cars in Liverpool according to Vice Consul George B. Stephenson, even during the opening and closing business hours of the day, when traffic is the heaviest. This problem has been dealt with and satisfactorily met by the local authorities placing upon the various tramway lines no less than 68 per cent additional cars during the rush hours. In a general way two distinct classes of passengers are carried, namely, the men employed in the shipping operations of the port along the line of docks and those engaged in the large commercial offices of the city. The former go to work much earlier than the latter and in this way the traffic during the morning hours is more easily regulated.

The regulation street car of Liverpool is the "double-decker;" that is, passengers are accommodated in the main body of the car and also by seats provided above. The length of the cars is 28 feet and the height 16 feet 8 inches. On the lower deck the seats are arranged along the side of the car, and accommodate 22 people seated; on the upper deck the seats are arranged transversely, with a passageway in the middle, and accommodate 38 people. The only provision made for standing on these cars is the straps attached to the pole just under the ceiling of the lower deck. Standing on the upper deck is absolutely prohibited.

Passengers board the cars at the rear end, the step being of sufficient width to admit two, but a heavy brass rod separates the space between them, which prevents crowding. The doors of the cars are only wide enough to admit one person at a time. On the upper and lower decks are signs stating the number of passengers which a deck will accommodate. The conductors become proficient in estimating the number of persons who have boarded a car, and when filled the iron gate is closed, indicating that there is no more room for passengers.

Until 1908 the cars of this district were of one uniform type, when an experiment was made with what are termed "first-class" cars, which showed the advisability of reserving only the inside of the cars for first-passengers, the upper deck being utilized for passengers at the usual prices. So satisfactory is this system that applications have been received for its extension to other routes.

Diversity Factors in Electrical Distribution.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

BY FRANK F. FOWLE, CONSULTING ELECTRICAL ENGINEER.

RAPID progress has been made during the past few years in analyzing the character of consumers demands upon central stations. These refinements in analysis have resulted from the growing tendency to place rate making on a scientific basis, as far as practicable, under the cost of service theory of rates. It is now widely recognized that the cost of giving service, as a whole, is divisible into two parts, one variable with the output or consumption and substantially proportional thereto, and one independent of the output, or practically fixed in amount. The first part is composed of all expenses which rise or fall, from day to day or even from hour to hour, with the variations of the central station load; examples of the kinds of expense in this class are fuel, a considerable fraction of the station labor, oil, waste, various details of maintenance or upkeep, lamp renewals, lamp trimming and some of the items classed with general expense. This group of expenses is reducible to a flat unit cost per kilowatt hour of output, and is therefore one of the direct elements or factors in the service charge.

The second group, comprising the fixed expenses, is again separable into two parts, one of which is proportional to the number of consumers; the second and largest part, is incurred for all the consumers as a whole. The first part of this group is often termed the consumer expense and the second the capacity expense. The general relations among these several elements of expense or cost are illustrated by the skeleton diagram shown herewith:

- Total Cost of Giving Service
  - Variable Part.
  - Fixed Part
    - Individual or Consumer Expense.
    - Common or Capacity Expense.

The consumer expense is comprised of items that are individual to each consumer, such as the meter charges, cost of energy losses in the meter, expense of meter reading, billing and collecting. The capacity expense is a large fraction of the whole cost of service and is comprised mainly of the interest, profits, taxes, depreciation, insurance and part of the upkeep on the central station and the distribution system. It includes also most of the items of general expense, such as salaries of officers, general office employees, office rent, light and heat, etc.

There is ordinarily no difficulty in arriving at the variable expenses and the consumer expenses, except in the matter of distinguishing sharply between the variable and the fixed elements of some particular item of expense which falls partly in each class. Various methods have been proposed and used in this respect, but the resulting differences in the final rate schedule are sometimes inconsequential, although not always so. It is not the purpose here, however, to present a discussion of that aspect of the rate situation.

In serving some particular customer it may be assumed that the fixed consumer expense and the variable element of cost per K. W. H. can be determined with fair precision. The major difficulties arise in finding what share of the capacity expenses should be borne by this customer. There are two well-known methods of distributing the latter expenses, termed the maximum demand system and readiness-to-serve system. Each method recognizes that the consumer's demand for energy, either the actual or the possible demand, is a factor which determines in part, the capacity expense. That is, the central station must be ready to serve the customer up to the limit of his possible demand at any time and must make the necessary investment to be in readiness to serve, whether actual service is rendered or not. This also applies to the distribution system as a whole, except possibly for those consumers beyond the region of dense population, in whose cases there will be some individual investment in the distribution lines required to reach and serve them.

But the question of how to distribute the fixed or capacity costs among the various consumers is perhaps the most interesting problem connected with rate making. The study of central station demands, in the effort to find an equitable basis of apportioning these costs, commences quite naturally with individual consumers. A consumer's maximum possible demand, of course, is equal to his entire connected load. His actual maximum is seldom equal to the connected load, however, unless the installation is very small. Under the maximum demand system of charging, with direct-current distribution, a maximum demand meter is generally installed, in addition to the kilowatt-hour meter. In this case the actual maximum is measured each month and therefore accurately known. This plan necessitates a second meter, with attendant increase of investment and maintenance expenses. For small consumers it is open to question whether the plan is ultimately economical. When alternating current distribution is employed, there is no satisfactory cheap form of maximum meter and the probable maximum demand must be estimated.

THE DEMAND FACTOR.

The term demand factor is here a very useful one, and is defined as the ratio of the maximum demand to the connected load. The factor is usually less than unity and can never exceed that amount, assuming that an accurate check is maintained upon the consumers' installations by periodic inspections. The value of the demand factor, under various conditions of service and for different classes of consumers, has been extensively studied by some of the central station companies and the public utility commissions. The average factors thus obtained, for each class and condition of service, are now used quite extensively in maximum demand systems of charging. Actual values of these factors will be touched upon later.

Assuming that the connected load and the demand factor are known for each consumer served, it is possible to compute the maximum demand in kilowatts in each case and from the sum of such demands to find the actual peak demand on the central station, assuming that these demands are all coincident in the matter of time. That they are not coincident, however, is too well known to require discussion. Instead, there is a great diversity in this respect, not only between motor and lighting service, for example, but also between two consumers in the same class and perhaps having equal installations. This question of diversity of demand is now receiving considerable attention and is of interest from several points of view.

THE DIVERSITY FACTOR.

The study of this matter has resulted in a new term, called the diversity factor. Inasmuch as we may speak of diversity of demand with reference to individual consumers, or with reference to groups of consumers, or again with reference to feeder demands upon the central station and in a variety of other ways, it is necessary to define the diversity factor in very general terms. But in order to explain the term in its elementary sense, the case of two adjacent consumers served from the same mains will be taken up first. Assume that consumer A has an installation or connected load of 2.0 kilowatts and a maximum demand of 1.0 kilowatt, corresponding to a demand factor of 50 per cent; while B, nearby, has a connected load of 3.0 kilowatts and a demand of 2.1 kilowatts, or a demand factor of 70 per cent. Assume further that the greatest demand which A and B make together is 2.17 kilowatts. The sum of the individual maxima is 3.1 kilowatts, which is the actual maximum they would have demanded of the central station had their maximum demands been coincident or simultaneous. The ratio of the actual joint maximum to the sum of the individual maxima is 2.17/3.10 or 70 per cent. and is termed the diversity factor. This factor has been defined also in the opposite way, or as the reciprocal of 70 per cent., which would be 1.43. It seems more logical, however, to use the first form defined, because the term factor implies a multiplier, and again because it is consistent with the definition of demand factor.

Stated more generally, the term diversity factor means the ratio of any given maximum demand to the sum of the individual maxima of its component demands. As thus stated the term covers any number of individual demands. It can be illustrated further, perhaps, by the use of simple formulas, given below. The whole connected load is

$$C = c_1 + c_2 + c_3 - - - - + cn$$

where C = total connected load, and c_1, c_2, etc., to cn = individual connected loads.

And the sum of the individual maximum demands is given by

$$D = d_1 c_1 + d_2 c_2 + d_3 c_3 + - - - - + dn\ cn$$

where D = sum of individual maximum demands, and d_1, d_2, etc., to dn = individual demand factors.

The actual maximum demand from the whole n consumers, or groups of consumers, is:

$$P = f D$$

where P = station peak load,

f = diversity factor for the n consumers or groups of consumers.

Since the definition of station load factor is the ratio of the average to the maximum or peak load, it follows that the average station load is given by

$$A = l D = l f D$$

where l = station load factor.

It is well to bear in mind that since these several factors all deal with peak loads of one kind or another, it is essential to adopt a uniform definition of the peak. The latter, for example, may be the instantaneous peak, or the ten-minute average, or the twenty-minute average, etc. Furthermore, it is essential that the several factors apply to equal time intervals in each case, such as a day, a week, or a month, etc.

It is possible, obviously, to introduce many more steps or links between the consumer and the central station than have been shown. In the case of alternating current distribution, for example, which usually presents the greatest number of links, diversity enters first in the demands of the consumers served by a given transformer and its secondary mains; second, in the demands of the transformers served by a given primary feeder; third, in the demands of different feeders on the central station or sub-station; and fourth (possibly), in the demands of the several sub-stations on the central station. If the power is transmitted from very large generating stations over a high tension network to numerous population centers, there may be still further links in the system, with attendant diversity.

It must be apparent at once that the general question of diversity in peak demands has an important relation to the design of central stations and distribution systems, as well as a prominent bearing on the question of rates. Stated broadly, the greater the diversity the less will be the station investment necessary for serving a given connected load and the lower the rates with a given area and density of development. In the ideal case, from the standpoint of the central station, where complete diversity exists, the demands would be completely non-coincident. For example, if two consumers made equal but alternate and separate demands, the plant investment to serve them would be but half the investment if their demands were simultaneous. Or stated in terms that perhaps are more familiar, the whole cost of power falls with a rising load factor. It is the object of every central station manager to improve the day load, and in general to raise the station load factor; this implies, in turn, greater diversity of load demands and points to the desirability of building up the consumption among all classes of industry and occupation in the community.

A very important contribution to the subject was made by Mr. H. B. Gear, in a paper before a joint meeting of the Chicago Section, A. I. E. E. and the Electrical Section, W. S. E., March 23, 1910, which dealt with an elaborate study of the conditions in the system of the Commonwealth Edison Company, of Chicago. The following table of factors has been rearranged from a table given by Mr. Gear in his paper.

TABLE I. EXAMPLES OF DIVERSITY FACTORS.

	Residence Lighting.	Commercial Lighting.	Scattered Motor Loads.	Large Customers: Motors and Lamps.
Meters to transformers......	33.%	63.%	91.%	....
Transformers to feeders......	56.%	80.%	50.%	80.%
Feeders to substation........	87.%	87.%	87.%	87.%
Total diversity factor........	16.%	44.%	40.%	69.%

The total diversity factors given in the table are the product, in each case, of the several factors above, in the same column. The following example will illustrate the use of these factors. Assuming a demand factor of 50 per cent., a total connected residence load of 100 K. W. will require the following capacities, making use of the factors in the first column of Table I:

	K. W.
Connected load	100.
Meters	50.
Transformers	16.7
Feeders	9.3
Substation	8.1

It should be borne in mind that the density of development and the class of service considered have much to do with the diversity of demand, and diversity factors obtained from a given locality or city must be applied with great caution elsewhere. This factor depends further upon the size of consumers' installations, being lower for large installations. The factor is usually smaller for residence lighting than in the case of commercial lighting. Window and sign lighting tend to decrease diversity and raise the factor. When a large number of consumers can be served from a single transformer, in a district of small area, the diversity is naturally much greater than in the case of large consumers who are served, perhaps, by individual transformers.

Owing to the shift in the peak of the lighting load with the different months of the year, as regards the time of day during which it occurs, there is greater diversity in the station load, as a whole, in summer than in winter. Naturally the conditions in December are the proper ones to consider in relation to the station and distribution capacities needed to serve a given connected load. It is also interesting to observe that there will be some diversity between the phases of a three-phase station when the lighting feeders are operated on a single-phase basis. Such feeders will ordinarily carry a load of small motors, in addition, of units not exceeding a few horse-power.

The way in which these factors affect the investment per kilowatt of generating capacity, for residence lighting as shown in the first column of table I, may be illustrated as follows: Assume that the generating station costs $100 per K. W., the feeders and overhead system $40 per K. W., transformers $10 per K. W. and meters $20 per K. W. The unit costs will be as follows:—

UNIT COSTS FOR RESIDENCE LIGHTING.

	TOTAL.
1.00 kilowatt of station capacity at $100	$100 00
1.15 kilowatt of feeder capacity at $40	46 00
2.07 kilowatt of transformer capacity at $10	21 00
6.21 kilowatt of meter capacity at $20	124.00
Total per K. W. of station capacity	$291 00
Total per K. W. of meter capacity	47 00

These unit costs very greatly in respect to the total, with local conditions. They are influenced by the area of distribution, type of construction, density of consumption and diversity of demand. The figures serve principally here to show how such costs may be computed from the several unit costs and the diversity factors.

The study of demand factors has been carried on extensively by the Railroad Commission of Wisconsin, in connection with the analysis of service costs in various utility cases. The following table of factors is taken from the Wisconsin decision in the Madison Case, decided March 8, 1910. These factors were given in the order establishing a new schedule of rates.

TABLE II. DEMAND FACTORS IN THE ORDER OF THE WISCONSIN COMMISSION IN THE MADISON CASE.

Class A.—0.5 K. W. or less, 60 per cent.; exceeding 0.5 K. W., 33⅓ per cent.

Includes residences, dwellings, flats and private rooming houses.

Class B.—70 per cent.

Includes banks, offices, business and professional establishments, stores, restaurants, saloons, theatres, halls, depots and corridors.

Class C.—55 per cent.

Includes factories, warehouses, shops, hotels, clubs, churches, schools, stables, garages and Federal, State and county buildings.

Class D.—30 per cent.

Includes the University of Wisconsin.

Class E.—55 per cent.

Includes all interior municipal lighting,—schools, police and fire stations, libraries, hospitals and other buildings.

Class F.—100 per cent.

Includes signs, outlines and windows,—unmetered and on a yearly contract basis.

Motor Installations.

Under 10 H. P., one motor, 90 per cent.

Under 10 H. P., two or more motors, 80 per cent.

Under 20 H. P., and over 10 H. P., 70 per cent.

*Under 50 H. P., and over 20 H. P., 60 per cent.

*Under 100 H. P., and over 50 H. P., 55 per cent.

*Over 100 H. P., 50 per cent.

Further examples of demand factors will be found in other decisions of the Commission, which have been determined in every case by careful investigation and analysis. An example of the diminishing demand factors in residence lighting, with increasing size of installation, was given by E. W. Lloyd, of the Commonwealth Edison Co., before the 1909 convention of the National Electric Light Association. These factors are given in Table III.

TABLE III. DEMAND FACTORS IN RESIDENCE LIGHTING AT CHICAGO, ILL.

CONNECTED LOAD.	DEMAND FACTOR.
0.3 K. W.	90 per cent.
0.5 K. W.	64 per cent.
1.0 K. W.	48 per cent.
2.0 K. W.	46 per cent.

Returning to the subject of diversity factors, it is almost superfluous to observe that diversity of demand is not confined to lighting and motor service, but extends also to railway service and to the other utilities such as water, gas and telephone service. It has not been studied to any great extent in these fields, but in the case of railway service in a large city some interesting results are available. In the case of a small generating station supplying a few miles of urban railway, the load fluctuations are violent, owing to the small number of cars in operation at one time. If such a system is increased several times in size, the extremely variable character of the load is still present on any limited portion of the system, such as that part which may be supplied by a single feeder. But the load swings

*Note.—On a yearly contract basis; 70 per cent. if less than yearly contract.

on the several feeders do not occur at the same time, that is, there is considerable diversity in the extreme fluctuations.

The tendency of this is to diminish the fluctuations in the total station load. When the system becomes very large, so that the economical distribution of power requires one or more large generating stations, with primary distribution at high-tension to a number of sub-stations, there is a further diversity element in the demands of the sub-stations on the main station. The load on the latter, in fact, may not fluctuate momentarily at all and instead may present a very even curve for a full 24-hour period. The same condition is approached in a large sub-station supplying a fairly dense track network.

In one case a series of observations taken at a sub-station equipped with four 1,500 K. W. rotary converters, supplying 15 feeders in the business district of a large city, showed a diversity of feeder demands between 3 p. m. and 5:30 p. m. of 74 per cent. During this time the individual feeders showed extreme fluctuations, in one or two instances opening the circuit breakers; while the output at the totalizing panel seldom fluctuated as much as 10 per cent. Simultaneous observations at another sub-station of the system, equipped with one 1,500 K. W. rotary supplying 5 feeders, exhibited a diversity factor of 62 per cent., with considerably greater fluctuations momentarily in the total load. The lower factor in the second case and the relatively greater fluctuation of total load were ascribable in part to the smaller number of feeders and in part to the fact that this sub-station furnished power for one end of an interurban line.

One naturally thinks of diversity in railway feeder demands as caused principally by the frequent slowing down, stopping and starting of cars. But other elements are ordinarily present, such as the non-coincidence of peak demands at different parts of the system during the rush hours and the diversity of maximum traffic movements as affected by the class of traffic handled, the time of occurrence and the direction. Under the complex conditions in a large city these elements are of considerable importance and in each specific case there are probably others, caused by peculiar local conditions.

Alternating Current Engineering.

(*Contributed Exclusively to* Southern Electrician.)

BY WILLIAM R. BOWKER.

CONTINUING this subject from the last issue, the essential features of the transmission of electrical energy will be discussed, taking up first the effects of inductance and capacity.

In any circuit, the reactive effects of inductance and capacity increase if the frequency is increased. The frequency used in electric lighting is from 50 to 120 cycles per second. Lower frequencies are unsuitable for electric lighting, owing to excessive fluctuation, although frequencies as low as 25 cycles per second are applicable for power transmission and power utiliation. High voltages are common with alternating currents because of the economy thereby effected in the copper mains, especially when used in conjunction with transformers.

The variation of the e. m. f. during the rotation of the armature conductor over one pair of poles is termed a cycle and the number of cycles or periods passed through in one second is termed the periodicity or frequency of the alternating currents, thus generated. Alternating current machines are generally constructed with a multiple of pairs of poles and are usually called multipolar machines. The object of this is to increase the frequency of the e. m. f. of the machine without increasing the speed, because there is a practical limit as regards the safe speed at which moving masses may rotate, the larger the machine the slower the speed.

Owing to the high voltages employed in alternate current generators, perfect insulation is essential in the armature, and this in practice is more readily attained if these parts are stationary. It is advisable and common practice, therefore, to rotate the field magnet or inductor with reference to a fixed armature. As previously stated, the variation of e. m. f. during one revolution of the armature coil when passing over one pair of poles is called one cycle. By employing two pairs of poles the number of cycles or the periodicity or frequency is doubled, with three pairs of poles trebled, with eight poles, that is four pairs, quadrupled, etc.

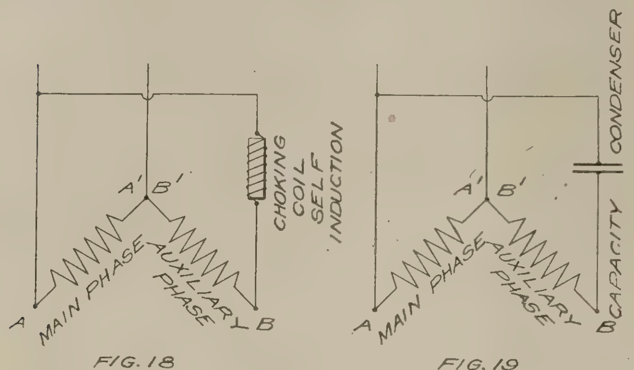
To find the frequency or periodicity of an alternator, the number of revolutions per second must be multiplied by the number of pairs of poles. For example, if the speed of an eight pole alternator is 600 revolutions per minute; this divided by 60 equals 10 revolutions per second. It has four pairs of poles, therefore its frequency is $4 \times 10 = 40$ cycles per second. Now each cycle consists of two alternations or reversals, therefore the number of alternations or reversals per second is $2 \times 40 = 80$.

Previous mention has been made of the actions and reactions when an alternating current circuit contains apparatus possessing either inductance or capacity or both. The knowledge of these properties is often utilized in practice to attain a condition of phase difference or phase displacement. Self-induction coils with large inductance and small resistance are sometimes used to impede alternating currents, and when so utilized are called choke coils or impedance coils. A choke coil may be composed of a coil or helix of copper wire, with or without an iron core.

A practical illustration of inductance is outlined in Fig. 18. We can cause a single-phase motor to become self-starting if we supply it during starting with a second current, which differs in relative phase with the main phase current. This condition can be attained by inserting in a branch auxiliary circuit a choke coil which possesses self-induction as outlined in Fig. 18.

The main phase is connected directly to the mains, the auxiliary phase, which is a branch of the main circuit, is in series with the choke coil. This produces a lagging effect due to self-induction and resultant retardation, and likewise a phase difference. This gives the desired condition to cause the motor to be self-starting. The single-phase motor cannot, however, start under full load, but with only a part of its full normal load.

As we have just seen, we can produce a phase difference by utilizing the property of self-induction effects. Likewise we can cause a phase difference by inserting capacity in an auxiliary circuit. This arrangement is shown in Fig. 19. As in the previous case, the auxiliary circuit is a branch to the main circuit, a condenser being inserted in the auxiliary circuit. This produces a leading effect and likewise a phase difference, attaining the desired object.



Showing Phase Difference by Self-Induction and by Capacity.

Sometimes the effects of both induction and capacity are employed for starting a single-phase motor, a choking coil being inserted in one circuit, and a condenser in the other. We can also produce a phase difference by inserting ohmic resistance in one winding.

In addition to the apparatus previously mentioned, there are transformers which transform alternating currents from one voltage to another. If the alternating current is increased in voltage, it is called a step-up transformer, if the voltage is lowered or decreased it is called a step-down transformer.

The operating principles of transformers depend upon mutual induction between two or more separate and distinct windings or circuits, efficiently assembled relatively to one another. A transformer consists simply of a laminated magnetic iron circuit, for the purpose of concentrating the magnetic lines of force, to form a good permeable, that is magnetic conductor path for the magnetic lines of force, over which two separate coils of wire are wound. These are called the primary and secondary circuits or windings.

In the case of a step-up transformer the primary windings consist of a comparatively few turns of insulated heavy wire or ribbon, and the secondary circuit of a great many turns of fine well insulated copper wire. In the step-down transformer the arrangement is vice versa.

That circuit to which the terminals of the primary or inducing current are connected is called the primary circuit. The secondary circuit is the circuit in which the current is induced by the mutual induction due to the primary current. The ratio of transformation is the ratio of the transformed to the original voltage, or the final to the initial voltage and theoretically depends upon the ratio of the number of turns of the primary and secondary windings. If we wish to transform from 2,000 volts in the primary to 100 in the secondary, the ratio of transformation is 20 to 1 and the comparative number of turns or coils of wire on the primary and secondary would be as 20 to 1.

The current increases and decreases in the same ratio as the voltages decrease and increase, neglecting stray losses, the total power put in being about equal to the total power taken out. Some of the stray losses are: (1) I^2R, that is current squared in amperes times resistance in ohms, in the primary and secondary windings, which depend upon the size of wire and length of windings used. (2) Losses due to eddy currents set up in the iron core. This source of loss is brought down to a very small percentage by constructing the core of very thin iron plates or wires, known as laminations. (3) Hysteresis losses in the iron core, that is loss due to molecular friction of the iron core caused by rapid reversals of the alternating current and resultant magnetic connection. Both eddy current and hysteresis losses are dissipated in the form of heat. (4) Losses due to magnetic leakage, that is the magnetic field produced by the primary may not all be wholly utilized by the secondary circuit. This loss is greatly minimized by practically assembling the coils, in combination with the magnetic circuit, in efficient relation to each other.

The object of transforming alternating currents is from an important financial standpoint of economy. The power transmitted by an electric circuit, whether it be as horsepower or kilowatts, depends upon two factors. The current in amperes, and the e. m. f. or pressure in volts. The product of the amperes and volts is watts, 1 kilowatt being equal to 1,000 watts and one electrical horsepower 746 watts. One of the chief considerations from a financial standpoint in the transmission of power or electrical energy over long distances, is the cost, both initial capital and interest, depreciation, maintenance, etc., of the transmitting mains, lines or feeds, usually of copper, although aluminum has been utilized.

The size of the wire used for a circuit is determined by the amperes or current to be transmitted, and this size factor is not effected by the voltage, which latter chiefly effects the insulating properties. Therefore the cost of copper increases as the increase in current in amperes, or it becomes absolutely necessary to increase size and weight of copper with increased amperage. This of course necessitates an extensive capital outlay on copper with its attendant interest depreciation and maintenance charges when large capacity mains are utilized. Thus it is obvious that by keeping the size and weight of copper as low as possible, we gain appreciable financial advantages.

This condition of low amperage and small size mains can be attained by increasing the voltage to within certain practical limits as regards efficient insulation. As the power transmitted depends upon watts, that is the two factors of amperes and volts, it is immaterial from a power standpoint whether we transmit at low voltage and high amperage or high voltage and low amperage, but from the standpoint of prudent finance and commercial efficiency, this then becomes a very important consideration. Therefore if it be required to transmit, say, 100 kilowatts, which is 100,000 watts over a distance of 50 miles, it would be more economical to transmit the power at a pressure of 20,000 volts and 5 amperes, than it would be at 1,000 volts and 100 amperes. This is because in the latter case it would necessitate mains having 20 times the current carrying capacity, with attendant increased weight and several costs, than in the former case.

Of course the 20,000 volt lines would need to be more highly insulated than the 1,000 volt lines, but the increased cost of high insulation and any practical difficulties to be overcome with the much smaller mains used, possess greater financial advantages than would the adoption of larger mains and lower insulating properties. Then again the supporting structure necessary for a heavy weight line has to be very much stronger than for a light weight transmission line, which is still another financial disadvantage from the low voltage transmission standpoint. The next article will continue this subject, taking up transformers and circuits.

Central Station Campaigns for Higher Off-Peak Loads.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

BY E. H. TENNEY, M. E.

THE increasing demand of the modern central station for greater off-peak loads is but the natural result of a company's desire to expand its business and increase its revenues. In some central stations peak loads will be as much as fifty per cent. higher than the average load on the station during the other hours of the day. This means that during a large part of each day a considerable portion of the station machinery is idle; that property representing a large outlay of capital, upon which interest, maintenance and depreciation must be earned, is non-productive. In expanding the business then, of the central station company and rendering more profitable the operation of the existing property, it is only natural that the greatest effort should be made to increase the demand for current during those hours of the day when the station load is comparatively small.

The campaign for higher off-peak loads which is being carried on by one of the largest central station companies of the southwest is probably representative of this effort among light and power companies. In this company special stress is laid upon educating the public to the fact of the economy, convenience and comfort which has to be gained by the use of electricity for light and power. A campaign of this sort must, of necessity, be carried on through publicity methods. The public as a rule is not as familiar with the advantages of electric service as it should be and as a result the desire to make use of such advantages exists only in a vague sort of way. To bring the true merits, then, of electricity to the attention of the public in a clear, convincing and effective manner must be the first move in the campaign of the central station for more off-peak load.

The many uses to which electricity may be put extends its field of operation over many and diversified lines of activity and brings it into contact with all sorts and conditions of people. Electricity for lighting will, of course, have most general use. The people, however, who will use electricity for industrial power will be in different lines of business and will see arguments from a different view-point than those who will use electricity for heating or ventilating. The same will be true between people who use electricity for labor-saving devices in the home and those using it for advertising, and so on. To bring the merits of electrical service before the minds of a large and diversified class of people requires in the first place, a general line of argument which will make its appeal to all alike; arguments which will bring the minds of the people in general to that point where it will be most natural for each person to ask himself whether electricity may or may not be available for his own uses, whether or not there may be some need which may be met better by the use of electricity than it is met in the present way.

This is brought about partly by well planned and artistically worked up newspaper advertising. These advertisements are kept running as a series and are made to cover many of the phases of activity to which electricity may be applied. Having thus attracted the attention of the many sided public and having brought the people into an inquiring state of mind, it is but natural that they should turn to the central station company for their answer. A great opportunity for the salesman comes in at this point and it must be taken advantage of to the fullest extent if the campaign for higher loads is to be successful. Many mistaken ideas as to the purposes and aims of the public utility corporation may be brushed aside and the confidence of the prospective customer won when once this hearing is gained. The public in general is apt to have, and actually does have, misconceived notions as to a public utility corporation. Especially is this true where a central station company is the only one operating in the city. People have an idea that because a so-called monopoly exists, its main object must be to squeeze the people and get every cent possible from them. They also have in a vague sort of way notions that the cost of installing electric service is high and that the cost of current and the maintenance of the apparatus will be excessive. Once the people have come to the point where they are ready to listen, all of such misconceptions can be readily explained away. As a rule men are reasonable and are willing to be shown, and the company salesman has his great opportunity when he has gained his hearing. To make a customer realize that the central station company, even though a monopoly, is in the field with a commodity to sell and that it is selling that commodity with a view to the customers' advantage as well as his own and is selling it as cheaply as is consistent with good business management, ought to be, to the wide-awake sales manager, one of the most gratifying features of the campaign.

In the case, for instance, of substituting motor drives in the place of steam engines in small industrial establishments, there are many arguments which if brought before managers in a convincing manner will show the advantages and the actual economy that is to be gained with motor drives. Motor equipment, with power furnished by a reliable central station company, gives to the small manufacturer an unlimited supply of power which is always ready for use and with which he is practically free from shut-downs. As compared with the engine drive, motors require less space, make less noise, are more easily controlled and at the same time permit of a wide range of speed. Such points as these coupled with a practical demonstration of the economy that may be expected in the doing away with former losses of transmission through belts and shafting are found to be strong arguments which may well be brought to bear to the advantage of the central station company. One of the largest sources of demand for off-peak current is in the increased use of electric motors for commercial and industrial work.

In initiating the minds of the people to the advantages of small motor driven and other current consuming devices, the co-operation of the manufacturers and the extensive advertising which they do is of great help to the central station company. The people must first know that there are such devices, that there is a real need for them, and that their value is far in excess of their cost or the expense of installing and operating them. There is no need to mention all of the many labor-saving devices for the home, that are now on the market. There are a multitude of them, all adding to the comforts of civilization as well as to the off-peak load of the stations supplying the current. Suffice it to say that if the ultimate success of any public utility depends, as has been said, upon the accomplishment of the greatest good to the greatest number, the recent development of labor saving devices, which has made electric service in the home almost a necessity, is to be of immense value to each central station company which by its co-operation with the manufacturers is bringing these devices into general use.

There are a few of these modern electrical devices which are worthy of especial mention partly because of their great value to society and their pre-eminent value to the central station company in the campaign for higher load factors and also because the methods for exploiting them may be somewhat unique. I refer to the more expensive articles such as electric vehicles, electric refrigerators, vacuum cleaners and washing machines. These for the most part will be used by those who are financially able to make use of expensive devices. In exploiting this field personal solicitation is of course the most effective method of reaching the customer. It is also possible by selecting a list of those customers best able to buy, to carry on an advertising campaign by letter along nearly personal lines. When correspondence is thus used great care is taken in the quality of the advertisements and in the tone of the correspondence, because people of this class are repulsed by anything that may sound sentimental or cheap. A letter campaign of this sort is bound to make customers among the wealthy class. Such customers as these are good references when the campaign is carried out further on more general lines.

It has been said that the electric vehicle promises to be the coming market for current. Whether or not this be true, it is a fact that the place of the electric vehicle both for purposes of pleasure and for business and social use is well established. For commercial use, in the cities, it is fast supplanting other forms of vehicle. As a current consumer, it is without doubt to be one of the great opportunities of the central station for disposing of its off-peak load. A five-ton truck will use from thirty-five to forty kilowatts per day, about twice as much current as the average family will use in a month for lighting. The demand for this current for battery charging usually comes to the central station during the night hours when the station load is small and when additional load is welcome. As compared to current sold for household use this current for the electric vehicle will be the more profitable, for small appliances and for lighting a small amount of current is sold to a great number of customers entailing a great many bills and much clerical work, whereas the relatively large amount of current for electric vehicles will be sold to a comparatively small number of customers.

The length of time which it is going to take to bring the electric vehicle into its greatest field of usefulness is to depend, as in the case of the small devices, upon the length of time required to educate the public to the advantages and the economy to be gained by their use. Certain it is that the electric vehicle is bound to bring to the central station company a most valuable outlet for its off-peak current.

Electricity for refrigerating purposes is being especially exploited at this time. The general impression in the public mind has been that to use electricity for this purpose was costly and extravagant. This, however, is not necessarily the case. The central station company by making a special rate to off-peak consumers can bring the cost of refrigeration low enough to easily compete with other and more familiar methods.

A large number of vacuum cleaners and washing machines have been brought out during the past few years and large numbers have been sold. The importance of such devices as these cannot be over-estimated. The modern washing machine is one of the greatest of time and labor savers for the home, and from a sanitary standpoint the modern vacuum cleaner is a preventer of disease the value and importance of which is not wholly realized even yet. Hence it is not at all remarkable that devices which give the excellent results shown by some of these now on the market, should immediately be taken up with and should become a source of so much gain to all concerned.

The central station company's gain primarily is in the current which these devices consume. To make this demand for current a permanent one it is to the advantage of the central station company that it exploit only those machines which have proven their worth. In this way a protection may be effected for both the central station company and its customers against cheap and poorly built machines. Permanent use of such devices as these requires that the consumer be satisfied with the results which his machine gives and that the machine itself be so made as to stand a reasonable amount of usage with little or no maintenance cost. Only when his machine will do this is satisfaction to be had by the consumer. It is of more permanent profit to the central station company to back up a great many small devices which give good service and fulfill all the expectations of their customers than to exploit devices which give poor satisfaction and thrust them on the market only because of the large amount of current which they consume.

Aside from the methods already mentioned for disposing of off-peak current, there is another which promises to be of value. This consists in supplying current to isolated plants during the summer months. Large buildings and industrial houses which generate their own current make use of exhaust steam for heating. Their net cost for power during the winter months is thus very low. During the summer months, however, when exhaust steam is not needed, the central station company could supply power at a lower figure than the isolated plant could generate it. In a community where there are numerous isolated plants a valuable addition to the summer off-peak load might be worked up along these lines.

Review of Central Station Practice and Developments in England

(*Contributed Exclusively to* Southern Electrician.)

BY CECIL TOONE, AN ELECTRICAL ENGINEER IN ENGLAND.

IN THIS article which is a continuation of the above general heading from last issue, the subject of private lighting will be taken up. It is the purpose of the writer to set forth in a brief way the general tendencies in private lighting, the influences of supply voltages, types of lamps used and the rates which have been found most satisfactory.

The general tendency of central station engineers is to increase as far as possible the number of consumers connected by "tapping the small man," while the tendency of the average consumer is undoubtedly towards an increase in the mean illumination of his rooms. Both tendencies combine to lessen the deleterious effect of the metallic filament lamp upon central stations and both movements are to a large extent forced.

The greatly reduced energy consumption per candle-power hour, roughly ½ to ⅓, where metallic filament lamps are employed in place of carbon filament types has compelled central stations to seek every means of extending the number of consumers and generally popularizing the use of electrical energy, while simultaneously reducing the cost of generation, distribution and extensions of supply. On the other hand, the difficulties of metallic filament lamp manufacture have forced consumers, particularly on high voltage direct current circuits, to install lamps of considerably higher candle power than would otherwise be adopted. This same influence, together with the conservatism or scepticism of the average householder, and even of large business houses, and the high cost of renewals has made the conversion of filament lamps more gradual than might have been anticipated. The delay has been especially welcome to central station engineers in that it has enabled the natural expansion of total demand to more or less keep step with the reductions caused by the adoption of metallic filament lamps and has given time for invigorated canvassing and general "booming" to yield results.

On alternating current systems, the consumer has been able, by the installation of an auto-transformer, to use strong, low voltage metallic filament lamps of moderate candle power in his existing fittings and with no wiring changes. The incentive to conversion being actually a substantial reduction in the energy bill, where such is preferred to an increase in the candle power hours per dollar, it naturally follows that the effect of high efficiency lamps has been felt most seriously by alternating current stations. Many consumers, adopting this method of working, and installing cheap or badly made transformers, have found the magnetizing watts of the latter to cost $20 to $25 per annum. Parsimony in the choice of this apparatus is the falsest economy and wherever possible the transformer should be cut out of circuit during daylight hours, a separate circuit being run to a few carbon filament lamps in basements and other places where artificial light will likely be needed during the day.

The marked tendency to low voltage lighting through auto-transformers on alternating current supply, is often carried too far. In a house wired for 200 to 250 volts, it is very undesirable to supply lamps, even of one-third current capacity, at any pressure below 50 volts and, wherever there is a considerable heating or cooking load to be supplied, 100 volts is certainly a more desirable minimum voltage, since manufacturers of electric cooking utensils report considerable difficulty in designing satisfactory apparatus for lower pressures and with moderate current demand.

Arc lamps are employed to a limited extent in interior lighting in this country, especially since the introduction of metallic filament lamps. In very large stores and for lighting staircases, and the wells and domes of the latter, concert halls and so on, arcs are often used, being generally of the open type, frequently of the enclosed type and comparatively rarely of the flame type, and then of a pattern in which the escape of corrosive or otherwise objectionable fumes is prevented. Among filament lamps, the old fashioned carbon lamp still retains a strong hold, though it is rapidly yielding place to metallic filament types or at least to the high efficiency metallized Gem carbon filament. The Nernst lamp is here, as in street lighting, see below, falling into disuse.

The lighting of the exteriors of shops, public buildings and so on is subject to conditions and developments so closely similar to those of street lighting that separate consideration is hardly necessary.

The general tendency in private lighting is decidedly towards reduced consumption per consumer in spite of the education of the public to higher illuminating requirements. The manufacture of mechanically satisfactory lamps of higher voltage and reduced wattage at lower and lower prices is causing a sustained shock to central statons which only the greatest enterprise on their part can minimize.

CHEAP WIRING, SAFETY, AND SPECIAL CHARGING SYSTEMS.

The securing of an increased number of small demand consumers who cannot afford to pay for the installation of a costly wiring system, however favorable the ultimate terms of lighting supply may be, together with the dire necessity for economy on the part of central stations, which requires their incurring a minimum expense themselves upon this heading, has led to the evolution of cheap wiring systems and elaborate tariffs, whereby the consumer contributes towards the prime cost of his installation. Such phrases as "the station pays" and "the consumer pays" are somewhat loose in their application. "The station pays" usually means that the station finds the capital required for a certain purpose and then retains ownership of the material results of the investment, while the consumer pays a suitable interest on the capital expended. On the other hand, if "the consumer pays" in the first instance, he is relieved from subsequent interest charges and retains ownership till such time as he makes the best terms possible with an in-coming tenant or other purchaser.

Considering each development in turn the following conditions exist in English practice: Official, Board of Trade, regulations considerably hamper the evolution of cheap wiring installations, but though there has been much grumbling on this score in the past, the necessity for rigorous precautions has been evidenced by several disastrous accidents attributable to their neglect. Among the most notable of these are the recent London shop fires traceable to the use of flexible wire in temporary window decorating schemes. There is no objection to using a good grade of such wire for pendant lamps, hung well clear of inflammable materials, but insurance companies are now insisting upon its application being very carefully regulated. During the past few years there have been frequent lamentations that our wiring regulations preclude the use, in domestic lighting, of flexible leads surface, hung on porcelain insulating reels or some such simple scheme. Probably the formulation of these rules has been wholly beneficial in effect, preventing the wholesale installation of shoddy materials in shoddy and dangerous manners and leading to the evolution of such cheap and reliable wiring systems as the Stannos, Simplex and others. Such wiring methods, employed with grounded neutral on three wire networks or grounded secondary, grounded permanently or earthed automatically on the occurrence of a high tension leak, in alternating current systems fed from high tension transformers, amply safeguard lighting circuits from shock and fire risks at all pressures employed on such in this country.

Flexible wire is now chiefly confined to short "finial" lengths from ceiling roses, wall plugs, etc., to pendant and table lamps and so on. So far as I judge, this form of conductor is now regarded suspiciously and used with as great caution in America as in England. Great improvements, too, have occurred of late in the mechanical and electrical design of all classes of switch gear for the control of lighting circuits and the retail price has been so far reduced as to offer no obstacle to the general use of high class apparatus.

In a small house, wired on the Stannos single wire system, return through the sheath, complete installation of electric supply can now be effected at $2.50, or even $2.00 per point in a thoroughly reliable and workmanlike manner. Even so, however, the cost of "service" totals $12.00 to $15.00 in the smallest consumers' establishment and this class of person cannot afford such an outlay, while, if the station bears the whole burden, vast sums of capital are speedily locked up. In many cases the cost per "point" rises to $4.00 to $6.00 and the problem becomes even more acute. To quote only a single instance, more than $100,000 is thus invested in the London district of Beckenham, including 1500 consumers. The Fulham, London, Borough Council recently laid down $10,000 in wiring and equipping 500 small consumers for about 6 lights each, which is about $3.33 per point. Beckenham is laying out a further $25,000 in a similar project. As might be expected, it is often found that the return from free wired houses is insufficient to cover the capital charges on the wiring installation, when supply is on a flat-rate basis. Thus, in the Beckenham area referred to, the ordinary lighting rate is 10 cents per kilowatt hour, but the net average return from persons having free wiring, allowing for the total loss on the investment represented by the latter, is only 6.6 cents per kilowatt hour.

This at once demonstrates the advisability of a reversion to a mode of charging very common during the early days of electric lighting. This was a certain fixed quarterly charge, sufficient to cover the cost of the consumer to the station, as represented by his maximum demand and the capital charges on his wiring system, to which may or may not be added a small charge per kilowatt hour consumed. The difficult problem is to determine the fixed quarterly charge. If this be reckoned on a per point basis, the liberal installation of lamps is hampered, if on the rateable value of the consumer's house anomalous results are liable to occur, though this system has given better results in practice than could reasonably have been expected. A very satisfactory method, employed in Harrogate, is to install a flicker apparatus set to cause an annoying flicker of all the lamps in the house when more than a certain number, determined by previous agreement with the consumer, are simultaneously in circuit. Liberal installation is thus unretarded but it is insured that the maximum demand from a given consumer shall never more than temporarily exceed the value on which he pays his fixed annual charge. This value can be altered at any time by agreement with the company and the consumer is never penalized, as with ordinary maximum demand meters, for temporary or accidental peak demands.

As to whether a kilowatt hour charge should be added to the fixed charge, considerable difference of opinion exists. The average consumer will no more deliberately waste electric light than he will unnecessarily leave his water taps running, and the average burning hours per annum of the small householder in various districts, varying largely with the prevalent industry in the neighborhood, being known, it is found easy to make an allowance in the fixed annual charge per lamp to cover unrestricted use of same. By this means the trouble and expense of metering is avoided and the consumer is better pleased with his installation than would otherwise be the case. The correctness of the assumptions concerning mean burning hours may be tested by "district" meters in convenient distributing boxes and a certain check may be imposed upon the wasteful burning of lamps by making the consumer purchase renewals and explaining to him the finite burning hours obtainable per lamp; with carbon filament lamps and even with recent metallic filament lamps this restriction is anything but powerful.

It has been found that although many classes of householders will adhere to the spirit of such unrestricted lighting supplies, others, among them colliers, will wantonly burn lamps perfectly unnecessarily. Indeed in some instances houses have been known to be fully illuminated day and night. A considerable advantage of the scheme is that every consumer knows precisely the amount of his lighting bill, and by collecting this in advance, the central station can avoid bad debts.

For larger consumers, the best charging system is generally considered to be a fixed quarterly charge, frequently based on the rateable value of the house plus a small charge, say 2 cents per kilowatt hour actually consumed. A very common method of taking into account the capital charges on free wiring installations, is to supply consumers thus equipped at a rate per kilowatt hour, usually 1 cent to 2 cents, but sometimes 3 cents or more, higher than that charged to normal purchasers.

Before leaving the consideration of the sharing of responsibilities between station and consumer, a peculiar point which has arisen in connection with the supply of blocks of "flats" or apartment buildings may be noted. The point is a minor one but is apt to be overlooked and certainly requires definite arrangement. Where supply is taken from a central station authority, the latter provides the mains and service wires bringing the supply into the basement of the building concerned. The owner has then to provide a suitable main distributing and fuse board and cables to the distributing boards in individual flats, the tenant usually pays for or at least maintains the room to room wiring. Now the supply authority must seal the main distribution and fuse boards in its own interests but the boards belong to the owner of the flats and in several instances, absurd though it may sound, the supply company has refused to maintain the boards on the ground that they belong to the landlord while the latter has declined on the ground that the supply company has sole access to the boards and is mainly, if not wholly, responsible for the deterioration requiring remedy. Such a dissension should be made impossible by a definite agreement for, small though the point is, it vitally affects the efficiency and safety of the system and may lead to much vexatious bickering.

The conversion of chandeliers, etc., to series connections, commonly necessary or at least advisable when low candlepower metallic filament lamps are to be used on 200 volt supply, or the installation of auto-transformers on alternating current circuits, affords a favorable opportunity at which to undertake an improvement in the location of lamps and possibly to install heating circuits. Contractors, however, are rather apt to be carried away by enthusiasm on such occasions, executing revolutionary schemes of which the cost is heavy and the net gain not adequately greater than could have been attained by a much cheaper procedure. To obtain and keep a satisfied consumer, it is necessary to make the actual conversion as cheap as possible and preferably showing a substantial reduction in the energy bill per quarter. Then, in the majority of cases, rapid extensions of lighting and other apparatus follow, particularly in shops, till the gross demand exceeds its value prior to the conversion, with the added advantage that the consumer gloats in the economy of his supply.

Among the many minor methods adopted by supply companies to popularize the use of electrical energy may be mentioned the reduction or abolition of meter rents, a charge which is always begrudged, and the hiring out or free loan of arc lamps and heaters to shopkeepers and others. It is usual to make all installations given a bonus in the first place, subject to a minimum annual charge more or less completely guaranteeing an adequate return for the encouragement offered. Such an arrangement is obviously necessary, for central stations cannot afford to be more philanthropic than their age. Nevertheless, though the consumer has in some form or another to repay his actual cost to the station plus an adequate clear profit, the various bonus systems of installation and supply have done much to extend the use of electrical energy in this country and are much appreciated by consumers.

A scheme which has facilitated the extension of outside arc lighting to small shop owners is the allowance of co-operative lighting. For instance, three adjacent shops may install or hire two arcs apiece running the six in series on 250 volt supply. One shop may then pay the bill for all three and collect two-thirds of the total amount from its neighbors or the central station may enter into an agreement with the three consumers, making them collectively responsible for the total bill and then send in separate accounts to each shop. This is for the reason that if one man removes or falls out of the agreement for any reason, the remaining two shops pay half the total cost each till such time as they can procure a fresh third party. The latter system is generally preferred as conducing to quicker returns and fewer bad debts. The burning hours required by the consumers may not be identical but the slight unnecessary cost to the short-hour consumers of burning to meet the needs of the longest-hour shop will usually be well expended in the advertisement thus derived by the group. Alternatives to such an arrangement are the u se of groups of metallic filament lamps under the sole control of the separate consumers or the use of small current, high voltage flame arcs such as are now available, 5 amperes and 90 volts, with a mean spherical candle power of 2500 to 3000.

In running several conduits together, a pull box will be found more economical than elbows for making turns, as one pull box will take the place of several elbows. Do not pull wires through conduits with a block and tackle, as it will not only injure the installation, but wedge the wires in such shape thatt hey cannot be removed readily if desired. Be careful to ream out the end when conduit is cut, as the burr may otherwise cut through the insulation. Conduits should be securely fastened to walls and ceiling by use of pipe straps or hooks. Plug all exposed ends of conduit in new buildings to prevent plaster and dirt from falling into it.

The Design and Development of Current Consuming Devices.

(*Contributed Exclusively to* Southern Electrician.)

BY G. J. KIRCHGASSER.

THE devices to be treated in this article are commonly referred to as "Current Consuming Devices," "Business Builders," "Load Curve Flatteners," or "Day Load Boosters." Yet with the many advances made in their design and construction and because of entirely new developments, they can properly be called Saving Devices. These devices, about which references will be made, were at first looked upon as luxuries or at least as unnecessary but as the standard of living has gradually risen, with the manifested attention to convenience, cleanliness and sanitation, the introduction of electric heating, cooking and small motor driven devices has become much easier.

The public is getting acquainted with electricity and is being educated to its usefulness through advertising in popular mediums, electrical publications, by central stations, and contractors. In fact at present the public is quite familiar with electric lighting, this artificial illuminant being accepted as the best. A great majority of new houses are wired for lights now which was not the case five or ten years ago. With electric heating and motor appliances the same general acceptance can be looked for. The electric iron, I am convinced, will be an absolute necessity in a few years.

One of the earliest features associated with the conduction of electric current, was that of the generation of heat. In the dynamo or motor it is known that to keep down the heating is desirable, as this heat represents waste and limits the output. It became known also that certain conductors heated more quickly than others and by proper arrangement heat could be transmitted so as to be of use, thus the advent of present day electric heating devices.

During the past half dozen years great advancements have been made. By following the publicity campaigns in the pages of the electrical papers, the gradual increase in manufactured electric heating devices is indicated very clearly. During the years 1902 and 1903 the advertising was very slim, while 1904 and 1905 showed slight increases. In these early years it will be remembered that the biggest efforts were spent in introducing electric lighting. In 1906 the first important advertising began to appear and we find such captions as "Central Station Business Producers," "Hot Air by Electricity," "Electric Heating Appliances," etc.. Since then and especially during 1910, vigorous heating device campaigns were instituted by manufacturers and central stations. The advertising was directed to the consumer, in popular mediums, helping greatly in educating the public to advantages and real economies.

The increased use of electric heating devices has not occurred because of decreased current consumption by new devices, for no strenuous efforts have been made to cut down the energy required. The energy consumed is possibly on a little higher scale, the resistance wires being operated at higher current densities. This does not mean that the efficiency has been decreased but that in the present appliances it is possible to raise the temperature to a working heat quicker and maintain it by a smaller energy consumption. Older types of devices took longer to raise to operating temperature. What is required by the public is something that quickly shows signs of thermal activity. Take for instance the toaster, the red glow of which favorably impresses the public as the heating is visible to the eye. The luminous radiator, not as efficient as the convector type radiator, appeals because of its apparent glow of warmth.

Electric irons now on the market are simpler, permit of easily removing and replacing the heating unit, have no interior connections, are more efficient, have better heat retaining qualities and will stand abuse. It is now under-

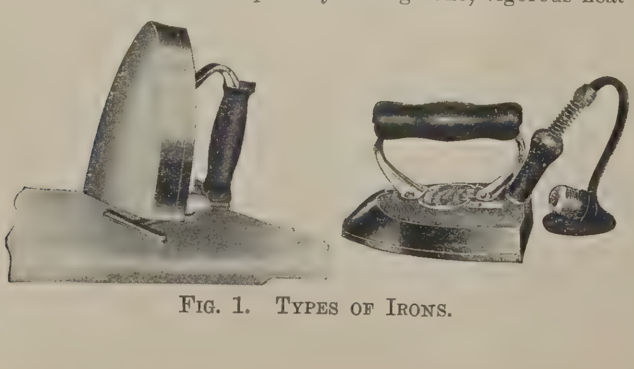


Fig. 1. Types of Irons.

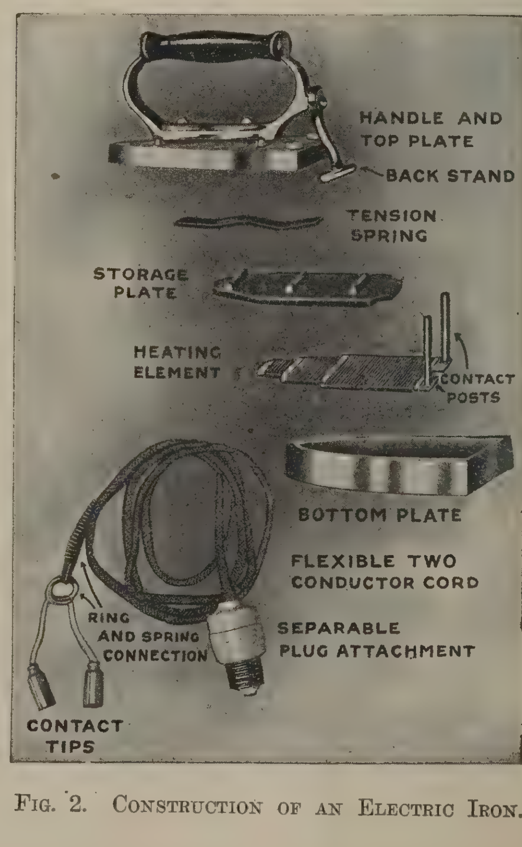


Fig. 2. Construction of an Electric Iron.

stood that the popular reasons for the substitution of electric irons in the household are:

The heat is only in the iron, which is especially vital in warm weather; saving of drudging back and forth from stove to ironing board; no fire, smell, danger, dirt, etc.; they permit of use anywhere; they are ready instantly, no waiting for heating of stove; easy regulation of temperature; and permit of quicker work.

There are many makes of irons now on the market, some of which have a few distinctive points, but any of a possible six or eight are absolutely satisfactory, efficient and reliable. The ones illustrated represent the American, made by the American Electric Heater Co., one of the pioneers in the heating field and the Cutler-Hammer, one of late design which requires no separate stand. An exploded view shows the simple yet finished design of an up-to-date iron and indicates the method of assembling the parts.

Among the smaller electrical conveniences is the electrically heated curling iron and the shaving mug, with an almost inappreciable consumption of current. The shaving mug used six times a week costs to operate only one

Fig. 3. Curling Iron Heater and Electrically Heated Chafing Dish.

and a half cents per week with current at 10 cents per k. w. hour. The electrically heated curling iron has such advantages over any other type that no lady's dressing table in a home electrically wired should be without it. For operating six days a week, fifteen minutes a day the cost is three and one-half cents per week. The electric hair drier is another small device used to considerable extent in hair dressing parlors and barber shops and lately has been added to the household line. The many comforts and uses of an electric heating pad make this an almost indispensable article in the household where electricity is used. It can be heated and applied more quickly and better than the hot water bag and can be connected to any lamp socket.

Fig. 4. Electric Water Heater.

Electric radiators, while they are not thought to be economical enough for the heating of large buildings at present, are an excellent auxiliary source for heating bed rooms or bath rooms in the morning, for use in spring and fall after the furnace is out or before it is in operation,

Fig. 5. Electric Toaster.

for the office, the cold corner or an exposed room. Unlike the older oil types of portable heaters, they are safe from fire hazard, give off no odors and use up no oxygen of the room, making them especially useful in the sick room. Two types of radiators are now in use, one known as the luminous radiator and the other the converter type or air heater. The first has several incandescent glowing units, giving apparently an idea of great heat, which consists of resistance units enclosed in a metal case through which air passes. This sets up a circulation and is the more efficient way of heating, both however have their uses.

For quickly heating small quantities of water small electric water cups, of pint capacity, have been on the market for some time. Somewhat new in the electric water heating

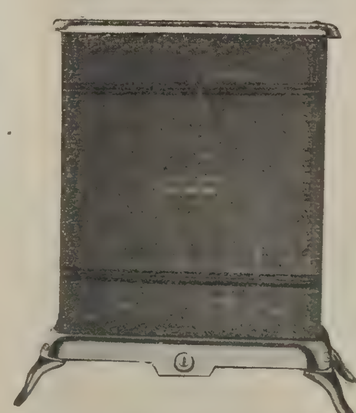


Fig. 6. Electric Radiator.

field, however, are the portable water heaters, made in three and four quart sizes. Five types of carbon element heaters for permanent attachment to the water piping have been put on the market during the past year. The three-quart portable is well adapted for the buffet in the home. Hot water for lemonade, malted milk, for medicinal or other purposes is provided in 45 seconds after the current is turned on. For use in the drug store, restaurant or bar these heaters are well adapted and convenient.

Practically all heating devices can be used on either direct or alternating current circuits, having non-inductive resistance elements. Types of instantaneous water heaters, however, one of which, the lavatory type is illustrated here, are practicable and efficient only on alternating current circuits. In these heaters carbon rods are used for conducting the current while the water bridging gaps between the rods is employed as the resistance element. These rods, varying in size and number according to the capacity of the heater, are enclosed in metal cylinders open circuited except when water is turned on. Steaming hot water can be drawn from this type of heater in from 15 to 20 seconds after current is introduced. No current is consumed nor any heat produced unless there is water in the cylinder. It is therefore the water that automatically makes and breaks the circuit. These devices have high ratings but the current is used for very brief periods. The therapeutic heater is convenient for physicians, dentists and druggists for sterilizing instruments, etc. By allowing current to be turned on for over 15 seconds a continuous stream of steam instead of hot water will result.

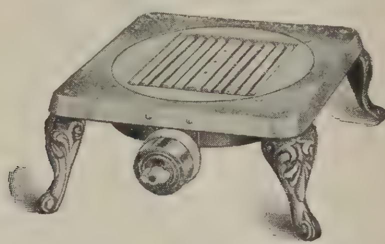


Fig. 7. Type of Electric Stove.

It would be interesting to review the history of cooking, starting with the primitive outside wood fire kindled by the flint spark and proceed to the present advent of electric cooking. As civilization has advanced and cities grew, it has become necessary to localize and control the fire for heating and cooking and to decrease the waste. Safer, cleaner and more flexible methods had to be adopted and with the past as a criterion, it is not improbable that electricity will ultimately be generally applied for cooking, if not for heating. Electric heat can be localized, concentrated and regulated, no waste heat need be passed up the chimney, no dirt, smell or soot result and there is a minimum danger from fire and none from explosion. In warm climates and during summer seasons electric cooking is especially desirable.

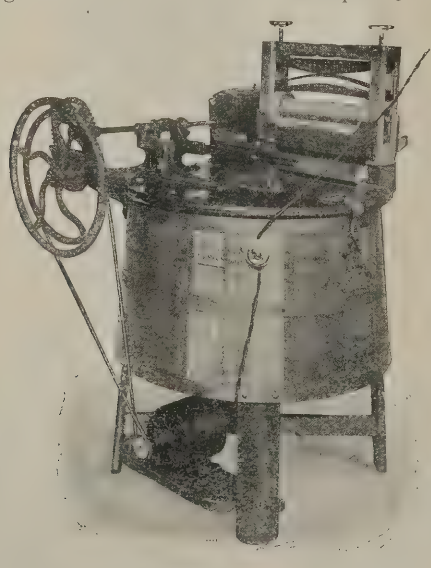


Fig. 8. Motor Driven Washer.

Cooking devices on the market consist of the electric range and also of separate utensils, some of which have a self contained heating element. Another method is to have a separate heating stove or disc with which a number of utensils can be employed. This latter method is less efficient but has the advantage of allowing the same stove to be used with a combination of cooking utensils. For all round use and as an emergency device it is of considerable convenience in the household.

Much has been said and written about the cost to provide a meal for a family of certain size the electric way, but proof has not been established that this is cheap enough to supplant the other means with electricity at present rates. With the increasing plane of living, however, and with special rates for cooking, a good outlook can be predicted. The perfection of fireless cookers for use with electric cooking utensils is a means to decrease the cost of electric cooking and this is given serious attention by central stations.

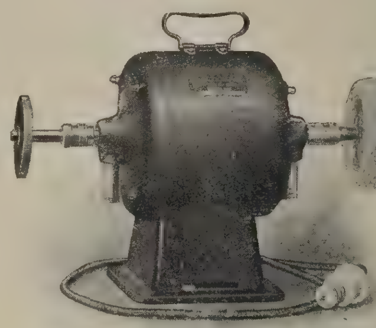


Fig. 9. Portable Motor for Household Use.

Of the separate devices, the electric toaster has found a ready welcome on the breakfast table and at the sick bed. The warm glow of the resistance wires with the appetizing browning of the bread exposed to view make a quick appeal. The chafing dish, percolator, waffle iron, and oven double boiler, are also members of the new family of electric cooking devices.

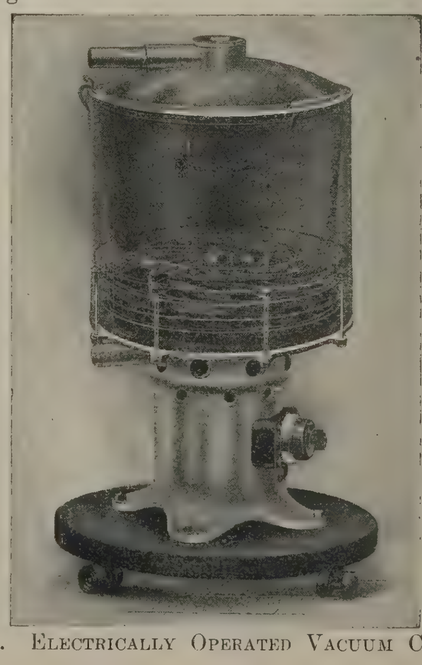


Fig. 10. Electrically Operated Vacuum Cleaner.

Industrial applications of electric heat have extended to the laundry, bakery, confectionery, shoe factory, hat factory and many others. In the print shop bindery electrically heated finishing tools and glue pots have superseded gas and steam. Electrically heated heads of embossing and stamping presses allow better control of temperature than steam and insure further uniform concentrated heat, making possible clearer impressions. The electric glue pot is ideal for piano factories, pattern shops, box factories and other wood-working plants, safety from the fire hazard standpoint alone being sufficient recommendation. They are clean and permit of easily keeping the glue at the desired consistency. Electric soldering and branding tools have established their economy. The soldering tool will solder at less expense than coppers heated in gas furnaces and give uniform results. The electric chocolate warmer, dental furnace and pyrometer also belong to industrial devices while the cigar lighter and sealing wax heater belong to a miscellaneous group.

A tabulation showing the watts consumption and cost per hour, at a rate of 10 cents per kilowatt hour, of some of the popular devices may be of interest:

	WATTS.	COST PER HR. 10C PER KWHR.
Iron 3 lb.	325	3.25 cents.
Iron 5 lb.	350	3.50 "
Iron 6 lb.	450	4.50 "
Iron 7 lb.	550	5.50 "
Tailors Goose Iron 12 lb.	660	6.60 "
Tailors Goose Iron 15 lb.	660	6.60 "
Tailors Goose Iron 20 lb.	750	7.50 "
Curling Iron Heater	220	2.20 "
Curling Iron	40-50	.50 "
Shaving Mug	220	2.20 "
Disk Stove	500	5.00 "
Toaster	500	5.00 "
Heating Pad	50	.50 "
Radiator	1000 (Ave.)	10.00 "
Sealing Wax Heater	100 (Ave.)	1.00 "
Cigar Lighter	75	.75 "

It must be remembered that these devices are usually operated at intervals. With the present standard electric iron, current can be turned on and off so that for an hour's ironing, current is used for possibly half the time, varying with the make of iron and the kind of work being done.

SMALL MOTOR-DRIVEN DEVICES.

The electric heating field is not the only one that offers

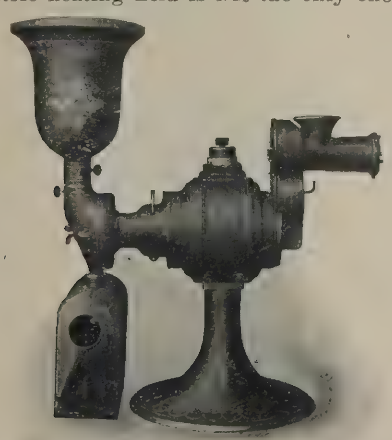


FIG. 11. COMBINATION GRINDER AND MEAT CHOPPER.

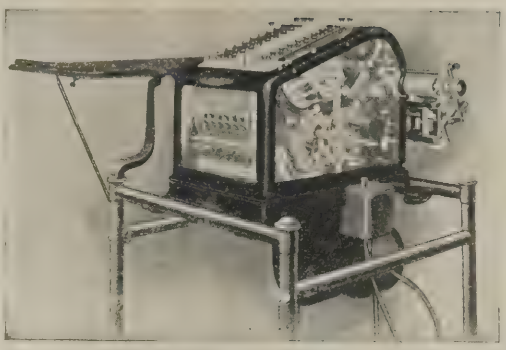


FIG. 12. MOTOR OPERATED ADDING MACHINE.

desirable business. The development of numerous devices which depend for operation upon the small motor has also made desirable business for the central station. Electric drive is so well adapted because of its cleanliness, safety and flexibility that the small horsepower motor has rapidly found many uses. Such devices as vacuum cleaners, ventilating fans, electric pianos, sign flashers, etc., without the electric motor are entirely impractical. The fact necessary to overcome in introducing small motor-driven devices generally is that they are machinery, which idea seems to imply expensive first cost and operation. The small utility motor as used in the shop, store, office or household for operating such devices as washing machines, vacuum cleaners, fans, blowers, pumps, meat choppers, coffee grinders,

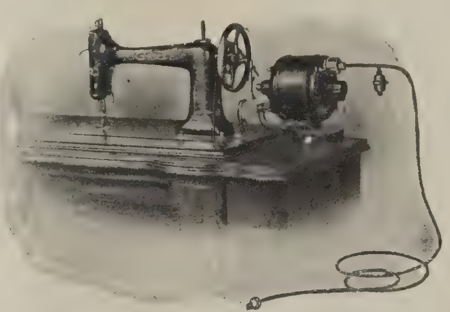


FIG. 13. SHOWING MACHINE MOTOR DRIVEN.

coffee roasters, sewing machines, adding and copying machines, cash registers, electric drills, jeweler's and dentist's lathes, buffers, carbonators, electric pianos, sign flashers, etc., vary between one-twentieth to one-fifth or one-quarter horsepower. These machines are operated intermittently and as they can obtain current from a lamp socket or rosette, the same as for an ordinary lamp, it should be evident that they do not require much power. The idea that a motor is a great power user is too prevalent.

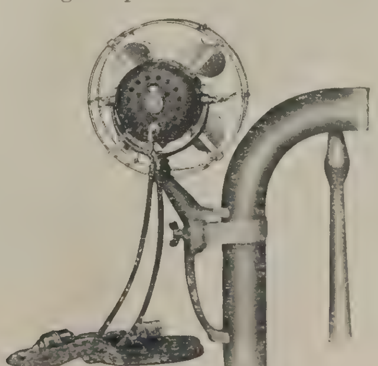


FIG. 14. BED ROOM ELECTRIC FAN.

Of the many applications of electric power for small devices the adaptation depends upon the size of the establishment and the amount of work to be done. Industrial plants, hotels and other large institutions use electricity for everything possible. Large residences find economy in the use of a greater number of these devices than the small home but even here the washing, ironing and cleaning can be done by electricity economically. Where any amount of sewing is done the electric motor can perform the work better, easy variation of the speed being accomplished by means of a small treadle controller placed beneath the machine board and operated by a slight pressure of the foot. In this way the speed of the motor can be varied and the machine started and stopped at will. The cost of current is almost inappreciable, about one-half cent per hour.

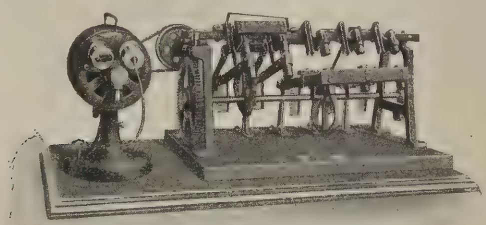


Fig. 15. Motor Operated Sign Flasher.

The electric washing machine will wash a tubful of clothes in fifteen minutes and permits the washing to be done in the home. For the restaurant, barber shop and hotel a great saving in laundry bills can be effected by the electric washer. The vacuum cleaner, made practical for portable use by the electric motor, saves all beating of carpets and cleans without making a dust, eliminating the dusting feature.

Fig. 16. Battery Charging Paull.

The increasing prominence and use of electric signs in which letters, words, lines of words, whole signs or various designs are flashed, has caused a distinct development of motor-driven sign flashers. All such effects as dust, rain, clouds, sparks, fire, water falls, waving flags, rat-chasing, etc., have been accomplished since the advent of the small motor. One of the numerous types of flashers thus operated is illustrated here.

In the store and office there are many devices that are operated electrically, as the adding machine, letter folder, copying machine, and addressograph. If an investment has been made by an office, for instance, to buy an adding machine, its worth is increased and its economy and usefulness by doing away with hand power operation. In the store the electric fan is of constant use. In the warm weather its use is well known but it is too often laid aside in winter. Many merchants fail to realize the great advertising value of a good window display and we often see windows on which steam has been frozen, hiding the display from possible purchasers. A fan set so as to blow over the inner surface and keep up a circulation prevents the moisture from settling. A practical use of a fan is the bed-room type used in hotels and residences and in the sick room. This type of fan has a support designed with

Fig. 17. Soldering Iron.

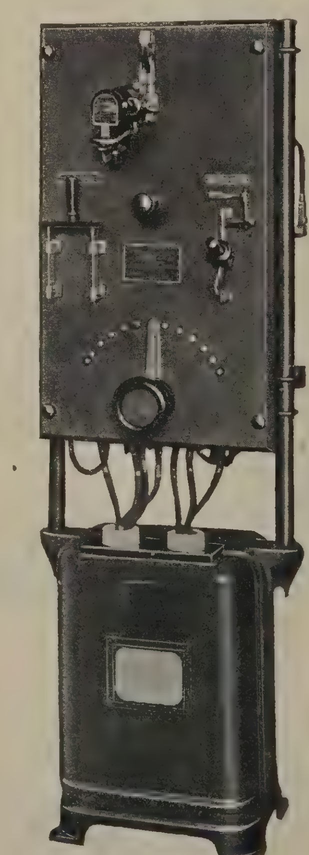


Fig. 18. Rectifier Charging Outfit.

swivel-trunnion adjustment, so that the fan can be turned to direct a breeze to any part of the room.

Ventilating fans of the blade type and blower type have found many uses as for telephone booths, bed rooms, offices, schools, halls, theaters, restaurants and wherever many people assemble. For underground telephone and electric light and power systems fans are useful in manholes. By providing a plug or two in each manhole, portable lamps, soldering tools or a fan can be connected as required, permitting much better efficiency in the work.

FIG. 19. SMALL BLOWER MOTOR DRIVEN.

It is said that about one-third of a blacksmith's time is taken up in blowing his fire. The electric forges for blacksmiths, horseshoers and repair shops are therefore made in a variety of styles, the blower equipped with a motor and speed regulator, being especially suitable where the fire is blown intermittently during the day. The equipments can be used on either direct or alternating current circuits and they usually have a simple separate regulator which can be located where desired and gives different speeds, suiting the blast to the work. Where continuous fires are the practice the motors are put to a greater wearing test and must be of sufficient size to carry the load at a safe temperature rise. For operating blowers under these conditions a direct or alternating current motor should be selected according to the current supplied and of sufficient capacity to carry the load continuously.

In rural and outlying districts where the water supply is inadequate or not entirely dependable an individual motor-driven house pump well furnishes domestic water supply. When pumping into a closed tank by the arrangement of a pressure regulator and self-starter the motor and pump will be operated only when the pressure in the tank is below a certain value. No attention is thus required. If pumping into an open tank, automatic control can be had by providing a float switch which will automatically start the pump when the water is low and stop it when high. A motor-driven sump pump makes unnecessary an expensive sewage system. This kind of pumping load is especially desirable for central stations, as it comes during day and in summer months.

In a miscellaneous class of current consumers, we find such apparatus as ozone generators, electric toys and novelties, Christmas tree outfits, horse clippers, motor-operated churns, cow milkers and incubators. Another interesting device not belonging to the heating nor motor-operated class is the small hand magnet which is used in the shipping department for recovering nails from the daily sweepings, in the hardware store for handling nails, nuts and screws, in the shop for separating brass and iron filings and waste, for clearing chips and borings out of the machinery and for many other purposes. The push-button at the top of the handle closes and opens the circuit magnetizing and demagnetizing the poles as desired.

The increasing use of electric vehicles has developed another profitable business, the private garage producing a revenue between $50 to $75 per year with an off-peak load. In the outlying districts where alternating current is distributed mercury arc rectifiers have been used while battery charging rheostats are used on direct current lines. Both have been simplified so that charging can be done with a minimum amount of attention.

In reviewing the vast array of electrical devices on the market many of which can effect absolute economy, it would seem that with the proper persistency and aim the load connected to any central station could be very profitably increased. Every one in the employ of a central station should know and be familiar with the latest devices so that they can help in educating the public and in making them familiar with electricity in general. As many as possible should use some kinds of heating devices. This idea is similar to that employed by a large mail order house selling soap and other toilet devices where every correspondent must use in his own home the articles sold.

Actual demonstration in the home, store or shop or a trial will often make a sale easy. It is sometimes difficult to make a customer realize that an electric iron, for instance, is not expensive to operate. He sees that the rating is, say, 5 amp., and if he is told that it equals the current needed for ten 16 candlepower lamps he is at once alarmed. As an iron is used usually only from two to four hours per week, it is better to give an approximate cost per ironing or per week, which in this case would be about ten cents. The cost to operate other heating and motor-driven devices does not depend upon amperes or equivalent number of lamps, the time is the important factor, and when consideration is given to them on this basis they are in nearly every case extremely economical.

N. E. L. A. Power Transmission Section

Under the auspices of the power transmission section of the National Electric Light Association, a public conference will be held in the United Engineering Building, New York City, April 8th, to consider the subject of the relation of the national and state governments to the conservation and utilization of water powers. This subject is one, not only of vital concern to the central station industry, but affects in many ways the conditions of engineering, the employment of labor and capital, and the welfare of the public. Two sessions will be held, afternoon and evening, and papers and addresses will be delivered by well known men. Invitations to this conference are being sent to members of engineering societies as far east as the Mississippi River, and it is hoped that all who are interested will make an effort to lend their presence and cooperation.

Heat, Light and Power in Buildings.

BY C. M. RIPLEY.

As a continuation of this subject from last issue, loft buildings, apartment houses and hotels will be considered. The loft structure discussed is the Weil & Mayer building, at New York City, consisting of three 50 by 200, 12-story loft buildings, with two basement and 17 electric elevators. The records of these buildings well illustrate the matter of neighboring customers for heat, light, power and hot water.

ACTUAL COST OF MAKING HEAT, LIGHT, POWER AND REPAIRS AND LIVE STEAM FOR 12 MONTHS.

Screenings, at $2.50	$ 6,830
Labor	8,617
Water for boilers from deep wells	———
Repairs, ash removal, oil, miscellaneous, etc.	1,881
Total manufacturing cost on Building Manager's books	$ 17,328
Less sale of electricity	13,336
Net total manufacturing cost on Building Manager's books	$ 3,992
10 per cent plant cost added by Treasurer	2,000
Net total cost on Treasurer's books	$ 5,992

This amounts to but little over $150 a month for each building for complete service of heat, light and power for pumping and elevators. Electrical output 402,000 kw. hrs.

ESTIMATE OF HEAT, LIGHT AND POWER COST OPERATING THE BUILDINGS TOGETHER AND BUYING ELECTRICITY.

402,000 kw. hours	$ 18,780
No. 1 buckwheat coal for heat and 12 months for live steam	4,500
Wages	3,500
Fireman	600
Oil, grease, ash removal, miscellaneous, repairs	1,000
Total	$ 28,380
Less sale of electricity	13,336
Net operating cost buying electricity	$ 15,044
Actual net operating cost on Treasurer's books when making electricity	5,992
Saving by making electricity	$ 9,052

ESTIMATE OF HEAT, LIGHT AND POWER COST OPERATING THE BUILDING SEPARATELY AND BUYING ELECTRICITY.

No. 1 buckwheat coal (at $3.35) for each building	$ 1,500
Wages, including fireman for 12 months, for live steam	1,800
Electricity for each building	6,700
Repairs, miscellaneous, oils, etc.	400
Total for each building	$ 10,400
Total for three buildings (3 times $10,400)	$ 31,200
Less sale of electricity (same as before)	13,336
Net total cost for three buildings operated separately, if buying electricity	$ 17,864
Actual total cost, net, on Treasurer's books when making electricity and operating building together	5,992
Saving by operating buildings together and making electricity	$ 11,872

The conclusion we draw from the above figures is that by operating three buildings together they save $2,820 per year, and by making their electricity they save $9,052 per year. The saving of $9,052 is equivalent to the annual income on a capital of $180,000 invested at 5 per cent. Yet the actual cost of the plant was $20,000. Again, the $20,000 plant was installed twelve years ago and paid for itself in two years and a half. Still again, the annual earning power of the plant is about 45 per cent. per annum on the investment.

These records show that the owner's first investment was paid back to him in savings effected, nearly ten years ago, and yet in order to be perfectly fair, I am still charging against the record of the plant, in my figures to-day, 5 per cent. interest on the investment. The plant has paid for itself many times over, and yet to be perfectly fair in my figures I still charge against the record of the plant another 5 per cent. for depreciation. The plant is in excellent condition to-day after twelve years of service and will probably last another ten years.

APARTMENT HOUSES

The Hendrik Hudson apartment house, at Riverside Drive and 110th Street, is 200 x 100, 9 stories high, containing 70 apartments. The 200 foot length faces the Hudson River, and beside the cold wind from the river, the building is exposed on the corner of 110th Street as well as at the corner of 111th Street. The boilers are used for heating, and in the coldest days for pumping also. All electricity is furnished by the New York Edison Co.

We have found that central station electric service is more profitable in a medium sized apartment house, without a refrigerating plant, than in any other type of building in New York except the theater. This is because the cost of operating the plant to provide a 24-hour service is high, and yet the electric consumption is much smaller than in an office building of the same size with a 12-hour service. Also the electric consumption and elevator travel is much less than in a hotel of the same size.

The total consumption of electricity was 102,105 kw. hrs. including the use by the tenants. It is necessary to use 100,000 kw. hrs. per annum in order to obtain the five cent rate in New York, and the custom is to sell to the tenants at ten cents per kw. hr. In winter the pumping is done largely by steam, the pressure being kept at about 60 pounds per square inch. The exhaust is used to help heat the building and for hot water for about 150 bathrooms. The fuel costs $1.98 per net ton and in addition the garbage and refuse is burned under the boilers.

In an apartment house the income from the tenants is almost nothing during the summer months where the tenants go away for the summer. For the year August, 1909, to July, 1910, the operating costs were:

Screenings, at $1.98	$ 2,185
Wages	2,233
Edison Company electricity	5,105
Miscellaneous, including lamps	1,149
Total operating expense	$ 10,672
Less sale of electricity	4,059
Total net operating expense	$ 6,613

An apartment house at 471 Park Avenue, corner of 58th Street, on a corner plot 100 x 125, and 12 stories in height. This apartment house differs from the Hendrik Hudson inasmuch as refrigeration is furnished to the tenants with the rent. Even after the building was filled it was found that the consumption of electricity was too small to obtain a wholesale rate from the Edison Co. Now, this situation had three disadvantages; first, the landlord had to pay a high price for the electricity he used; second, there was almost no profit for him from the sale of electricity to the tenants, and third, the refrigerating equipment required high pressure steam twelve months in the year.

It was therefore decided to install a small electric plant and the installation was as follows:

2 Harrisburg engines	$ 2,550
High pressure steam work	1,250
2 60 kw. dynamos	1,940
Switchboard	875
Electric wiring	632
Gould storage battery	2,540
Meters for each apartment, etc.	875
Total cost	$ 10,662

No complete figures are available, as the plant has only been operating for a few months, but the coal bill has been increased only slightly above what was needed for heating and refrigeration only. The record of this plant will be interesting to follow in the future.

THREE HOTELS.

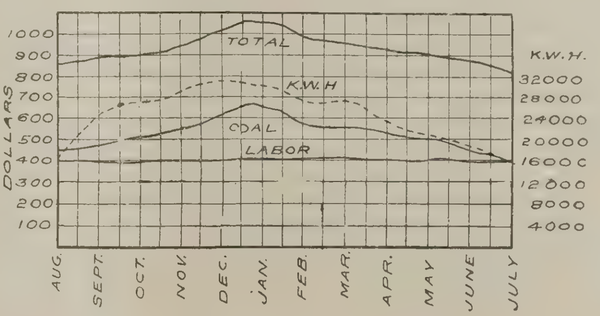
Hotel Hargrave, 50 x 200, 12 stories and basement, located on 72d Street, has 300 guest rooms, 200 baths, a restaurant, four electric elevators and complete ice and electric plants, but no laundry. Of course, being a hotel, they have 24-hour service. The electric plant, including a storage battery, cost $13,063. The operating cost for the past year was stated by the owners to be $200 per month less than that of any other hotel they knew of similar size. The costs are as follows:

Screenings, at $2.22	$ 6,237
Wages	4,895
Boiler water (estimated)	150
Ash removal	120
Repairs, oil, lamps and miscellaneous	1,400
Total manufacturing cost on Building Manager's books	$ 12,802
10 per cent. of plant cost added by Treasurer	1,306
Total operating cost on Treasurer's books	$ 14,108
Sale of electricity—nothing	———
Actual total net operating cost	$ 14,108

Above is the cost of producing 239,377 kw. hrs. of electricity, ice, refrigeration, heat for a building a block long and twelve stories high, and hot water for cooking and 200 bathrooms. Estimated cost of running this hotel in case electricity were bought would be as follows:

Edison electricity (239,377 kw. hrs., at 5c and 4½c)	$ 13,944
No. 1 buckwheat coal for heat, ice and hot water	4,500
Wages	3,480
Repairs, ash removal, oil, water, etc.	600
Total operating cost	$ 22,524
Sale of electricity—nothing	......
Total operating cost if buying electricity	$ 22,524
Actual net total cost on Treasurer's books when making electricity	14,108
Saving by making electricity	$ 8,416

Thus the plant paid for itself in less than two years, or, looking at it in another way, pays 65 per cent. per annum on the investment. It happens that when this hotel was half its present size it did not have any electric plant,



COST CURVES OF HARGRAVE HOTEL.

thus we are in possession of records of operating expense of the ice and heating plant before it was supplemented by the electric plant. It is from these records that I estimate the value of the ice, heating and hot water service given above. The fuel burned here for the last three years has cost $2.23 per net ton. Please note that the total operating expenses of $14,108 for ice, heat, light, power, repairs and fixed charges, is only $164 more than the cost of the electricity alone would have been if purchased from the Edison Co. The hotel is the most profitable place for an electric plant that I know of, unless it be a factory needing heat for drying or for other manufacturing purposes.

Reisenweber's Hotel, at Columbus Circle, near Central Park, is a favorite place for late suppers and private parties who like good things to eat and drink. It is an apartment hotel, containing 50 furnished apartments, each of two rooms and bath, and has a large restaurant business. It is on a corner plot 50 x 120, half rising to a height of ten stories and half to five stories.

The building uses Edison electricity exclusively and makes its own ice, but has no laundry. The cost for the year June, 1909, to June, 1910, was as follows:

No. 1 buckwheat coal, at $3.35	$ 2,757
Wages	2,400
Edison electricity	6,848
Miscellaneous, including lamps, oil, etc.	983
Total	$ 12,988

The electric consumption is 137,038 kw. hrs. Please note that this is only 46 per cent. as large as the Hargrave's electric consumption, and that the hotel is much less than half the size of the Hargrave, and yet the cost of heat, light, power and repairs is more than the manufacturing cost at the Hargrave, although it is about $1,100 less when fixed charges are considered. In reality, however, the Hargrave plant has already paid for itself. In Reisenweber's a properly designed electric plant which would cost less than $10,000 would save yearly about 40 per cent. of its first cost even after 5 per cent. interest on the money and another 5 per cent. for depreciation is considered.

INCREASED INCOME FROM ENGINE ROOMS.

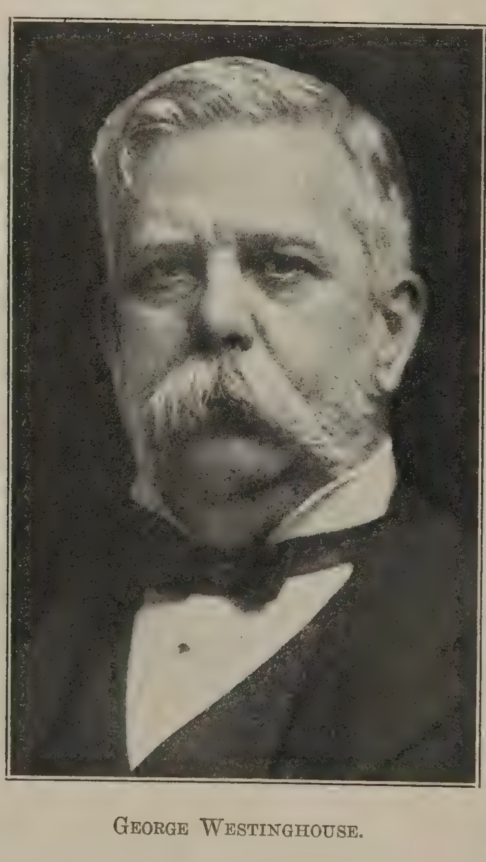
In New York City in the past it has been difficult for one building to sell electricity to its neighbors on account of the threatened classification of the building as a central station by the insurance companies and the increase of insurance rates to a prohibitive amount. Besides selling electricity to the tenants an apartment house on Broadway with an electric plant is getting $1,800 per year by selling exhaust steam to a neighboring building. Another apartment house on Park Avenue is heating every house on the block and deriving a good profit. A hotel on West 47th Street is supplying its next door neighbor with electricity and steam. A packing establishment on West street is selling electricity, ice and refrigeration to every building on the block. An office building in Binghamton, N. Y., is selling electricity, heat and hot water to a nearby office building and to a Carnegie library. For much of the information and cost data presented in this paper Mr. Ripley gives credit to P. R. Moses, Electrical Engineer of New York City.

Electricity in Southern Development.

BY GEORGE WESTINGHOUSE.

AMONG the numerous speeches presented before the third annual meeting of the Southern Commercial Congress at Atlanta, Ga., March 8 to 10, the following abstract of an address by an authority in the electrical industry treats important features of Southern electrical development, the achievements and possibilities.

If we still think of the present as the era of steam and steel, unquestionably the coming epoch, whose dawn we are privileged to witness, will be known as the Age of Electricity. First the toy, and long the mystery of the scientist, electric power is now a familiar tool for the accomplishment of the work and the increase of the comfort and pleasure of mankind.



George Westinghouse.

Although we may not know the ultimate nature of electricity, yet we do know some of its essential laws and methods of controlling and using it.

During the twenty-five years in which I have been intimately interested in the electrical art, a development has been witnessed which has surpassed the most optimistic predictions. At the beginning of this period it was the general conviction that electricity would be limited to local use in the lighting of densely populated districts or the supply of power to adjacent factories. Indeed, there had been no developments to remotely foreshadow what has since been accomplished.

At that period, however, there had already been developed and operated electric arc lighting circuits of high voltage, extended over rather large areas, with the pressure upon the wires of from 2,000 to 7,000 volts, which practically demonstrated that considerable electric power could be cheaply transmitted if means could be found to utilize safely high-voltage electric current for power and light and for other purposes; but such means were not then known. It often happens, when something is greatly needed for any great purpose, that as a result of a lively appreciation by many of the existing need, there arises in due course invention or discovery which meets the demand, and so it was in the matter of invention and discovery which gave us a simple static device, consisting of two coils of copper wire surrounded by sheets of iron, which could, without an appreciable loss of energy, transform alternating electric currents of high voltage and small quantity, dangerous to life, into low voltage currents of large quantity, safely available for all power, light, heat and other purposes.

To the part I took in bringing forward in the 80's of the last century the alternating current system of electric generation and distribution, I owe much, if not all, of the reputation accorded to me as one of the many pioneers in what is now a great and important industry.

The introduction of alternating current apparatus was bitterly opposed by those who were then exploiting direct current apparatus, and legislation was sought to prohibit its use because of its alleged danger to life. I mention this incident because it clearly shows that restrictive laws are not always advantageous, for had the legislation sought for by the opponents of the alternating current system been secured and enforced, I would not now have any justification for this address, because the influence of electricity in the development of the South would be too unimportant to entitle it to consideration on this occasion.

As a result of the development of the alternating current and of years of experience in the manufacture of electric transformers and of insulators for supporting electric conductors, power is now successfully transmitted by alternating current over distances of two hundred miles or more. Thus waterpower in almost inaccessible places awaits only the coming of engineers and of capital to be made available for industrial purposes.

It is estimated by those who have made a study of the sources of waterpower of the Appalachian mountains, that there can ultimately be developed from 5,000,000 to 7,000,000 horsepower during the dry season of the year, and a much larger quantity at other times.

PRESENT ACHIEVEMENTS IN THE SOUTH.

In the development and utilization of the energy of waterfalls, the South has already taken a leading position, and the industrial benefits thereof are so widely and favorably known that no argument is now needed to justify the work already done or to point out the great and lasting benefits to be derived from its extension.

Any address on electricity in the South would be incomplete without an expression of high appreciation of the work of the Southern Power Company, begun by Dr. Wylie and developed to its present stage by the Messrs. Duke.

This is the largest power transmission system in the South and is among the most extensive and important in the country. It is not a simple transmission line from a single power house to a single mill or city, but an extensive system which receives power from many power plants on different streams in several States. Hence low water or high water on one river, which might temporarily disable certain plants, has but a slight effect on the whole system.

The lines of the Southern Power Company extend 150 miles north and south and 200 miles east and west, and connect into a single hydro-electric power system plants aggregating 100,000 horse power. It is a magnificent demonstration of what electricity can do to conserve and utilize water-power in developing the great and growing textile and other industries of the South. The Southern Power Company is furnishing light to forty-five cities and towns and supplying current to six street railway systems and to hundreds of motors for various uses. This power development is the result of intelligent and far-sighted business courage and confidence in Southern affairs, which have inspired and actuated the men who have built up this great enterprise.

INDUSTRIES LIKELY TO BE DEVELOPED.

The industries most likely to be developed and to increase because of peculiar suitability to conditions now existing in the South are: textile mills, fertilizer works, cement plants, coal, iron, copper and gold mining, ore reduction plants, iron and steel mills, agricultural implement works, canning factories, road building, furniture manufacture, lumber plants, paper mills, shoe and leather factories, and oil refineries, in all of which industries electric power increases production.

The South abounds in coal and iron as well as other metals, which can be cheaply mined. Owing to the presence of impurities in the iron ore, especially phosphorous, the pig irons produced in the South have not been considered so suitable for steel manufacture as those made from the purer ores of the North. The electric furnaces for refining steel, which have been recently developed and quite extensively used, will make available the iron resources of the South in the production of the high grades of steel, and it is no stretch of imagination to forsee that the South will become a large producer of the raw material, and through the cheapness of its labor it will be able to turn these materials into finished products. At the same time the slag by-product of blast furnaces will remain to be used for fertilizing purposes.

The South is already a large user of fertilizers, much of which is imported and the supply of which is limited and exhaustible, nitrogen forming an important part of the fertilizers which are commonly used. During the past few years great attention has been given to the development of means for the electric production of fertilizers, and, so much has already been accomplished, it may be said with confidence that the fertilization of our soil within the near future will be largely dependent upon electricity. Most of the material required, coal and limestone, for this purpose, is found in the South in unlimited quantities. Were the soils in the United States as carefully tilled and fertilized as in many densely populated countries, there would be an immense increase in our agricultural products.

A brief consideration of the special advantages already derived from the use of electric power in the cotton industry will well illustrate the benefits to be gained from the general extension in the use of this wonderful force to other fields.

The output of cotton mills has been increased and the quality of goods is improved, due largely to the uniform speed attained by the electric drive compared with power conveyed through belts and lines of shafting. This uniform speed has resulted in an increased production with an increased profit, which in some cases exceeds the cost of the electric power.

In the territory of the Southern Power Company, it was at first difficult to induce the mill managers to adopt electric power, and it took three years of effort to introduce ten thousand horsepower; then, however, mill managers observed the advantages of their neighbors who used electric power, with the result that at the end of the next period of three years electric power had increased to more than 65,000 horsepower, while now there is a total of 80,000 horsepower of electric machinery installed.

Of the 300 or more cotton mills in North Carolina, about 25 per cent. are now wholly driven electrically. Although there has been a great increase in the number of cotton mills in the South in recent years, the mills have been devoted to the production of the cheaper grades of cloth; but it is predicted that the future growth will not be merely in the number of mills, but will be in the production of the finer grades of cotton fabrics.

LOOKING FORWARD.

Having been asked to speak upon the subject of electricity in the development of the South because of my connection with the electrical industries of the country, it seems to me I cannot fulfill the expectations of those who have planned this Congress by limiting my observations to matters with which you are more or less familiar from personal experience or from articles in your daily papers and in magazines; I should also ask you to look forward to what we may expect in the years to come.

In 1906-7 some experiments were made in England with the co-operation of Sir Oliver Lodge, the eminent English scientist, in the stimulation of plant growth by electricity. It has been frequently observed that plant growth is stimulated by electric light, and numerous experiments have been made, having for their object the stimulation of the soil by the application of electric current.

An explanation given for the excitation of vegetation by these high tension currents is that high-frequency electrical discharges favorably affect the deposit of the nitrogen in the atmosphere into the soil, upon which deposit vegetation so largely subsists.

The outcome of the efforts of one who specializes in any particular kind of apparatus is often interesting. The development, by Doctor Peter Cooper Hewitt, of the mercury vapor lamp has provided a light which is the least fatiguing to the human eye of all artificial lights, and experimentation with this lamp has led to the development of several other uses of the mercury vapor arc, one of which is the production in quartz tubes of ultra-violet rays, the effects of which are likely to be of the very highest importance in our daily lives. While these ultra-violet rays are emitted in the quartz tubes, they are effectively neutralized by the glass tubes which contain the mercury vapor used in lighting.

One of the important uses to which these ultra-violet rays have already been put has been to absolutely sterilize water, however much it may have been contaminated by bacteria. Experiments have also shown that the ultra-violet rays will sterilize milk without the application of heat in such a manner that it can be kept in properly sterilized vessels for long periods without deterioration or loss of its food values.

Not only have water and milk been sterilized, but in other experiments, also carried on at the Sorbonne, it was found that new wine was affected in a manner to give it the qualities normally attained in years, or an age of apparently many years was given by a few seconds' application of the ultra-violet rays. These experiments and investigations suggest that uses for the ultra-violet rays will be found which have not yet been conceived.

The transmission of electrical energy through the atmosphere without wires has, in a very few years, so far advanced that wireless telegraphy is now an important feature of our daily life. Not only has it been possible to communicate by wireless in the Morse code, but it has been found that, with suitable apparatus, telephone conversations can be carried on over considerable distances, and it is expected that by improvement in the apparatus, conversations can be carried on over very considerable distances.

The advantages of co-operation in the matter of the development and supply of electricity, having regard to a lessening of the cost and insuring the certainty of supply, cannot be overestimated, and those already secured by operations on a large scale are well known. Further co-operation in this great work for the benefit of the public, if not voluntary in the future, should, in my opinion, be an enforced one, notwithstanding the outcry which has been raised by the illinformed with reference to an imaginary monopolization of the water-power of the Nation. Encouragement should be given to the investment of capital in the development of these enterprises under such wise and reasonable regulation as will insure economy in the construction and operation of plants, adequate returns to the capital invested, and at the same time protect the consumer against exorbitant rates or unfair discrimination.

In the larger industrial developments which I foresee for the South there are other important factors which equal in importance the development of the waterpower resources upon which I have dwelt. I have particularly in mind those existing restrictions which make it difficult and expensive for a small corporation to carry on conveniently and in a simple manner its business with ramifications in several States, which restrictions, however, the great corporations of the country can easily surmount by reason of their financial ability to organize separate subsidiary companies in those States where such an expedient is rendered necessary to meet legislative requirements.

FEDERAL INCORPORATION.

I have long held that a Federal Incorporation Act, which the President advocates, under which all companies doing an interstate business could organize, would be a solution of the difficulties which are now almost insurmountable, and which are being added to in an alarming manner in the endeavor of the Legislatures of the several States to curb a few of the tens of thousands of companies and firms doing an interstate business.

After having read and carefully studied the bill providing for Federal incorporation, which was introduced in the long session of the present Congress, I am constrained to say I would prefer to see a Federal law in terms more easily comprehended by business men and devoid of those provisions which would give to a privileged few a practical control of corporation.

I have in mind particularly the depriving of minority owners of possible representation by the formation of voting trusts and the election of directors in classes, methods which can, and often do, defeat the purposes of laws which have provided for cumulative voting, whereby a substantial minority can insure the election of at least one member of a board of directors.

In my judgment, each director of a corporation should be required actually to own a substantial interest in the shares of the company, the affairs of which he aids to control, and the term of office be only from year to year.

Each of the great corporations of today had its origin in a business established by an individual or small company based upon the skill and efforts of one or more individuals. The development of the South must be more or less rapid according as the work of such men is appreciated and encouraged, especially during the period of strenuous effort necessary to the building up of large and prosperous industries from small beginnings.

The Duties of the Central Station Contract Agent or the Attorney for the Consumer.

(*Contributed Exclusively to* Southern Electrician.)

BY T. K. JACKSON, PRESIDENT MOBILE ELECTRIC COMPANY.

In the early days of electric lighting the manager or operator of the local electric company, knew all of his consumers by their first names, devised their lighting systems, superintended their installations, as well as frequently collected their bills. With the great growth of public service corporations, and the increasing complexity of the duties devolving upon the central station manager, it has become impossible for him to know many of his consumers personally, and to look out for their individual needs, and the solicitor's or contract agent's position was evolved with a view of better looking after the interests of the individual consumer.

In the struggle for business, however, the contract agent has frequently lost sight of the basic idea of his employment, and has literally become a solicitor of business only. This is a wrong conception. The true contract agent is not only a solicitor of business, an illuminating engineer, and often a power expert, but is as well the attorney for the consumer, representing his interests and fighting his battles.

The basis of all modern business is confidence. It is therefore a matter of policy, if nothing higher, for the contract agent to seek to obtain the respect and confidence of the consumer in his district. To do this he must try to furnish the highest illumination that the consumer's expenditures will permit, to quarrel with the consumer if need be, to prevent the introduction of false ideas of illumination, and to quarrel, if necessary, on behalf of the consumer with the manager of the Public Service Corporation, whose too stringent rules effect a particular hardship in the particular case.

It is only by honestly looking after the best interests of the consumer, even against himself or against the Public Service Corporation, that the true confidence of the consumer can be obtained and his business permanently secured. It is also the duty of the contract agent to keep his consumer informed of any methods to which he may resort in order to bring down the cost of his illumination. This is both true as to the physical means of obtaining the highest illumination for the money, and also true in obtaining the benefits of any peculiarities in the rates of the serving company.

The day of the "smart Aleck" solicitor whose proudest boast was that he had succeeded in making a consumer sign up an unfavorable contract instead of a favorable one is gone. That solicitor, by his own methods, rang his own death knell. A high order of integrity is essential, and the best solicitor is always the man of highest character, as well as of the greatest technical experience. The true solicitor is the true attorney for his consumer and the same essentials which mark the successful attorney mark the successful solicitor. As indicated before, the first essential is lofty ideals, second, a thorough knowledge of the business. Given these two with a fair share of aggressiveness and conservative optimism and the successful solicitor is at hand.

Southern Commercial Congress.

The third annual meeting of the Southern Commercial Congress was held March 8th to 10th, at Atlanta, Ga. The success of this meeting not only demonstrated conclusively the well founded purpose of the organization, but plainly indicated the national interest in it. The name Southern Commercial Congress as a result of the Atlanta meeting has become synonymous with an endeavor to induce a proper understanding by the people of the South regarding the physical resources of their States, a centralized agency for creating self-knowledge and greater activity toward progress within the South and a fulfillment of the organization slogan, a greater nation through a greater South.

The movement had the support at Atlanta of the chief executive of the United States and his predecessor, and the leading authorities in the political, financial, engineering, commercial, agricultural and editorial fields. In another section of this issue appears the address of George Westinghouse on the electrical development of the South. This address from its original features presents valuable information on Southern achievements and possibilities.

A section of the meeting was devoted to Southern water resources, at which time the following subjects were treated: "Water Resources," by John H. Finney, Washington, D. C.; "The Significance of Southern Water Resources," by Marshall O. Leighton, Washington, D. C., chief hydrographer Geological Survey; "Federal and State Co-operation in Water Power Development," by Capt. W. P. Lay, Gadsden, Ala.; "The Ownership of Running Waters and their Development," by Philip P. Wells, Washington, D. C., counsel National Conservation Association; "Hydro-Electric Corporations, Their Duties and Responsibilities," by Gano Dunn, Ampere, N. J., vice-president and chief engineer, Croocker-Wheeler Co. All this information as well as the entire proceedings of the third annual meeting are to be published in book form and can be obtained from G. G. Dowe, managing director, 1425 New York Ave., Washington, D. C.

Suit Against Incandescent Lamp Companies.

The United States Government through a suit filed March 3, began a fight against thirty-five concerns engaged in electrical and manufacturing business, on the ground of engaging in combinations and conspiracies to restrain trade and monopolize the sale and manufacture of incandescent lamps.

The General Electric Company is said to be the principal defendant in the present suit involving the electric light bulb section of the business and alleging unlawful agreements beginning with the machinery and ending with alleged price fixing and control of dealers. The General Electric is alleged to own more than 75 per cent. of the stock of the National Electric Lamp Company. The Westinghouse Company is a defendant on the charge that as the principal competitor of the General Electric and National Electric Lamp Companies it entered into unlawful agreement with them for the purpose of suppressing absolutely all competition.

The companies named as defendants engaged in the manufacture of incandescent lamps are as follows:

General Electric Company, New York; Westinghouse Electric & Manufacturing Company, Pennsylvania; Westinghouse Lamp Company, Pennsylvania; National Electric Lamp Company, New Jersey; Aetna Electric Company, New York; American Electric Lamp Company, New York; Banner Electric Company, Ohio; Brilliant Electric Company, Ohio; Bryan-Marsh Company, New York; Buckeye Electric Company, Ohio; Capital-Electric Company, Colorado; Colonial Electric Company, Ohio; Columbia Incandescent Lamp Company, Missouri; Economy Electric Company, Ohio; Fostoria Incandescent Lamp Company, West Virginia; Franklin Electric Manufacturing Company, Connecticut; General Incandescent Lamp Company, Ohio; Independent Incandescent Lamp Company, Missouri; Kentucky Electrical Company, Kentucky; Liberty Electric Manufacturing Company, Pennsylvania; Munder Electric Company, Maine; the New York and Ohio Company, West Virginia; Shelby Electric Company, Ohio; Standard Electrical Manufacturing Company, Ohio; Sterling Electrical Manufacturing Company, Ohio; Sunbeam Incandescent Lamp Company, New Jersey; Warren Electric and Specialty Company, Ohio; Gilmore Electric Company, Massachusetts.

The companies named not directly engaged in lamp manufacture but having to do with machinery or parts of lamps are as follows: York Electric & Machine Company, Elmer F. Dwyer of Lynn, Mass., as the Dwyer Machine Company; Corning Glass Works, of New York; Fostoria Bulb and Bottle Company, Ohio; Libbey Glass Company, Ohio; Phoenix Glass Company, West Virginia; and the Providence Gas Burner Company, Rhode Island.

Congress of Technology.

The sessions of the Congress of Technology with which the Massachusetts Institute of Technology will celebrate the semi-centennial of the granting of its charter, will be opened in Huntington Hall, Boston, on Monday afternoon, April 10th, with an address by President Maclaurin of the Institute. Later in the afternoon there will be read a few papers of special interest, but the remainder of the first day after these papers will be devoted to the entertainment of the alumni, large numbers of whom are expected to attend the Congress. Various excursions will be undertaken during the late afternoon, and in the evening there will be an alumni smoke at Symphony Hall.

On the second day, April 11, a large number of papers will be presented by distinguished alumni and members of the faculty of the Institute at sessions in the forenoon and in the afternoon, held in the various buildings of the Institute. These second day sessions will be open to the public, which will also be given an opportunity to inspect the laboratories and other interesting features of the Institute. On the evening of the second day there will be, in Symphony Hall, a banquet open to alumni and invited guests, at which men of national reputation will speak.

The papers to be presented before the Congress will constitute, taken together, a somewhat remarkable record of the achievements of applied science within the last fifty years, and this record will be at the same time in large part a record of the work of men trained at the Institute. The papers will cover such general subjects as Architecture, Business Administration, Economics, Public Health and Factory Sanitation, Industrial Organization and Training, Power Production and Distribution, Materials and Manufacturing Processes, Reclamation of Arid Lands. The subject of scientific management will be presented from many points of view, as it may affect railroads, and various manufacturing industries.

An N. E. L. A. Section at Pittsburg.

At a banquet given to the employees of the Allegheny County Light Co., by the officers at the Hotel Duquesne, Pittsburg, February 28, a section of the National Electric Light Association was formed, to be known as the County Light Section. The total number of employees of this company is 615, and 150 of the employees accepted the invitation, and joined the section. Prior to this time about 35 of the employees were already Class B members and therefore the section started with 185.

H. N. Miller, superintendent of distribution of the Allegheny County Light Company, acted as temporary chairman; W. H. Donkin, general contracting agent of the same company, acted as temporary secretary, and James M. Graves, temporary treasurer. H. H. Scott, chairman of the membership committee of the N. E. L. A., gave a history of the organization, told of its growth and the objects for which the Association was striving. A. R. Granger, of Chester, Pa., president of the Pennsylvania Electrical Association, followed Mr. Scott and told of the work the Company Sections were doing, particularly the Philadelphia Section, and also dwelt on the work of the Pennsylvania Association. R. S. Orr, general superintendent of the Allegheny County Light Company, W. A. Donkin and F. Uhlenhaut also spoke briefly and pledged their best efforts to make this section a success.

American Society of Mechanical Engineers.

The sixty-third meeting of the American Society of Mechanical Engineers will be held in Pittsburg, Pa., from May 30th to June 2d, inclusive. Last year the Society held a joint meeting in England with the British Society, the Institution of Mechanical Engineers, when George Westinghouse, then president of the Society, presented a paper on the "Electrification of Railroads," which aroused a great deal of interest. The British Society through its local committees in Birmingham and London, entertained the American Engineers by showing them many things of professional interest as well as providing delightful social functions.

The Society has not met in Pittsburg since 1884, and with the executive committee consisting of E. M. Herr, chairman, George Mesta, J. M. Tate, Jr., Chester B. Albree, D. F. Crawford, Morris Knowles and Elmer K. Hiles, secretary, the meetings promise to be decidedly profitable. It is expected that from 300 to 400 members and ladies will be in attendance. There will be professional sessions when papers will be read and discussed, and also inspection trips through the leading local industrial establishments, besides automobile trips through the parks and a visit to Carnegie Institute and Memorial Hall.

The American Society of Mechanical Engineers is one of the foremost organizations of technical and professional engineers in the world, with a membership of over 4,000 in this country as well as abroad. The headquarters are in New York City, Col. E. D. Meier, of St. Louis, being president for 1911. The Society has in the Pittsburg District alone a membership of about 160.

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.

POWER FACTOR OF MOTOR LOAD.

Editor Southern Electrician:

(205.) "Kindly advise if for practical purposes it is sufficiently accurate to measure the power factor of an induction motor load by means of a single phase wattmeter. In other words, can I assume a balanced condition?"

G. W. B.

SINGLE-PHASE LOAD ON THREE-PHASE SYSTEM.

Editor Southern Electrician:

(206.) Kindly publish information from your readers in regard to the use of the balance coil to get single phase connection on a three-phase system. I would like to get information and comparisons of this method of taking single-phase load from a three-phase generator as against placing load across any one of the three phases."

A. F. L.

TRANSMISSION LINE PROBLEM.

Editor Southern Electrician:

(207.) "The plant with which I am connected has a transmission line 15 miles long supplying about 200 horsepower of variable speed motors, and 400 horsepower of induction motors along the system. It is expected to connect lighting loads along the line at several places also. How can the power factor best be raised, by installing at the sub-stations rotaries, motor generator sets, or synchronous motors and generator sets. How about unbalancing the system by taking the lighting off the 6,600 volt circuit?"

A. H. B.

CALIBRATION CONSTANTS FOR WATTMETER.

Editor Southern Electrician:

(208.) "Please ask your readers for the testing constants and the necessary calibrating data and directions for the old style Stanley integrating wattmeter. I would like to have a complete table of constants for different sizes of meters."

E. D. D.

FUSES FOR INDUCTION MOTOR.

Editor Southern Electrician:

(209.) "Can your readers give me the actual safe size of fuses for induction motors, expressing the capacity of same in terms of the full load current. For example, what fuse should be used in the circuit of a 50 horsepower motor on a 3-phase, 220-volt circuit?"

H. A. P.

COST AND DESIGN OF ELECTRIC SIGNS.

Editor Southern Electrician:

(210.) "I shall appreciate information from engineers in the field of illuminating engineering as to the average cost of an electric sign made up of two plain words of twelve letters, the sign to be operated by a flasher. The sign will read J. J. Brown, Shoes. I would like also to know the approximate cost of a design for the same sign of an oblong style to give a rat chaser effect. If data can be given of a general nature on the installation cost, apparatus cost and operation of such a sign per letter or per lamp it will also be appreciated."

H. H. C.

Questions Unanswered Since January.

GENERATOR FOR CHARGING STORAGE BATTERIES.

Editor Southern Electrician:

(188.) "Kindly request readers of SOUTHERN ELECTRICIAN to give information on the following: Can I use a compound wound generator for charging a storage battery of 60 cells without danger of reversing its polarity? The generator is a 110-volt machine. If it is necessary to make changes in the field windings, please give directions for such changes together with diagram of connections."

W. T. R.

CONNECTION TO MAGNETO AND COMMON BATTERY LINES.

Editor Southern Electrician:

(196.) "I would be glad if you would publish in your columns a circuit by means of which I may connect a single telephone to either a magneto or common battery line, using a switch or other means for making the shift. The circuits and induction coils are not of the same size and the general arrangement is different in the two telephones. The common battery instrument is of the type used on the Bell lines."

S. O. L.

Remarks on Question No. 158.

Editor Southern Electrician:

"Referring to the discussion of my answer by Mr. Patton in the February issue, I have refrained from sending in any further criticisms for the reason that, no doubt, he realizes the incorrectness of his answer to Question 158. I do not quite agree with Mr. Patton's criticism of my answer. In the first place he states that for all practical purposes the loss in voltage may be neglected. This may be true in some cases where the voltage is high, but in sign work, using low-voltage Tungsten lamps, it is a very important thing to obtain as near as possible the rated voltage of the lamps at the sockets. Of course I do not mean by this that one should use wire of such weight that the interest on the investment would overbalance the losses sustained. Mr. Patton criticises very forcibly the fact that I have exaggerated the example. I wish to call Mr. Patton's attenion to the fact that the reason I exaggerated the example was to show various readers that there is a loss and it should be considered. Therefore, any one reading over the discussion could not possibly be misled. That was the great trouble with Mr. Patton's answer to Question 158, because he said very distinctly that each lamp would receive the same voltage. This is a very misleading statement, especially to those readers who are just studying the elements of electrical engineering."

E. J. MORA.

Remarks on Question No. 187.

Editor Southern Electrician:

"In further answer to this question, I can give some figures which may be considered as the efficiencies of various prime movers under average conditions. It is not safe to take these as final in selecting an equipment, without checking up with actual results from practice under conditions similar to those in the case under consideration. I give data from two different sources:

	WATER	OIL	STEAM	GAS
Initial cost per K.W.	$137.00	$217.00	$130.00	$270.00
Investment cost per year per K.W.	13.70	21.70	19.50	27.00
Operating cost per year per K.W.	3.00	59.90	52.50	38.50
Total cost of energy per K.W. year	16.70	78.60	72.00	65.50

Another table largely taken from practice, is as follows:

	RELATIVE COST OF OPERATION AND MAINTENANCE.	RELATIVE INVESTMENT COST.
Reciprocating engines	$100	$100
Steam turbines	90	82
Reciprocating engines and steam turbines	76	77
Gas engine plant..........	51	100
Gas engines and steam turbines	46	91

These figures appear to favor the economy of putting in a plant composed of both gas engines and steam turbines, in proper proportions. To thoroughly enter into all the various factors which help to determine the best equipment would take up too much space, and through ignorance of the questioner's conditions, would likely not be satisfactory to him.

A. G. Rakestraw.

Answer to Question No. 192.

Editor Southern Electrician:

"I reply to Question 192, in your February issue. I beg to advise H. M. P. that it is not satisfactory to attempt an approximation or give off-hand data for the cost of an hydro-electric development upon which cost data can be based. However the following information based on the experience of successful engineers, may be of some value for very approximate work.

"The horsepower of a waterfall with no storage may be taken as follows: H. P. = H V/528. In this formula H is the head in feet and V the flow in cubic feet per minute. In most sections, a storage is required, in which case the horsepower is obtained as follows: H. P. = (A $\times$ H)/7. In this expression, A is the drainage area in square miles and H the height of fall in feet.

"The approximate cost of a masonry dam may be obtained from this formula: Cost in $ per lineal foot = ($H^2 \times$ L)/10. In this, H is the height of dam in feet and L the length in feet.

"The cost of power equipment, including generators, exciters, switchboard, water turbines and draft tubes, will be about $25 per horsepower utilized. The transformers will cost about $5 per kilowatt output.

"The cost of concrete powerhouse can be taken at approximately $25 per kilowatt output when a substantial and up-to-date construction is required.

"It is to be understood that this data is not to be depended upon further than as a means for mental calculation somewhere in the neighborhood of the probable cost of the ordinary development. Many conditions and circumstances enter into the design of a hydro-electric power station in different localities. It will be seen, therefore, that off-hand data has little value for a particular installation unless the complete information and data in connection with the power site, use of power, etc., is at hand. The writer will be pleased to see comments on this data from other readers who may be using other approximate methods to obtain these results."

H. L. Williamson.

Answer to Question No. 192.

Editor Southern Electrician:

"In answer to Question number 192 in the February issue I wish to give the following: The simplest rule that I know of for determining the horsepower of any waterfall is to multiply the cubic feet of water passing over the dam or waterfall by the effective head in feet and divide this product by 706, the answer will be the available horsepower at 75 per cent. efficiency, which is about correct for the average plant.

"To make this clearer let us assume that we have a stream 50 feet wide and 5 feet deep at the point of measurement. This gives a cross section of 250 square feet. To get the number of cubic feet passing over the falls per minute, multiply the square feet by the rate of flow per minute in feet. If no velocity meter is at hand, a float may be timed between two points, which will give good average results. We will assume that by timing the float in the center of the stream a velocity of 300 feet per minute is shown. Allowance must be made for loss due to friction on the bed and banks which averages 17 per cent., so we have a mean velocity of 249 feet per minute. 249 feet $\times$ 250 square feet = 62,250 cubic feet. By assuming that we have a 20-foot effective head and applying the foregoing rule we have 62,250 cubic feet $\times$ 20 feet $\div$ 706 = 1,763 horsepower.

"All measurements should be taken as near the fall as possible and where the bed of the stream is reasonably smooth and free from large rocks. To arrive at a fair estimate of the horsepower that may be developed at all seasons of the year it is often necessary to take the flow daily or nearly so, for several years.

"Having no information as to the size or location of the water power, or the conditions to be met with, it is impossible to give more than a guess at what the cost of development would be. These costs for hydro-electric plants range all the way from $100 to $400 per kilowatt of station capacity, depending largely on the cost of power rights and development of the water power part of the proposition."

H. M. Beal.

Answers to Questions Nos. 190, 192, 199 and 204.

Editor Southern Electrician:

"Referring to Question 190, in the February issue, the loss of energy on a transmission line of 125 volts either A. C. or D. C. would be practically that due to the resistance loss, which in the case of a 15 volt drop in 125 volts would be 12 per cent. Unless the insulation were very faulty there would be no leakage. At high voltages, however, there is often considerable leakage, and since these high voltages are almost exclusively alternating current, we have loss due to resistance, leakage and capacity. The resistance loss is found by multiplying the current by the volts drop. The leakage loss depends upon the voltage, frequency, spacing of the conductors and the condition of the atmosphere. At 55,000 volts, with a spacing of 29 inches and a frequency of 73 cycles per second, the loss through the air is about 25 watts per 1,000 feet or 132 watts per mile. Besides this we have leakage over the insulators. With this same line, three phase, and assuming towers 500 feet apart, we have a loss per insulator varying from 20 watts in clear weather to 50 watts in drizzling rain. This gives a total loss of 700 to 1,600 watts per mile of line. In addition to this we have a small capacity loss. We know that parallel conductors act as a condenser and therefore draw a charging current. This current would be largely wattless, as it would be out of phase with the impressed voltage. It depends upon the voltage, and frequency of the line and the spacing and size of the conductors, and whether they are solid or stranded. We can therefore hardly give any exact data on the capacity loss, but it would be small compared with the other losses mentioned."

"No. 192. Since one horsepower is equal to 33,000 foot pounds per minute, the theoretical horsepower of a waterfall is found by measuring the cubic feet of flow per minute, multiplying by 62 pounds per cubic foot, then by the height of the fall in feet, and dividing by 33,000. The actual horsepower obtainable varies with the head and the type of wheel, from say 60 per cent. in the case of an ordinary overshot bucket wheel, to 80 or 85 per cent. in the case of a high head Pelton wheel. The flow may be measured in various ways. The most accurate is by measuring the flow over a wier. The wier is simply a dam-like obstruction across the stream, falling away rapidly on both sides and with means for accurately measuring the depth of the water as it flows over the crest. In the absence of a wier, the measurement may be taken on an ordinary dam crest, but it is necessary to apply small corrections on account of the variation in the shape of the obstruction. The cubic feet per minute is given by the formula: Cubic feet $= 200 \times L \times \sqrt{H^3}$, where L is the length of the wier in feet, and H the height of the water flowing over it in feet.

"Another, but not so accurate a way, without constructing a wier is to measure the depth of the stream at various points across, and thus prepare a map of the cross section. Then measure the velocity at different heights with a velocity meter, or a Pitots tube, and compute from this the flow of water. Sometimes the velocity is computed by timing a floating object. If a weighted rod is used such as will nearly touch the bottom of the stream, the rate of progress will give the average velocity of the water. None of these methods are as accurate as measurement by a wier.

"Regarding the investment necessary to develop the power, it is impossible to give any accurate figures, as these vary largely with the head available and the size of the installation. It has been found, however, that hydro-electric plants in general call for an investment of from $75 to $200 per K. W. The larger figures being for the smaller plants and those of low head."

No. 199. "The main advantage secured by impregnation is the reduction of manufacturing costs. Good results can be secured by any method if care is taken to have the insulating material thoroughly penetrate the coil. The process consists in placing the coils in a large tank of boiler iron, from which the air is exhausted, the insulating compound being then admitted will fill every interstice and since there is no air, there can be no bubbles to cause flaws. The process makes a better job at less cost than could be done by other means.

No. 204. "The majority of central stations now give free lamp renewals. The precedent has been set by the largest operating companies and the others are following their example. There may be some reasons against it, but there are many for it. One is that it is a means of providing every customer with a lamp for every socket, and if the lamps were bought there would be many empty sockets, each of which would mean some loss of revenue. Furthermore, it secures the use of lamps of proper efficiency and voltage, which otherwise would be uncertain. Moreover, it secures high grade lamps. All companies of any size now maintain a department for the testing of lamps, and consequently demand and receive a high-grade product. If this were not done no doubt some customers would get good lamps, but there would be some that would not. The natural desire for getting bargains, would lead to bargain sale methods in lamps as well as in other things, and the result would be that customers getting cheap lamps would have poor service and the central station would get the blame.

"As to the methods in use, for taking care of this service, I believe the most successful is to have a wagon with a special crew, which makes the rounds at least once every year. The employes enter the house and personally change the lamps in every socket and fill the empty ones. The lamps which are returned are tested as to candle power and assorted into three groups. The first, which are practically as good as new are returned to stock and given out again. Next come those which still have a good portion of their useful life remaining. These may be used around the power houses and other property of the company. The ones which are burned out and those whose useful life is about over, are of course, discarded. Lamps which burn out between trips of the wagon are exchanged at the office on request. New customers are of course provided with a full set of new lamps when the service is put in, but where the service is transferred from one customer to another, it should not be necessary to supply any lamps unless there is complaint of shortage. I also believe it pays to furnish a good grade of lamps, such as the 3.1 watt metallized filament lamp."

A. G. Rakestraw.

Answer to Question No. 193.

"I wish to give H. L. W. information drawn from my experience with A. C. machines. In regard to Question No. 193, which he asks in the February issue, I am not sure what particular conditions he has in mind, however, in this explanation I will compare the operation of rotary converters, induction motor generator sets and sychronous motor generator sets, which will cover the largest number of conditions.

"The use of a rotary converter is most satisfactory when connected to a transmission line along which a large direct current load is carried. Its efficiency is better in most cases of well designed machines than motor generator sets. It also offers a means for power-factor correction.

"There are some cases when the motor generator set possesses advantage. The induction motor generator set is best suited to a condition where a large portion of the total load is direct current and unsteady. In this case where the power-factor correction is not important this type of equipment is well suited on account of its large overload capacity. Speed characteristics of a satisfactory character can be obtained by a fly wheel, thus making the set itself a uniform load on the A. C. line.

"The synchronous motor generator set is best suited to those conditions where the load on the system is largely induction motors. This set also gives very good voltage regulation on the direct current side. A great advantage of this type of apparatus is the large capacity for power-factor correction, this being much more than with the rotary converter. From these brief statements it will be seen that the actual operating conditions determine the successful use of the particular type of equipment." H. F. Boyle.

Answer to Question No. 194.

Editor Southern Electrician:

"From the description of trouble in Question 194, of your February issue, it appears that there is some trouble on your outside line. As you do not state whether or not the party for whom you are called is in the same neighborhood, it is possible that this is the case and that one side of each of two pair in the cable are crossed together, or the open wire part of the line, if any, may be crossed.

"It is seldom that mechanical defects are found in the central office which would cause the trouble mentioned, unless there was a B party on your line. If this was the case a reversal of the jumper to one of the stations on the main frame, that is if the jack per station system is used, could be the cause. Perhaps the connections in the sub-station are wrongly arranged and you are receiving calls for some discontinued station which was at one time on your line and for which the proper designations have not been made on the switchboard by which the operators would be advised that the line was not to be called.

"It may be seen by the accompanying diagram how the ringing trouble could occur between your line and another in the same cable or on the same route.

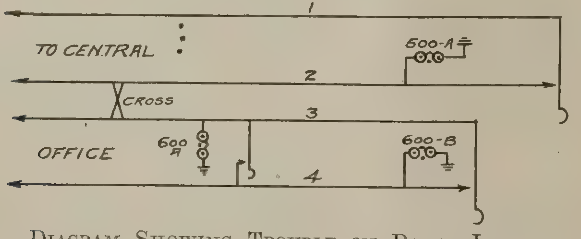


Diagram Showing Trouble on Party Lines.

"We will suppose that lines 1 and 2 of No. 500, go to your telephone and yours is the only party on same, at present the A party. In proximity within the cable or on the route, is another party line on pair 3 and 4 No. 600 with an A and B party, or only an A party. Now, if the wires 2 and 3 become crossed, a ring intended for 600-A would divide at the point of the cross and ring both bells at the same time. Some noise would be evident while talking but not appreciably annoying, as the other line may not be used at the same time. If it was, the combined resistance of the crossed wires 2 and 3 from the cross to the office would create an unbalanced condition which might cause a noise. Also some cross talk would be heard, but not necessarily as loud as if the two lines were in good metallic contact, for reason that ringing current will pass over some points which would not be such a good conductor of the feeble voice currents.

"However, your line should not test busy to parties calling you, unless on account of some discontinued number as mentioned before. It can be understood that either line would read "clear" by test with a volt-meter, yet the cross exist. Probably an inspection of the route between the cable box and the station or tests between pairs of the cable would remedy the trouble. Try changing the pair in the cable or on the route." L. O. Surles.

Answers to Questions Nos. 195 and 198.

Editor Southern Electrician:

"I submit the following in answer to Questions 195 in the February issue and 198 in the March issue. It is not advisable to install a one horsepower alternating current motor on a 5 ampere meter since the efficiency and power factor of even the best types are so low that the meter will be overloaded. It is altogether out of the question to build it in the manner described. The only type suitable is the induction motor. If J. M. M. wants to have a little fun would suggest that he hunt up an old 125 cycle motor or a burned out one and rewind it. Will be glad to furnish the necessary data for same, but in order to do so it is necessary to know the number and dimensions of stator slots, dimensions of teeth, depth of iron under the slots, diameter and length of rotor. It would be well also to know the thickness of the stator iron and length of air gap, but these are rather difficult to measure.

"If he finds a burned out 60 cycle motor, it will of course only be necessary to rewind the stator as it was before unless it should have been wound for 110 volts, in which case it will be necessary to use twice the number of turns of half the size wire."

No. 198. "The power factor of a system is determined by the character of the load and cannot be directly altered by varying the generator field. The only effect of changing the field would be to raise or lower the voltage, and whether or not this change in voltage would affect the power factor would depend on whether there were synchronous motors on the system. Raising the line voltage on a synchronous motor has the same effect as weakening its field. That is it causes lagging current and lowering the line voltage has the reverse effect. Therefore varying the generator field would in this case indirectly affect the power factor. However there would be very little need to vary the voltage even in this case since the same effect can be obtained by varying the fields of the synchronous motors.

"It may be stated as a general proposition that when a motor is in operation, it will generate a counter electromotive force which will be lower than the line voltage by the amount necessary to send the working current through the motor. For example, if the required voltage is 4 volts and the line voltage 220 volts, the counter e. m. f. will be 116 volts. If it be a direct current motor the speed will automatically adjust itself so that the counter e. m. f. will have the required value. If it be a synchronous motor the speed cannot vary and therefore the field must do so. If the field excitation is not what it should be the motor will automatically move ahead or drop back by a small angle until there is just enough lagging (magnetizing) or leading (demagnetizing) current to give it the proper value.

"It is evident that if the line voltage be raised the counter e. m. f. must raise with it. Otherwise the difference between them, the effective voltage, would become excessive and would result in excessive current flow. In the direct current motor this is accomplished chiefly by the natural increase of field magnetism, if the iron is not already near saturation, which results from the increased voltage, and partly by increased speed. The synchronous motor field being separately excited cannot be directly affected by the increase of line voltage and therefore if it be not adjusted by some external means the motor will take lagging (magnetizing) current, as mentioned above.

"Raising the voltage on an induction motor also causes it to take more magnetizing (lagging) current, but as the total magnetizing force, which is all furnished by the lagging current, is comparatively small because of the short air gap, this increase is not appreciable. The same is also true of transformers which have no air gap at all in their magnetic circuits. The synchronous motor has a comparatively large magnetizing force, furnished chiefly by the direct current field winding, because of the long magnetic circuit and air gap and the lagging or leading current necessary to affect it becomes decidedly appreciable. It is also true that if two synchronous generators are operating in parallel there will be wattless current circulating between them if their fields are not adjusted to generate the same voltage. This wattless current may become excessive if the machines are designed with strong fields and low armature reaction.

"Change of load does not necessarily affect the power factor. The power factor depends upon the relative amount of lagging current and of power current and not on the amount of either one. Of course if we can increase the power current without increasing the wattless current we will raise the power factor. I should judge that most of D. A. F.'s wattless current is the magnetizing current of the transformers and so is constant at all loads. Increasing the power load will of course make this wattless current bear a smaller ratio to the whole current. Therefore when the transformers are loaded with incandescent lamps, the power factor will be at its best.

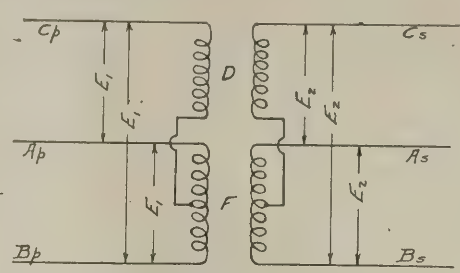
"Since the magnetizing current of an induction motor is also practically constant at all loads it is evident that it will have a better power factor when fully loaded.

"As a general proposition it is well to use a few large motors or transformers rather than a large number of small ones since the efficiency and power factor of the large ones are much better. However they must not be larger than their load requires, for since the magnetizing current and core loss are constant at all loads the efficiency and power factor will be low at light load. The power factor and all day efficiency of small 60 cycle lighting systems is sometimes made low by using old style transformers, some of which perhaps were originally built for 125 cycle systems." T. G. SEIDELL.

Answer to Question No. 197.

Editor Southern Electrician:

"In reply to Question 197 in the March issue I offer G. W. H. information as to obtaining three phase current from two transformers. The accompanying diagram shows the method of connecting the transformers. This scheme is known as the T connection.



TRANSFORMERS CONNECTED IN T.

"As shown in the sketch, one of the transformers must have a tap brought out from the center of the primary and secondary windings and the two transformers should have the same ratio of primary to secondary turns. In this arrangement the voltage on transformer D is only 86.6 per cent. of that on transformer F. The rating of F will therefore be E $\times$ I and the rating of D, equal to .866 E $\times$ I. In these expressions E is the voltage shown in the diagram and I is the current in each line. This arrangement is better than the open delta connection and does not require but little larger rating of transformers than the Delta or Y connections, the difference being 1,866 E I against 1.732 E I for the three one-phase transformers."

H. F. PATTON.

Answer to Question No. 198.

Editor Southern Electrician:

"As to the question signed D. A. F. in your March issue, I wish to state as follows: The power factor of a circuit cannot be changed by making changes in the operating conditions of the generator unless such changes affect the nature of the load. If induction motors are operated on the circuit referred to by D. A. F., varying the field excitation would affect the voltage and thereby change somewhat the power factor of the load taken by the induction motors. In regard to the effect of change of load requested, I would say that the addition of induction motors and transformers lowers the power factor, while synchronous motors raise it. This is due to the fact that the induction motor requires a magnetizing or wattless current, while the synchronous motor can be excited in such a way that the low power factor of the induction motor load may be corrected by drawing a leading current." W. A. BATES.

Answer to Questions Number 198 and 200.

Editor Southern Electrician:

"The power factor of an alternating current generator cannot be changed by altering the field excitation. Power factor depends upon the nature of the load. If synchronous motors are operated on the line, over excitation of the fields of the motors will cause the current to rise to its maximum ahead of the electro-motive force giving a leading power factor to the motors and consequently bringing up the power factor of the whole system. On the other hand if induction motors are operated on the line the current lags behind the electro motive force, thereby lowering the power factor of the system.

"A change in the amount of load or in the voltage does not effect the power factor of the unit. Power factor may be expressed as a ratio between the apparent power and the actual power of a circuit. If the electro-motive force and the current are measured separately the voltmeter and ammeter will give the individual mean effective values. The product of these two would represent the apparent power of the line. If, however, the power of the line is measured on a wattmeter, the combined synchronous effect of the volts and amperes is indicated. This will be less than the product of their separate values, which do not come to a maximum at the same time, and represents the actual power of the line. As a formula this would be expressed thus: Power Factor = Volts × Amperes/Watts. Thus any change in the electro-motive force or current will cause a corresponding change in the watts, and vice versa. Since these vary directly the power factor, which is a ratio, will remain unchanged.

No. 200. "Every direct current motor is an alternator with the windings so attached to the commutator bars as to give a continuous direction to the flow of current. A direct current motor could be changed to a single phase alternating current generator by doing away with the direct current commutator and connecting the winding terminals each to its proper A. C. collector ring."

E. H. TENNEY.

Answer to Question No. 200.

Editor Southern Electrician:

"For the benefit of H. L. W. who requests directions for changing a direct current motor so that it can be used as an alternating current generator, I will advise as follows: Place two slip rings on the commutator and connect points on the armature to them 180 electrical degrees apart. This is the arrangement to give a single phase generator. Without further details as to the particular design of motor and armature windings, it is impossible to tell exactly where to make these connections. This will depend upon, form of winding, number of armature slots, and the coils per slot, number of poles and commutator segments.

"For a three-phase generator, three slip rings and connections 120 electrical degrees apart are required. The frequency will depend upon the number of poles and speed of the machine." If H. L. W. will give the details of design of the direct current motor referred to, I shall be glad to give directions for the necessary connections mentioned."

H. L. WILLIAMSON.

Answer to Question No. 204.

Editor Southern Electrician:

"In answer to Question 204, I wish to say that if G. W. H. is figuring on a street lighting proposition or any layout that has a fixed charge per lamp, he may adopt the free lamp renewal proposition to an advantage. In this case he can add the cost of renewals to the rate and not lose the cost of the lamp. Where current is charged for on a meter basis I would not advise him to give free renewals, as it is not a good policy in my opinion, for the company that does it is in reality competing against itself. Some one must sell electric lamps and the central station might just as well get the small profit to be had on the sale of the lamps if it is doing a contracting business. If not then let the local contracting firm have the business and kept on good terms with such, for it is the best salesman for the station. Every job the contractor does is to make money for the central station and they are too near together not to be on good terms.

"Just for an illustration drawn from similar circumstances, the gas company will not give away a gas range that they might sell gas, nor does the feed man give a horse that he may sell feed. Lamps cost money, and if the central station has any money to give away, it had better give it to the church or to the poor, for they will appreciate it, the public never. I think that if G. W. H. will give this a few minutes time in earnest thought, he will readily see my point."

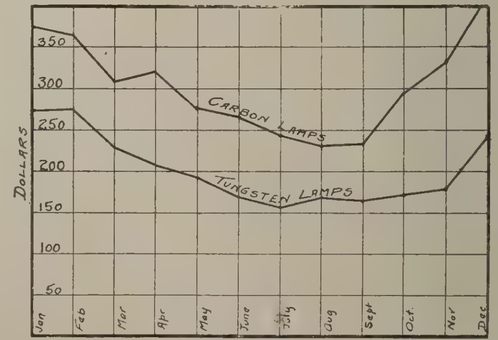
E. D. DUMAS.

Change from Carbon to Tungsten Units.

Editor Southern Electrician:

"It has occurred to the writer that it might be of interest to the readers of SOUTHERN ELECTRICIAN to read a report of lighting a sixteen-story building one year with the carbon filament lamp and note change by use of tungsten. In the original installation there were 750 lamps divided in 600, 16 candlepower and 150, 32 candlepower; 525 carbon lamps were then taken out and tungsten 25, 40 and 60 watt lamps put in. The results are shown herewith:

Month—	1909.	1910.	Saving.
January	$373.20	$266.72	$106.48
February	368.24	277.80	90.44
March	313.84	231.20	82.64
April	326.24	211.60	114.64
May	278.88	191.60	87.36
June	269.89	174.40	95.49
July	248.16	156.40	91.76
August	237.04	169.60	67.84
September	235.24	166.40	68.84
October	294.88	174.00	123.88
November	337.00	184.80	152.60
December	407.12	244.80	162.32
Total			$1,243.81



SAVING IN USE OF TUNGSTEN UNITS.

"There are 25-watt lamps in the building that have been there for fifteen months, burning about twelve hours per day. There are also two 40-watt lamps in the elevators that have been there for eight months. It therefore pays to put in the tungsten lamp."

L. A. COLE.

New Apparatus and Appliances.

The Delco Current Consuming Devices.

A new line of domestic and industrial heaters have been placed upon the market by the Diamond Electric Company, of Binghamton, N. Y. Special attention has been given to the long life of the heating element, simplicity of construction, convenience of operation, attractiveness of design and low wattage consumption. The line is characterized by the trade-mark "Delco."

The Delco oven is $11\frac{1}{2}$ inches by $14\frac{1}{2}$ inches by 19 inches with let-down, grate-protected glass door. This allows inspection of cooking without the loss occasioned by heating the cold air admitted when the door is opened. Having air-wall insulation, double at top and bottom, and no castings to absorb heat, a great saving in current consumption is obtained. A downward reflecting plate placed above the upper heating element, eliminates the natural conjection of superheated air at the top.

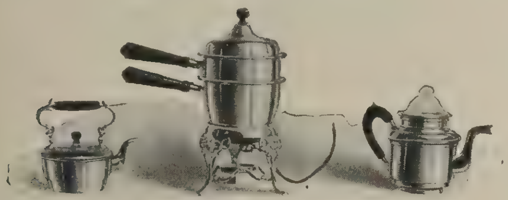


Fig. 1. Delco Combination Set.

The Delco air heater is a particularly attractive design, portable and tubular in style. It is of light construction and furnished in brass, oxidized copper, silver or verd antique finishes. The heating element is supported at the bottom only and is free to expand independent of the tubes. All connections are at the bottom and, being always cool, many possibilities of trouble are eliminated. A three heat switch is supported on the base and a cord and plug of ample capacity permanently attached.

The Delco chafing dish heater replaces the alcohol lamp in all standard makes of chafing dishes. It is furnished separate or with dish complete. The reservoir effect of the heater will hold the food above eating temperature for half an hour after the current is turned off.

The Delco combination set is a combination of utensils with heater-stand with which an entire epicurean meal may be prepared. The set comprises a stand with removable heater, into which may be set a tea kettle of fancy design, a coffee percolator or cereal cooker. This cooker is separable and may be used for many purposes. An egg rest or holder is also supplied, holding six eggs for boiling. This attractive outfit is furnished in polished nickel copper or brass, all tin lined, and with or without three-heat switch attached. It is an economical purchase for students and persons living in like circumstances.

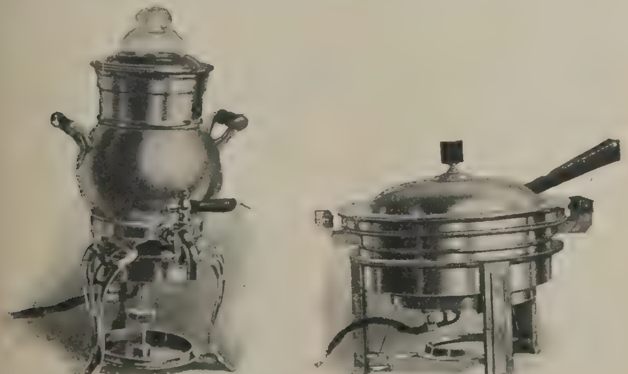


Fig. 2. Delco Percolator and Chafing Dish.

Fig. 3. Delco Toaster.

The Delco toaster is of the glowing, horizontal, radiant type. It is serviceable and makes a dainty appearance upon the breakfast table with its white porcelain base, polished nickel frame and green silk attachment cord and with or without on and off switch attached. Bread, crackers, cheese, marshmallows, etc., can be toasted to a nicety upon it, or if desired water boiled or an entire meal economically produced.

The Delco domestic, laundry and tailor irons are neat and rugged in appearance and hold up to work and abuse. They will not burn out if left running over night. The heating element consists of a long length of large cross-section conductor which is free to obey the dictates of expansion and contraction. All the metal surrounding the element is homogeneous with that of the ironing surface. The large storage effect will allow of use twenty minutes after current is turned off. Permanent or plug attached cord is provided, also three-heat switch supported at back. A most efficient and satisfactory domestic electric iron on the market is the Delco three-heat iron. A small three-heat switch attached to the back of the handle strap enabling the user to obtain different degrees of heat, a feature not common to other electric irons.

The Delco glue pot is of the water jacketed type, white porcelain enameled inside and out and has brass bails. It is extremely clean and efficient and has a three-heat switch attached to cord for wall location.

The Delco soldering iron is substantially built and convenient in operation. It is entirely made of brass, dull nickeled, excepting the copper tip and ebonoid handle. Removable tips of any shape are supplied for soldering, branding or other purposes. When too hot the plug may be slipped off and iron used some time without current. The large reservoir of heat relieves the heat from winding and aids toward long life. The handle is exceptionally cool at all times.

The Delco wax or solder pots are made of a single casting, comprising pot and legs, mounted upon a slate base. The heater is secured under the bottom of the pot, the heat passing through but one thickness of metal. A three-heat switch or cord is furnished for wall location. The company is open to consultation, estimates and designs on special heaters and apparatus for special purposes.

Pelouze Electric Irons, Stoves and Toasters.

The accompanying illustrations show types of current consuming devices manufactured by the Pelouze Electric Heater Co., 232 East Ohio St., Chicago, Ill.

In the Pelouze iron the current and temperature can be controlled at the iron by a simple movement of the hand while ironing, a great convenience in operating, besides time saving and economical. In the case of many other irons it is necessary to either detach the cord from the iron or to turn the current off at the socket each time. As the coil is wound in a flat plane it operates only and directly on the bottom of iron, hence the current is not wasted and the bottom becomes sufficiently hot for service it is said in four minutes.

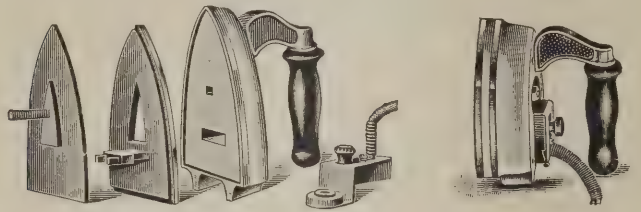


FIG. 1. PELOUZE IRON AND PARTS.

The body is completely filled with magnesia asbestos so that the top of the iron, while in use, does not become extremely hot and because of this advantage the usual cord troubles are eliminated.

All parts of the Pelouze iron are interchangeable. The heating unit and the contacts are complete in one piece, and can be sent by mail and replaced by any one, the operation consisting in removing one nut only on top of iron. The iron requires no extra stand and is therefore labor saving, as it does away with constant lifting. When not in use it may be tipped back until it rests on the rear lugs and end of handle.

The Pelouze disc stove embodies in its structure, engineering principles to secure efficiency, speed, and endurance. Mechanical difficulties have always been in the way of attaining the first two. It has been necessary to use a considerable amount of material in the tops, or in the heater itself, to make them sufficiently rigid to prevent warping and twisting from heating. Through the invention of an under-truss, which is very rigid and strong, both the heater and a thin top is retained in a plane surface. This allows not only use of a thin top, which eliminates storage, but also enables the use of alloys, or copper.

FIG. 2. PELOUZE GRIDDLE.

As a result this combination of flat iron heater, built in the round form, with the patented truss, enables the Pelouze stove structure to obtain both very high efficiency and starting speed. Since the high efficiency of the Pelouze stove is reached owing to the patent truss structure which concentrates the heat in the copper top, it therefore follows that the bottom and legs do not get nearly as hot as in other stoves, and consequently there is no danger of injury to the finish of a highly polished table.

The Pelouze stove-toaster and griddle embodies a utilization of new principles in the art of electrical heating, and may be said to represent a distinctive system of applying electrical heat. This new method might well be called the "radiant suspension" of applying heat. The principal object of this new system is to utilize radiant heat with the greatest possible speed, and with the smallest loss of heat. Radiant conductors have been used many times before, but they have always been associated with insulators or other bodies of matter, so that the larger part of the heat has been absorbed as generated, which resulted in the maximum effect being reached very slowly. By suspending the conductors in the air, above a proper reflector, these defects are said to be avoided, and an instantaneous result is obtained.

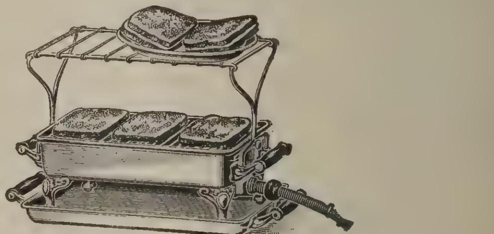


FIG. 3. PELOUZE COMBINATION STOVE, GRIDDLE AND TOASTER.

The current consumption of the Pelouze stove-toaster and griddle is only 450 watts. The toaster will toast the first piece in fifty seconds, and each piece thereafter in forty-five seconds. The heating element in the Pelouze toaster is complete in one piece with the contacts. It is supported from underneath by one screw. All heating elements are interchangeable, and can be replaced by anyone, should an accident ever occur.

Acme Electric Iron.

A new electric iron with some unusual features of construction, has been brought out by the Acme Electric Heating Co., of Detroit, Mich. There are no screws used in the construction of the iron and it can be taken apart and put together without tools of any kind. The iron locks together with a key carried on the handle by a twist of the wrist operation.

The smoothing base is a straight casting weighing four pounds and having vertical slots into which the heating unit slips. The heating unit is practically surrounded by the base so that the heat is absorbed from all sides of the unit directly by the base. This is claimed to be very

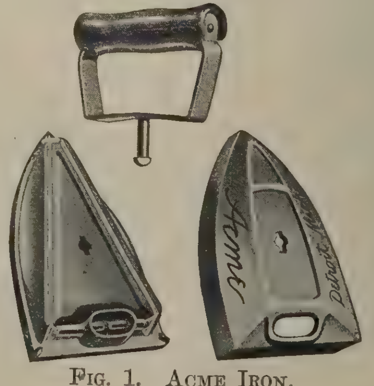


FIG. 1. ACME IRON.

efficient. The heating unit with the terminals permanently attached, is protected with a steel armour properly insulated. The terminals are set down in a heavy steel case to protect them from bending or the insulation from breaking should the iron fall or receive other accident. There are no nuts, washers, or small insulators used in the construction and should it become necessary to renew a unit, a new one is furnished complete for fifty cents which can be easily fixed in place.

The cord furnished with this iron has one unique feature, in that it is enclosed in a steel wire spiral throughout

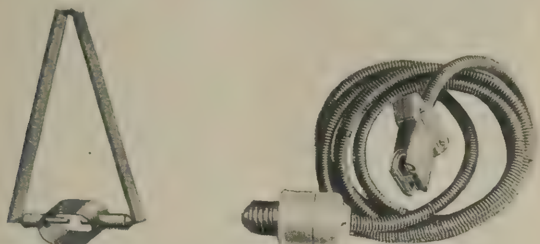


FIG. 2. HEATING UNIT AND CORD.

its whole length. This is done to protect it from wear, to prevent short bends and kinks and to give it the feature of untwisting itself when detached at one end should it have become twisted in use. George J. Schneider, president of the Acme Electric Heater Company, and patentee of the device has been for the past fifteen years connected with some of the larger companies engaged in the same line and has produced successful and well known irons. His present design is simple and contains features that should make it durable and efficient.

Cutler-Hammer Heating Devices.

Among the heating devices included in the new Cutler-Hammer line, the instantaneous water heaters because of their newness prove interesting, it being claimed that the turning on of the current for 15 seconds, will provide steaming hot water. In the five types at present designed, carbon rods varying in size and number according to the size of the heater are used, installed so as to be ordinarily open circuited. When water is turned on these rods are spanned, making a circuit and heating the water instantly. Withdrawing of the water, even though the current is on will stop the flow of electricity. The bath heater and tank heater shown here are of the largest types, the latter being designed for permanent installation as part of the tank piping.

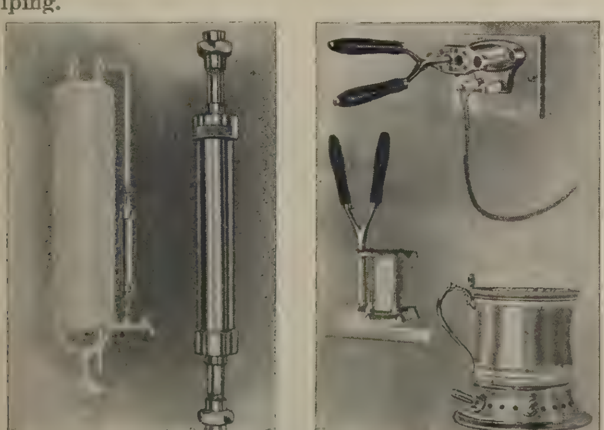


FIG. 1. CUTLER-HAMMER WATER HEATER, CURLING IRON HEATER AND SHAVING MUG.

The curling iron heater has two heating chambers and is provided with a heavy base so that it may be used either on the dressing table or may be fastened to the wall. The insertion of an iron in the heating chamber starts the current while withdrawing cuts it off, preventing possible waste. These heaters permit of using irons of somewhat different sizes and are adapted for the hair dressing parlor and for the home.

For the men nickel plated shaving mugs having a removable soap tray has been provided. If shaving stick or powder is used this tray can be dispensed with and the mug used for heating water alone. The capacity is about one-half pint so that it can be used as a water cup in an emergency for heating water for many other purposes.

The So-Easy Electric Iron.

The "So-Easy" electric iron shown in the accompanying illustration is manufactured by the Phelps Manufacturing Company, Detroit, Michigan. The heating element is entirely new and has been patented by J. Wiley Phelps. It consists of a piece of mica the size and shape of the bottom of the iron perforated so as to place radiation where desired. Through these perforations is wound over and over a very finely rolled resistance tape made from a nickel chronium alloy which has a very high melting point and great resistance. This element is placed over the bottom of the iron and secures an absolutely perfect distribution of heat to the entire ironing surface. No part of the heat has to be supplied by conduction.

THE SO-EASY IRON.

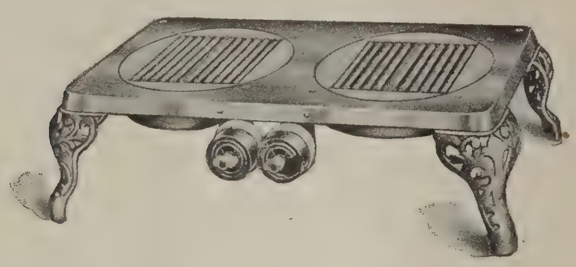
The electrical contact is made by the pressure of the terminal plates on the ends of the resistance tape. There are no screw joints or binding posts. The plug connection is very superior, having split pin terminals providing for the take up. The brass sleeves in the plug are bored out of a solid piece of brass.

The iron is said to be ready for work in three minutes after the current is turned on. It also has a specially large storage capacity, which is very important for heavy work, as there is no waiting for heat. The iron is nicely finished and furnished with a heat insulating stand, six feet of approved cord and a separable attachment plug.

Hughes Electric Hot Plates.

The latest electric cooking devices developed by the Hughes Electric Heating Co., of Chicago, Ill., are hot plates designed to meet the demand for a moderate priced stove for all kinds of cooking except baking. They resemble in a general way the ordinary gas hot plates, are very attractive in appearance and substantially made. The heating units are exactly the same as used in larger ranges made by this company and are guaranteed against burn-out for a period of one year, renewals being furnished should a burn-out occur within that time.

Renewals are easily made by the consumer without the expense of returning to factory and the renewals cost but one dollar per burner. Central stations and electrical dealers carry the renewal parts or they can be obtained direct from the factory or branch offices.



Hughes Two-Burner Hot Plate.

The hot plates are made for use on any commercial voltage. The current consumption of the two-burner plate shown for three heats is 220, 440 and 880 watts per burner.

Eureka Vacuum Cleaner.

The accompanying illustration shows an electric vacuum suction cleaner manufactured by the Eureka Vacuum Cleaner Co., Detroit, Mich. The Eureka cleaner is driven by a motor manufactured by the above company and especially designed for the service. It is hung on the under side of the cleaner out of the way in operation, an arrangement which makes the cleaner compact and easily handled. The motor is controlled by means of a switch on the handle in easy reach of the operator while in a standing position. The complete machine is very simple in construction consisting of three parts, the motor, the fan and dust bag. It can be used for all kinds of cleaning, on carpets, rugs, floors, draperies, walls, bedding, etc., and it is claimed that the cost of operating it two hours a day for one year at the average cost of current will not exceed two dollars.

Eureka Vacuum Cleaner.

Semco Vacuum Cleaner.

The Semco Vacuum Cleaner shown herewith has been designed to operate as a cleaner or remover of all substances from the face or top of carpets, floors, upholstery, drapery, ceilings, etc., and at the same time raise no dust. The cleaner has no vibrating parts or revolving brushes, there being only one moving part, namely that creating the

Semco Vacuum Cleaner.

suction. A too strong vacuum has been avoided which is injurious to carpets and the machine is adapted for use in exhausting foul air, hair drying, grinding and sharpening cutlery, polishing silverware and brass, running sewing machine and numerous other small power devices.

Adams-Bagnall Electric Fans.

The Jandus fans are being manufactured and placed upon the market for 1911 by the Adams-Bagnall Electric Company, Cleveland, Ohio. These comprise the direct and alternating-current swivel-and-trunnion desk or bracket fans, oscillating fans in sizes of twelve and sixteen inches and alternating and direct-current eight-inch desk and oscillating fans in addition to a complete line of ceiling and column fans of all types.

The direct-current oscillating type desk or bracket fan is divided into two classes—the vane and the positive drive, the former depending for its angular motion upon the impingement of the air blast upon a movable metal vane and the latter upon motion transmitted by a train of gears.

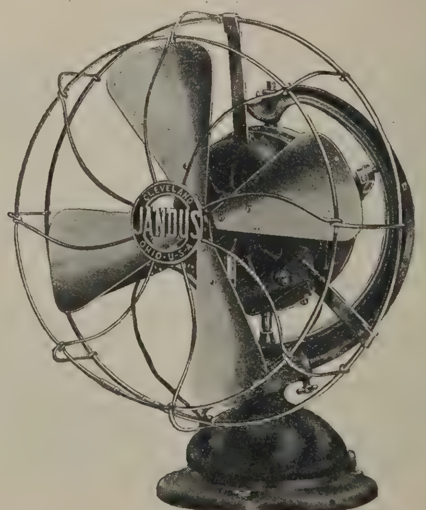


Fig. 1. Jandus A. C. Desk Fan.

This season's fan is much improved by the addition of ball bearing for the lower steel pivot point. The actuating mechanism consists of two steel gear wheels, forming the simplest type of differential gear. One is stationary and the other is actuated by means of an eccentric carried by the motor shaft.

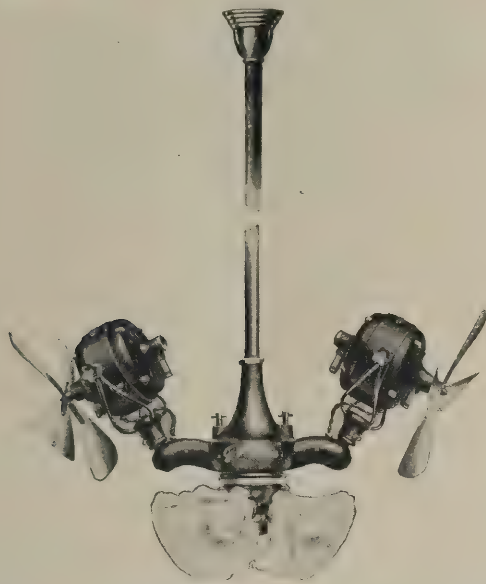


Fig. 2. Janders Ceiling Fan, Gyrofan Type.

The Jandus alternating-current fans of both the swivel-and-trunnion types and oscillating types are of the induction-motor type, single phase, self-starting and entirely free from moving contacts. The mechanical construction of these fans is the same as for the direct-current fans and they are also made in twelve-inch and sixteen-inch sizes. The eight-inch fans are available for either direct or alternating-current circuits, in all styles, and embody the same characteristics of design as the larger fans.

Century Alternating Current Fans.

The fan motors described herewith and manufactured by the Century Electric Company, St. Louis, Mo., are what is commonly known as the split-phase induction type, no moving wire being used. The construction of the cast-iron motor frame and laminated field is such as to permit of a maximum amount of ventilation, resulting in the fan operating with an exceptionally low temperature rise. The rotor is the well-known squirrel-cage type. Every part is built to standard gauges and is interchangeable.

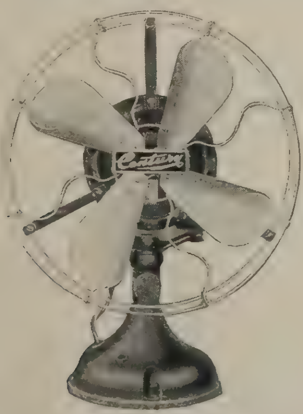


Fig. 1. Century Desk Fan.

To provide a close adjustment of speed, a five-point speed-regulating switch is located in the base of the fan. The contact points are of such construction, that the contact is positive and substantial. The standard winding and connections are for 100-108 and 110-120 volts, a third terminal being provided on the switch base to permit of proper connections being made for the voltage of the circuit on which the fan is to be used. The speed-regulating coil is located in the base of the fan immediately above the switch.

The fans will operate satisfactorily on all variations of voltage and frequency between five per cent. above or below that for which they are wound and connected, although the amount of speed variation will be affected by any change in either voltage or frequency. Each fan is provided with swivel and trunnion and can be converted to a bracket type without extra parts. The trunnion is provided with a positive lock to hold the motor in any position it may be tilted.

The oscillating fan motors can be used as either desk or wall bracket fans without extra parts. When tilted from a horizontal adjustment, throughout its 120 degrees of oscillation, the air is blown in the same plane. When the motor is operating at full speed, it will make about six complete oscillations per minute, which has been found to be the number most efficient and best suited to the majority of conditions. The oscillating fans are not equipped with a multiple-speed switch.

The Century ceiling fans are of the split-phase induction type. The fan blades have a sweep of fifty-eight inches, and all fans are equipped with a two-speed switch; the slow speed being about 180 revolutions per minute on sixty-cycle circuits.

Tuerk and H. E. Fans.

The line of "Tuerk" and "HE" fans for 1911 offered by the Hunter Fan & Motor Company, 114 Liberty Street, New York, N. Y., comprise direct and alternating-current twelve and sixteen-inch desk and bracket fans of both swivel-and-trunnion and oscillating types, eight-inch desk and bracket, telephone booth and oscillating fans, two and four-blade ceiling fans, and two and four-blade columns and counter fans.

The "Tuerk" type C four-blade alternating-current ceiling fan with electrolier attachment, has a slow-speed induction motor with a two-speed regulating switch. The motor is equipped with four blades, the blades being per-

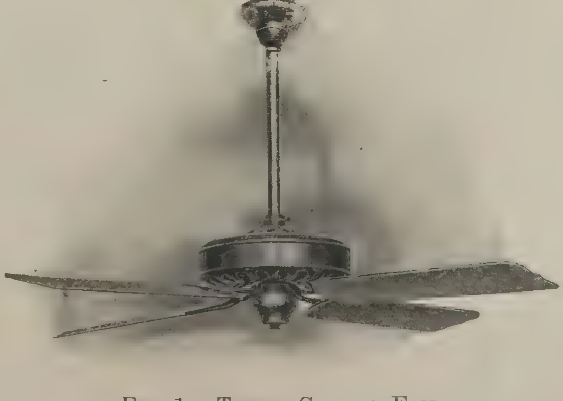


Fig. 1. Tuerk Ceiling Fan.

manently fixed at a correct angle to the revolving rotor. The four blades are six and one-half inches wide at the tip and have a fifty-two inch sweep, operating at a speed of 225 revolutions per minute. The type C fan is adapted to frequencies of 25, 40, 50, and 60 cycles. The electrolier attachment with either two or four lights can be attached to the bottom.

Western Electric Fans.

Five new types have been added to the already large list of "Western Electric Hawthorne" electric fan motors and the line is now such that it will meet every requirement necessary to good ventilation. The most important addition is a new mechanically-operated oscillating fan. The oscillating device consists of a double-worm reduction controlled by an oscillating lever, the gears being inclosed in a dust-proof case filled with lubricant. The fan can be used either as a desk or a bracket type. The oscillating motion is very smooth and even, and wholly free from jarring. The range of oscillation is ninety degrees and is adjustable.

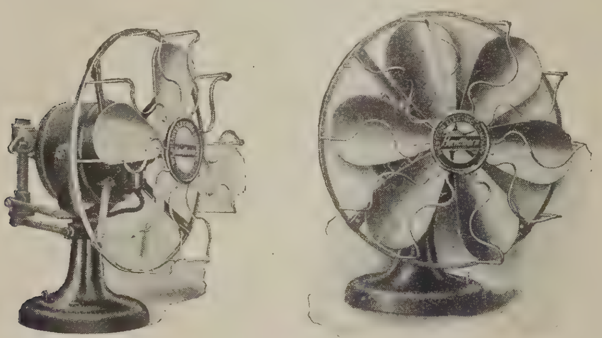


Fig. 1. Hawthorne Oscillating and Desk Fan.

The success of the twelve-inch, alternating-current, six-blade residence fan introduced last year has led the company to place on the market this same style of fan for use on direct-current circuits and also an oscillating fan of the six-blade type. As the increase in the number of blades allows the speed to be cut down without any decrease in the volume of air moved, this fan operates noiselessly, and because of this fact has become very popular. It can be adapted for use either as a wall or bracket type and has two speeds.

The line of "Western Electric Hawthorne" fans now consists of eight-inch, twelve-inch, and sixteen-inch desk and bracket fans; twelve and sixteen-inch oscillating fans; eight-inch telephone-booth fans; air operated and mechanically-operated oscillating fans, and a full line of battery fans, ceiling fans, column fans and exhaust fans for all commercial voltages. These fans are made in various sizes for use on all standard commercial circuits, both alternating current and direct current.

Robbins & Myers Fans.

The fans for the season of 1911 marketed by Robbins & Myers Co., of Springfield, Ohio, include the direct-current swivel-and-trunnion desk and bracket fans, oscillating fans, of both the self-starting and gear types, and the alternating-current swivel-and-trunnion and oscillating fans of the same type.

The direct-current swivel-and-trunnion fan is known as model 15 and supersedes model 4. It is convertible into

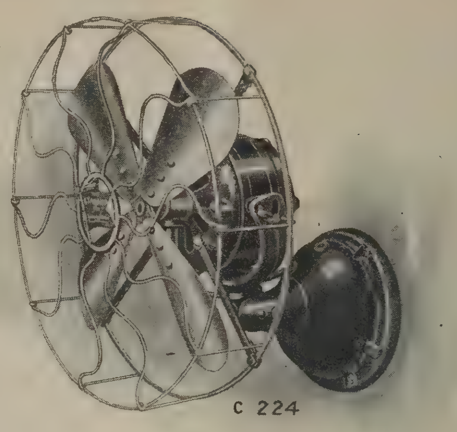


Fig. 1. Robbins and Myers Bracket Fan.

wall bracket fans without the use of an adapter. A positive, rigid, vertical adjustment of the body in different position is secured by a strong wing screw which passes through a slot in the yoke and screws into the body. The switch lever of this fan works over a cam and takes a positive position for each speed, so that it cannot bridge two contact points at the same time. The speed regulating coil is mounted on the switch base and is held by screws.

The alternating-current swivel-and-trunnion fans, known as Model W-S, is available in twelve-inch and sixteen-inch sizes. These fans are of the single-phase, centrifugal-switch, self-starting induction type and are thoroughly well designed, along the lines of the direct-current fans.

The oscillating fans of the self-starting, vane type for both direct and alternating-current are known as model 10. This fan is self-starting in all positions, as well as being convertible from a desk to a bracket fan without the use of tools or any other extra attachment. The fan is equipped with a worm-wheel operated with a thumb piece, so that the plane through which the fan swings may be adjusted by hand to a depressed or an elevated position of any angle desired. This adjustment applies to the fan used either as a desk fan or as a bracket fan. The oscillating movement will begin automatically whenever the fan is started, no matter in what position the fan may be stopped.

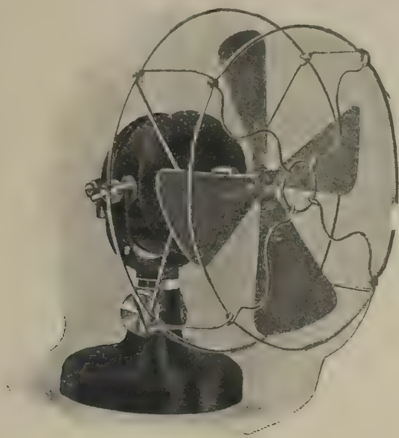
A new fan which the Robbins & Myers Company is placing on the market this year is the universal oscillating gear-type desk or bracket fan. These fans are for both alternating and direct-current and are known as Model 11. The reduction mechanism consists of a double worm and wheel train inclosed entirely in an oil-proof box and moving the fan from side to side by a crank disk and pitman operating in a horizontal plane.

The Robbins & Myers alternating-current swivel-and-trunnion desk or bracket fans are known as Model 14 and are made in twelve-inch and sixteen-inch sizes only. The general construction of these fans are essentially the same as those already described.

The New Carleton 6-inch Fan.

The Carleton Company, of Boston, known as the manufacturers of the "Imp" torch, has placed on the market its 1911 model 6-inch fan, the outcome of several years of experimenting and much investigation. This fan is primarily for desk use, but easily changed to the bracket type, the trunnion suspension permitting adjustment at any angle.

The bearings are bronze and of ample size, oil cups are generously large, the commutator is built up, with mica insulating strips punched to shape and held in place rigidly under pressure. The brushes are of carbon with core of copper, this insuring perfect conductivity and long life. The finish is of black enamel with all bright parts nickeled on brass.



Carleton 6-Inch Fan.

The amount of breeze delivered is surprising and greater than would be desirable blowing directly. The manufacturers claim that the fan is suitable for use in any place where a ceiling type fan is not required, and is well adapted for general home and office use, for picture shows, telephone booths, as a hair dryer, etc. It is practically noiseless, there is no sparking and it is furnished for A. C. or D. C. at the same price, and is also wound for seven volt battery current. The retail price is but $6.50.

Fort Wayne Electric Fans.

The line of fans placed on the market by the Fort Wayne Electric Works, Fort Wayne, Ind., for 1911 include a complete assortment of styles and sizes. The fans are designed for all standard voltages and frequencies, and while they are substantially the same in appearance as those of last season, there has been various improvements in important details.

The line includes eight-inch alternating and direct-current desk and wall bracket fans, both four and six blade; eight-inch alternating and direct-current telephone booth fans and eight-inch alternating and direct-current revolving fans; twelve-inch alternating and direct-current swivel-and-trunnion oscillating desk and wall bracket fans; sixteen-inch alternating and direct-current swivel-and-trunnion universal desk and wall bracket fans. Also a complete line of alternating-current and direct-current counter-column, floor-column and ventilating fans.

Special attention is called to this year's eight-inch fans which have a number of commendable features. They are neat in appearance, easily portable, noiseless, and give an especially efficient breeze.

Dayton Fans.

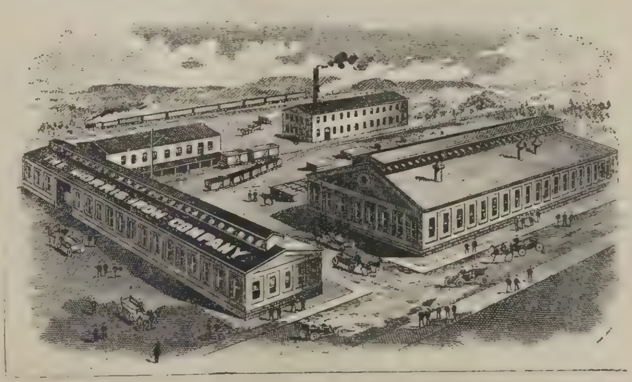
The line of fans for 1911 manufactured by Dayton Fan and Motor Co., Dayton, Ohio, consist of direct and alternating ceiling, desk, and bracket types. The desk fans include the oscillating type in 12 and 16-inch sizes, the trinity and the 8-inch universal. The trinity type is adaptable to desk or bracket use and is furnished to operate on 30, 60, 110 or 220 volts. The A. C. desk fans have two speeds, 1,500 R. P. M. and 1,300 R. P. M., with automatic starting device, and adjustable for wall use. The 8-inch universal desk fans for direct current and for alternating current are suitable for residence or small office. The blades of these fans have an angle of 30 degrees and will diffuse a strong draft of air, with arrangements for use as swivel trun-

Dayton Desk Fan.

nion or bracket swivel trunnion. Another type of fan offered by this company is the water fan. This fan will operate on line of 60 pounds pressure with a speed of 1,780 R. P. M., which is as fast as an electric fan. The fan has a one-sixteenth inch jet and with 60 pounds pressure uses 455 gallons of water in 12 hours. This fan can be used in a country residence where electric current is not available and where a water system of 60 pounds pressure can be secured.

New Plant of the Morris Iron Company.

Announcement has recently been made that the Morris Iron Company, successors to the Elmer P. Morris Company, Frederick Iron Works, and Montrose Iron Works, are reconstructing their plant at Frederick, Md., for supplying ornamental posts, castings, and out-door lighting specialties. The plant will consist of seven buildings with a total floor space of some two and a half acres and will have direct connection with the Pennsylvania Railroad and the Frederick Railway.



The sales office will remain at 98 West St., New York City, but the general offices will be installed at Frederick in a two-story building .

In addition to the line of ornamental poles, brackets, and electric light and railway fittings, this company will supply small castings, such as building columns, plain and ornamental; machine tool castings; grate bars; man-hole covers; frames and a general line of aluminum, brass, grey iron and semi-steel castings.

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.

ALBERTSVILLE. A bond issue of $7,000 has been voted for the construction of an electric light plant. The engineer is J. W. Taylor.

BAY MINETTE. The installation of an electric power plant to cost $20,000 is contemplated by the citizens. H. D. Ewing, W. H. Isabell are interested.

HUNTSVILLE. The Huntsville Gas & Light Co. has been sold to a Philadelphia corporation of which M. R. Eanine is president and W. P. Voco, secretary. The capital stock of the new corporation is $300,000.

MONTGOMERY. It is understood that Richard Tillis has secured engineers to prepare plans for the generating plant to be installed in the North Montgomery district. The proposed plant is said to be of 5,000 K. W. capacity.

MONTGOMERY. It is reported that the Montgomery Light & Power Co. is to reinforce the hydro-electric plant at Tallassee, by doubling its capacity.

TUSCALOOSA. Information is required by C. H. Rudgles as to prices on a 2 H. P. and a 7½ H. P. three phase alternating current motor.

Arkansas.

EDMONDSON. The Edmondson Electric Plant and Manufacturing Co. has been incorporated with $50,000 capital stock and will operate an electric light plant and manufacture lumber.

HARRISBURG. The Harrisburg Electric Light & Power Co. has been purchased by Morris Hayutin, and extensive improvements will be made.

HELENA. The Helena Gas & Electric Light Co. has been purchased by a Philadelphia syndicate and it is reported that improvements will be made to the extent of $350,000. A new power house will be built at once. Representatives of the syndicate are Newsburger, Henderson & Loeb.

MARTICELLO. The electric light plant, which was recently destroyed by fire, is to be rebuilt. Boilers and a 75 and 100 K. W. direct connected alternating current generator with the necessary auxiliary apparatus will be installed. It is understood that bids are asked for this equipment

SNYDER. An issue of $4,000 in bonds has been voted for the extension of water works and electric light system.

Florida.

JACKSONVILLE. The Stone & Webster Co., owners of the Jacksonville Electric Co., is preparing to expend a million dollars in improvement of the electrical property. A new power station of 2,500 K. W. capacity will be constructed and equipped and new cars will be added and extensive improvements made to the car lines.

JACKSONVILLE. It is understood that bids will be received for the machinery and equipment of an isolated power plant for an apartment store and manufacturing purposes by H. J. Klutho. Board of Trade Bldg., Jacksonville, Fla. He also desires bids on vacuum cleaning systems for stores and offices.

LIVE OAK. Bids will be received about April 1st for the construction of a $5,000 plant by C E. Jones, box 495, Live Oak, Fla. Mr. Jones is vice-president and general manager of the Live Oak Electric Light Co.

McDONOUGH. Plans have been ordered by the city for an electric lighting system. It is understood that J. B. McCrary & Co., of Atlanta, Ga., have been elected as engineers.

MICANOPY. It is reported that the installation of an electric light plant and water works system is under consideration for Micanopy.

GAINESVILLE. Gainesville is discussing a new electric light plant and has engaged an electrical engineer to look into the matter of a plant to cost approximately $50,000.

Georgia.

BARNESVILLE. It is understood that the Central of Georgia Power Co., of Macon, is to furnish power for Barnesville. The current will be brought to the city over transmission lines from the Forsyth substation.

BAXLEY. The J. B. McCrary Electric Co., of Atlanta, have submitted plans for installing an electric light plant. The proposed plant is to cost $12,000.

CARTERSVILLE. Plans are under way, it is reported, for the issue of bonds to improve electric lighting and sewerage systems.

CARTERSVILLE. The matter of an inter-urban trolley system between Cartersville and Atlanta, Ga., is being talked. If the project goes through it is expected that the Georgia Railway and Electric Co., of Atlanta, will extend their car line from Marietta, Ga.

DOERUN. The city has recently authorized the issue of $15,000 for the erection of an electric light plant.

COMMERCE. It is recently reported that development of Hurricane Falls, four miles West of Commerce, is under consideration by L. G. Hardeman, T. H. Dozier, of Atlanta, Ga., and E. W. Giliddine and J. S. Linler, of Cornelia, Ga.

CUTHBERT. The Cotton Belt Telephone Co. is contemplating the issue of $50,000 in bonds for improvement and extensions to its telephone system.

DALTON. It is understood that contracts for the enlarging and removal of the water works and electric light plant have been awarded by the council. The expenditure is to be approximately $50,000.

ELLAVILLE. It is understood that S. Edward Strange has under consideration the purchase of an electric light plant at Leesburg, Ga., and removing it to Ellaville.

FORT SCREVEN. The installation of an electric plant and lighting system for Fort Screven is announced.

HAMILTON. It is reported that plans are under way for the enlargement of the electric light plant.

MACON. Active work has begun for the formation of a company to build and operate a $200,000 hotel on the corner of Third and Cherry Streets. It is understood that Architect Stoddard, of New York, is conferring with the management in regard to the necessary structure required.

MARIETTA. The city council has ordered an election to be held May 1st for the purpose of voting on $20,000 for electric lights and $15,000 for sewerage tanks and water works.

OGLETHORPE. The city is discussing the installation of water works and electric light system. The mayor can give other information.

SAVANNAH. It is understood that the "great white way" of Savannah is now to be extended on Whitaker Street. Broughton Street, the main thoroughfare, has now the system its entire length.

SYLVANIA. J. B. McCrary & Co., of Atlanta, has drawn plans for a new water works plant. It is understood that the city has taken over the Sylvania Water Supply Co.

WAYCROSS. It is understood that an agitation for a great white way is going on in Waycross.

WASHINGTON. The Washington Telephone Co. has plans under way for improvement to its system to the extent of $2,500. The general manager is W. A Slaton, and give other information.

Kansas.

DODGE CITY. Bids to the extent of $25,000 have been voted by the city for the construction of an electric light plant and sewerage.

KANSAS CITY. The city has voted $350,000 in bonds for a municipal light plant. The commissioner of light is J. A. Cable and can give othere information.

Kentucky.

BOWLING GREEN. It is announced that the board of public works desires bids on engines and pumps for the electric light plant. It is understood that the machinery will cost approximately $8,000.

CLINCHFIELD. According to reports the Clinchfield Coal Corporation has plans under way for the construction of a $500,000 electric power plant.

FRANKFORT. Prices are desired by L. L. Oberwarth on electrical wiring and telephones.

GRAYSON The capacity of the Home Light Company's plant will be increased by additional generating equipment. It is understood that boilers are also to be installed.

GREENVILLE. Reports state that J. L. Rogers has purchased the Elkhorn Consolidated Coal and Coke Co. An electric power plant to operate coke ovens will be installed.

HICKMAN. The Hickman Ice and Coal Co., is to add an electric plant to their works. It is understood that one 150 K. W. alternating current generator is to be secured.

JEFFERSONTOWN. It is reported that a lighting company which will be given a twenty-year franchise will be formed at once and will spend $15,000 installing a plant. Further information can be obtained from the commercial club.

LA GRANGE. An electric light franchise has been recently granted to the Lewisport Electric Light Co., and it is understood that bids are to be open April 1st for the installation of generating equipment. J. C. Emmick is manager of the company.

LOUISVILLE. The Kentucky Electric Co., it is understood have arranged plans for the construction of a $500,000 power plant. Sargent and Lundy, of Chicago, are said to be consulting engineers, and Lewis Streng the engineer for the Kentucky Electric Co.

MAYSVILLE. A company has been formed known as the Maysville Public Service Corporation with a capital of $150,000 to take over the gas and electric light and street railway properties. It is understood that the electric light plant will be enlarged by additional machinery.

RICHMOND. The capital stock of the Richmond Electric and Power Co. has been increased and it is understood that improvements will be made.

WHITESBURG. Arrangements have been completed for the construction of an electric light plant at Whitesburg. The site for the power house has been purchased and work is expected to begin at once.

Louisiana.

GRETNA. It is reported that the construction of an electric railway from Gretna to Avondale is under consideration. It is further understood that a power house will be located in this vicinity of such a capacity as to furnish power for commercial lighting and motor loads.

Missouri.

MONNET. Plans have been prepared for an electric light plant by Rollins and Westover, Kansas City, Mo.

ST. LOUIS. The Board of Public Works is to install an isolated plant i nthe city hall at a cost of $70,000.

ST. LOUIS. A factory building 75 by 125 feet, four stories high, is to be equipped with lighting system and electric elevators. The company is to be known as the Star Bucket Pump Co. of St. Louis, Mo.

Mississippi.

BOYLE. It is understood that an electric power plant is to be installed by N. E. Pitre and that he desires information on equipment.

BYHALIA. The city council contemplates the installation of an electric light plant and water works system, bonds for which will be issued to the amount of $10,000. The mayor is C. M. Hendrick, and other information can be obtained from him.

GULF PORT. It is understood that the Gulf Port and Mississippi Coast Traction Co. will place contracts in the next two weeks for the erection of a high tension, three phase, 13,200 volt transmission line 15 miles in length. The general manager of the company is W. F. Gorenflo, of Gulf Port, Miss.

LAUREL. The Laurel Light, Heat and Power Co. has recently been incorporated with a capital of $30,000 by J. T. Pullen, of Laurel, and R. J. Young, of Jackson, Miss.

McCOMBS CITY. It is understood that the city council is considering the installation of an electric light plant.

NEWTON. It is understood that the city has voted bonds to the extent of $11,000 for the installation of an electric light plant in connection with water works. The supervising engineer is said to be X. A. Kramer, of Mongolia, Miss.

TAYLERTOWN. It is understood that the city council is considering the installation of an electric plant and water works system for Taylertown. X. A. Kramer, of Mongolia, Miss., is to act as engineer.

TUPELO. A bond issue of $50,000 has been voted by the city for improvements in electric light plant. Further information may be obtained from C. E. Goodlet.

North Carolina.

CHARLOTTE. Work is to commence at once on the proposed Inter-urban Railway system by the Piedmont Northern Railway Co. The road will link the towns, from Anderson, Spartanburg, Greenville, S. C., to Charlotte and on to Salisbury, High Point and Greensboro, and perhaps to Durham and Winston-Salem. The road will cost in the neighborhood of $10,000,000 and both freight and passenger business conducted.

LENOIR. It is understood that the Lenoir Chair Co. will equip its new factory with electric drives.

LEXINGTON. It is understood that the city will vote about April 1st on granting a franchise to the Lexington Light and Power Co., to furnish electric lights to Lexington. The mayor can give other information.

RUTHERFORDTON. An issue of $35,000 in bonds has been voted on for the construction of a water works system and electric light plant.

SMITHFIELD. At a recent election, $55,000 in bonds was voted for the installation of a water works system, electric light plant and sewerage system. Gilbert White, of Durham, N. C., is engineer in charge of the work, and H. L. Skinner is town clerk.

SUMTER. Prices are wanted on water, electric and gas light supplies by G. S. Jackson, manager of the Jackson Water Works Co.

WILMINGTON. It is understood that R. W. Hex, Jr., desires catalogues and prices on electrical fixtures for an apartment house.

WINSTON-SALEM. The Norsleet Hardware Co. desires manufacturers to send catalogues of gas, electric and combination fixtures.

Oklahoma.

BARTLESVILLE. The prices on an isolated plant equipment for a hotel to cost approximately $100,000 is desired by J. H. Bullen, of this place.

CHICKASAW. It is reported that the Chickasaw Cotton Oil Co. is in the market for machinery for an electric light plant. The superintendent of the company is R. G. Latting, and will receive communications.

DURANT. It is reported that $17,000 has been authorized by the city for the construction of an electric light plant. The superintendent can give other information. H. C. Lent is the engineer in charge.

WAUKOMIS. It is reported that work is soon to commence on the construction of an electric light plant for which citizens have recently voted.

WOODSBURG. This place has under consideration the issuing of $30,000 in bonds for a lighting plant.

South Carolina.

COLUMBIA. A municipal lighting plant is under consideration for the city to cost approximately $40,000. Councilman W. S. Steiglitz can give further information.

DILLON The electric light commission will soon begin the erection and installation of an entirely new electric light plant. Bonds were voted last summer to the amount of $15,000 for this purpose and the present property is valued at $7,000, giving the commissioner about $22,000 to put into a new plant. The commission is composed of A. J. P. Cunningham, E. D. Elliott, and M. A. Stubbs.

GREENVILLE. It is reported that the work on the new inter-urban line of this section has been started. Stewart & Jones, of Baltimore, is the contracting firm doing the work. It is understood that the terms of the contract give 120 days for the building of the line between Charlotte and Kings Mountain.

ORANGEBURG. It is understood that Orangeburg is to have a "great white way" and that work has begun on the installation on the first of the system.

WALTERBORO. It is recently reported that an electric light plant project is being supported by J. D. Grover, G. A. Brown, G. J. Blanchard.

Tennessee.

AUSTIN. An investigation has been carried on by C. J. Hardy of the firm of Ford, Bacon and Davis, of New Orleans, to determine a suitable situation for the construction of a dam across the Colorado River and the installation of a hydro-electric plant.

BIG SANDY. An electric light plant is under consideration by the authorities at this place.

CHATTANOOGA. It is understood that a $35,000 apartment house three stories and basement will be erected by Geo. T. and T. E. Hall. The building will be equipped with steam heat, gas and electric lights. Plans have been drawn by C. G. Barnwell and C. T Jones, of Chattanooga.

CHATTANOOGA. According to proposed plans an electric power plant is to be installed together with improved hot blast stoves by the Citico Furnace Co.

COAL CREEK. The Coal Creek Electric Light Co. is planning to erect an ice plant and laundry.

JACKSON. The city is to construct and equip an electric light plant. R. L. Beare is in charge of the work for the city.

JACKSON. It is understood that the city council is interested in ornamenting street lighting fixtures for the business section. R. L. Beare is chairman of the committee.

KNOXVILLE. It is understood that the Dirby Coal Mining Co. is in the market for direct current generators and motors. C. H. Thompson is manager of the company.

LYNNVILLE. The Lynnville Mill and Elevator Co. is to install an electric light system. It is also reported that this company is to remodel an old mill and install new machinery.

MANCHESTER. A bond issue of $20,000 has been authorized and preparations are being made to erect an electric light plant and water works.

MEMPHIS. According to reports, the Ocodee Gas Engine Co., of Beloit, Wis., is to establish a plant at Memphis.

MEMPHIS. A municipal electric light plant is under consideration. Officials, it is understood, are inspecting and investigating plants of other cities for information on the subject.

NASHVILLE. It is understood that the Nashville Railway and Light Co. is to install a new steam turbine and make other improvements to their system.

SHELBYVILLE. According to reports J. F. Boyd, of the local electric light company, will install a new 500 K. W. turbine early in the summer.

Texas.

ALVIN. A water works plant and distributing system and also an electric light and ice plant will be installed by H. P. Rhodes, Houston, Texas.

CRYSTAL CITY. An electric light and ice plant is being installed by E. C. Robinson, St. Louis, Mo.

FORT WORTH. According to reports the Stone & Webster Syndicate, of Boston, has completed arrangements to construct an inter-urban railway between Fort Worth and Cleburne and is ready to begin construction as soon as the right of way has been provided by the citizens. The equipment is said to be similar to that used on the Dallas-Fort Worth inter-urban road.

FLATONIA. The Flatonia Ice, Water and Electric Light Co. is installing a new power plant to provide electric lights for the town of Flatonia.

GEORGETOWN. About $35,000 will be expended in improvements on the municipal water and light plant. New generating equipment will be installed and other improvements made.

LOCKHART. The Lockhart Water Works and Power Co. is installing a new ice manufacturing plant and will also install motors and other equipment in the power plant.

MISSION. The company has been recently organized with a capital stock of $60,000 known as the Mission Cotton Oil Co. This company will establish a cotton seed oil mill, a water works plant and distributing system and also an electric light plant at Mission.

RAYMONDSVILLE. Plans are under way for the installation of a water works an delectric light system for Raymondsville. It is understood that S. L. Gill and James Lagro are interested.

SAN ANTONIO. Reports state that $35,000 will be expended in remodeling the power plant of the San Antonio Gas & Electric Co. Boilers and machinery will be installed in the gas plant also at an approximate cost of $58,000. Extensive improvements are also planned for the street car lines.

TEXAS CITY. The Texas City Electric Light & Power Co. has been incorporated with $100,000 capital stock by R. C. Trube, F. N. Danforth and William Dossett.

WACO. A bond issue of $250,000 has been voted for the erection of a municipal electric light and power plant. The plans will be prepared immediately and the work started as soon as the bonds can be issued and sold.

Virginia.

ELKTOWN. W. H. Marshall reports that he desires prices on electric motor.

RICHMOND. The construction of an overhead distribution system for the municipal electric plant is under way. It is reported that the city engineer is securing estimates on the system. E. W. Traford is the engineer in charge and can give other information.

RICHMOND. An apropriation has been adopted by the council for the extension of lights on Broad street. The appropriation is stated at $9,000.

WAVELEY. A bond issue of $7,000 has been voted for the construction of an electric light plant.

Book Reviews.

EXPERIMENTAL ELECTRICAL ENGINEERING AND MANUAL FOR ELECTRIC TESTING. By V. Karapetoff. Published by John Wiley & Sons, New York, N. Y. Second edition revised and corrected in two volumes. Price bound in cloth, Vol. 1, $3.50; Vol. 2, $2.50.

The work, Experimental Electrical Engineering and Manual for Electrical Testing, was prepared by the author principally as a laboratory manual for general electrical engineering work in colleges. The first edition proved that its conception was based upon a thorough understanding of the demand of students and electrical engineers in general, as the work has been successful not only in connection with the author's own instruction but by others in various places. The work is not only a manual for engineering students, it is a reference text covering broadly the field of electrical engineering. The important and complete theory of various apparatus is treated separately from the experimental directions to be carried out when performing tests.

In the new edition the original volume has been divided into two. Vol. 1 contains all of the elementary and fundamental measurements and the principal experiments and tests of direct and alternating current machinery. Vol. 2 contains comparatively advanced and special tests suitable for more advanced students. This work by one of the foremost engineers and teachers in electrical engineering, is in a class by itself. There is no other work of exactly the same design and covering exactly the same ground. To the electrical profession in general, it is not necessary to recommend this work other than to say that the first edition of the book received comments from nearly every electrical journal in the country and abroad and has been accepted by the foremost engineers and educators as complete, thorough and original in every detail.

THE ELECTRIC CIRCUIT. By V. Karapetoff. Sold by Corner Book Stores, Ithaca, N. Y. Price, $1.50. Prof. Karapetoff's work on the electric circuit is a companion pamphlet to the magnetic circuit and is intended to give the student of electrical engineering the theoretical elements necessary for calculation of the performance of dynamo-electric machinery and transmission lines. The subjects treated are presented in a clear concise manner characteristic of other works by this author. Beginning with the elements of direct current and alternating current circuits, the work develops into a carefully outlined analysis of the complex quantities found in alternating current systems. For the engineer who desires to have at hand an authority on the elementary theory of alternating current systems, we heartily recommend this work.

IGNITION HANDBOOK. By H. R. Van Deventer. Price, 50 cents, bound in paper. This handbook is a common sense treatise describing electric ignition systems for internal combustion engines. It takes up modern ignition equipment for high and low tension systems and the methods of installing and operating same. The book is carefully illustrated and numerous details gone into in a very clear and interesting manner. Those who are using magnetos for ignition of internal combustion engines will find much of value in this book.

DATA. Publication office, 92 LaSalle St., Chicago, Edward Wray, Managing Editor. Subscription $1.00 per year. Monthly. Beginning with September, a monthly publication known as DATA, devoted exclusively to engineering information, has been published at the above address. The name DATA fittingly applies to this publication, due to its nature and make up. Further than being a monthly publication, it is arranged so that it can be converted into a convenient and valuable card system. The pages are 3 x 5 arranged with headings in such a way that the material can be filed by subjects. We heartily recommend this publication to every engineer who values information and data in condensed form and endeavors to keep this information revised to date. The publication covers an extensive field and the information which has been presented since the September issue indicates that it is to fill a large place in recording engineering information.

Personals.

EDWARD H. BUSSEY, who has recently succeeded M. S. Allen as telephone sales manager for the Atlanta house of the Western Electric Company, is a native Georgian, having been born and reared in Cuthbert, Southwest Georgia. During his boyhood, Mr. Bussey was attracted by "the Voice of the Wire," and accordingly spent his spare time and vacations as operator, instrument setter and trouble shooter of the local exchange in Cuthbert. The benefit of a technical course at the Georgia School of Technology, where first honor was awarded him, was his. After graduation, he was fortunate enough to secure an appointment to a student's course in the engineering department of the Southern Bell Telephone and Telegraph Company. After twelve months student work, Mr. Bussey was assigned a regular engineering inspector's place and for two years was employed as a specialist in standardizing the methods and material used by the Southern Bell Company.

Edward H. Bussey.

Having previously come in contact with practically all branches of the telephone industry except the commercial, an opportunity for gaining this experience presented itself in the shape of an offer as General Manager of the Georgia-Alabama Telephone Company at Cuthbert, Georgia, which was accepted. While in that position, the Western Electric Company, realizing that Mr. Bussey was familiar with all branches of the telephone art, offered him a position as sales engineer for the Atlanta house, and the offer was accepted. His thorough familiarity with his specialty and acquaintance throughout this territory fits him splendidly to assume the responsibilities of his new position as telephone sales manager in the Western Electric organization.

H. S. GIBBS, who for several years has been connected with Southern manufacturing industries, advises that he is now in a position to act as Southern representative for a reliable Eastern or Western house. Mr. Gibbs' address is 617 Pacific Electric Bldg., Los Angeles, California.

Industrial Items.

THE NEW YORK INCANDESCENT LAMP CO., of 134 West 14th Street, New York City, has been incorporated with a capital stock of $150,000 to manufacture carbon and metal filament incandescent lamps. The officers of the company are G. A. Pfizer, of Paris, France, president; Charles Pfizer, of the Charles Pfizer & Company, chemical manufacturers of Maiden Lane, New York City, vice-president; F. F. Lyden, of the banking house of Wasserman Bros., 42 Broadway, New York City, secretary and treasurer; and E. W. Boyce, electrical engineer and general manager. Mr. Lyden has, for a number of years, been well known throughout the South, and is a son-in-law of Dr. Henry L. Wilson, of Atlanta, Ga.

The central location of the company, to all railroad and steamship lines from New York City, combined with the large stock of standard lamps that they carry, should prove to be advantageous to buyers who desire prompt shipment. This company believes strongly in the possibilities and future of the South and will make a specialty of introducing their goods to Southern buyers and assisting them with illuminating problems.

FLOUR CITY ORNAMENTAL IRON WORKS, Minneapolis, Minn. This company calls attention to the resistance which the Corinthian design of their decorative lamp posts offered to the recent fire in their city. The posts were stationed on the sidewalk around the entire block which was the center of the intense heat. This resistance to expected ruin of the decorative lighting system of the city, saved a considerable sum in the repairs to same, and gives an idea of the substantial features of the posts.

THE RAIL JOINT COMPANY advises that since March 1, 1911, the address of the company's office in Chicago has been Room 215, Railway Exchange building. All friends and customers are asked to note this change and correct address formerly used.

THE FORT WAYNE ELECTRIC WORKS, Fort Wayne, Ind., announce the appointment of Sam A. Hobson, formerly with the Wesco Supply Co., as manager of the St. Louis office.

H. M. BYLLESBY & CO., of Chicago, has published in pamphlet form the address of Arthur S. Huey, vice-president of the company, delivered before the second annual convention of the organization in January of this year. The subject treated is "The Ethics of a Franchise," and is a valuable, interesting and liberal conception of the whole situation. The key note struck by Mr. Huey was that the utility corporation should look upon a franchise as a trusteeship to be administered in the interests of the people as well as the company.

THE VICTOR ELECTRIC CO., Chicago, Ill., expect to move about May 1, into larger and better quarters at the corner of Robey Street on Jackson Boulevard, the building being known as the Victor Electric building.

The company now occupies the entire second and third floors of the north section of the building at 55 to 61 Market street. The officers of the company are: Charles F. Samms, president; Julius B. Wantz, secretary. The company's new building is to be 90 by 130 feet in ground area, with four stories and basement, and will cost $70,000. The entire space will be occupied by the Victor company.

Trade Literature.

THE RENEW LAMP CO., of Boston, is now represented in Cincinnati by F. J. Norris with offices at 1810 First National Bank building. Mr. Norris will have charge of their business in Southern Ohio, Southern Indiana and Kentucky where their business has shown a material increase during the past season.

JAMES G. BIDDLE, Philadelphia, Pa. The following catalogues have been received descriptive of electrical and scientific apparatus handled by this company: Meggers and Bridge-Meggers; Frahm Resonance Frequency Meters; The S. H. Standardizing Set for standardizing A. C. and D. C. Instruments; Tachometers, electrical, centrifugal, and vibration types; The "S-H" Precision Transformers for Current and Potential and the S.-H. Precision wattmeters for use with transformers. The bulletins devoted to meggers and bridge-meggers takes up the Evershed megger describing in detail its construction, operation and application. Special directions are given for using the instruments for testing insulation resistance of D. C. motors and dynamos, explicit directions being given and diagrams of circuits. All of the above named bulletins are well illustrated and contain valuable and useful information on the subjects treated.

BETTS & BETTS CO., New York, has recently issued catalogues No. 61 and No. 62. No. 61 describes color caps manufactured by the company to be used on signs to give color effects. The catalogue illustrates various types of signs showing effects produced. Bulletin No. 62 describes various types of flashers manufactured by Betts & Betts Co., giving numerous illustrations of not only flashers but types of signs which they operate. The bulletin is complete in every detail and gives much information of interest to central stations and contractors.

THE DAYTON FAN AND MOTOR CO., Dayton, Ohio, has recently issued and circulated their fan motor bulletin. This bulletin takes up several types of direct and alternating current fan motors giving complete information and details of construction. The types include ceiling fans, desk fans for A. C. and D. C. circuits, wall fans, and oscillating desk fans. Another type of fan treated is the water motor fan. This fan is operated from a water main at 60 pounds pressure, the speed of 12-inch blades being 1780 r. p. m.

THE DISPATCH MFG. CO., Minneapolis, Minn., manufacturers of the Dispatch electric oven, has issued booklets descriptive of this apparatus. These ovens are especially designed for laboratories, bakeries, etc.

THE FORT WAYNE ELECTRIC WORKS. Among the attractive fan motor bulletins recently distributed by various manufacturers of fan motors displaying and describing the offerings for 1911, the Fort Wayne Electric Works have one of the most unique productions both in design and make up. The cover is of white material upon which the name Fort Wayne Electric Fans with the Fort Wayne trade mark is embossed. The 26 pages contained in the bulletin are devoted to the different types of fans, many of which are of new design. The fans are built for operation on standard voltages and frequencies and include the desk, bracket, ceiling and other types of standard designs.

WESTERN ELECTRIC CO. The fan motor bulletin for 1911, published recently by the Western Electric Co., contains besides the number of standard fans which this company has offered in previous seasons, a number of new designs. In addition to the six blade residence fans for alternating current furnished last year, this type is offered for direct current. A 32-inch direct current ceiling fan is also offered and 12 and 16-inch exhaust fans. The bulletin completely described the various types before placed on the market as well as the new types for 1911. The Hawthorn fans are designed for every condition of service and include all the standard types for home, office, factory, hotels, etc.

THE CUTLER-HAMMER MFG. CO., Milwaukee, Wis., has recently published a folder entitled "The Thomas Meter." This meter is a new product invented by Prof. Carl C. Thomas, of Wisconsin University. The meter is intended for indicating, integrating, or graphically recording the quantity of flow of gases including air at any pressure and at any temperature independent of fluctuation of pressure or temperature. The operation of the meter depends upon the principle of adding electrically a known quantity of heat to the gas and determining the rate of flow by the rise in temperature of the gas between inlet and outlet of the meter. The bulletin takes up in detail the features of construction, the operation and application of the meter. Information will be furnished upon request by the company.

H. W. JOHNS-MANSVILLE CO. Catalogue No 407 taking up the subject of J.-M. Linolite System of Lighting, is being circulated. The bulletin is neatly printed in colors and the method of treating the subject is such as to give a clear idea of the construction application and use of the Linolite light and reflectors. The system is shown for use in illuminating show cases and show windows.

SEMCO VACUUM CLEANER CO., of Nashville, Tenn., has interesting literature on the Semco Vacuum Cleaner. This cleaner has only one moving part, namely, the revolving part, which creates the suction. The dust is collected in a large bag and the machine is well adapted to all kinds of cleaning such as carpets, draperies, etc. Information will be sent on request to the company.

THE AMERICAN ELECTRIC HEATER CO., Detroit, Mich. Catalogue No. 25 has been received descriptive of the current consuming devices manufactured by this company. These devices include electric irons, disk stoves, percolators, electric radiators, curling iron heaters, soldering irons, glue pots, etc. Bulletin contains 100 pages and is well illustrated containing complete information in regard to the construction and current consumption of the different devices.

THE ELECTRIC FIRELESS COOK STOVE CO., Buchanan, Mich. This company has recently circulated literature descriptive of their cabinet and range electric cook stove. Literature contains interesting information and data on the cost of operating the stoves as well as a price list for the various types and sizes.

THE BISSELL MOTOR CO., 226 Huron St., Toledo, Ohio, has issued a folder descriptive of the Bissell motor used on sewing machines. The Bissell motor operates in the position of the driving wheel on the head of the machine and can be used on the drop head machine as well as any other.

VULCAN ELECTRIC HEATING CO. has issued circulars showing electrical soldering and branding devices and electric curling irons. These tools are very desirable for introduction by Central Stations, because they can be used in large quantities, make heavy aggregate consumption during the most desirable hours of the day while at the same time recommending themselves to the users because they will save them money in operating their plants.

THE BIRTMAN ELECTRIC CO., 12 N. Clinton Street, Chicago, Ill., the manufacturers of the Bee Suction Cleaner, has issued literature descriptive of their apparatus. Their small booklet entitled "The Bee Suction Cleaner and Renovator," gives complete information on the design and uses of the device as well as a price list of the complete outfit and parts.

WESTINGHOUSE ELECTRIC & MFG. CO., Pittsburg, Pa. Among the electrical manufacturing companies circulating extensively, literature intended to increase the off peak load of central stations, this company is one of the first. The line of apparatus manufactured and exploited includes small motors and heating devices of all types and for all purposes. The Westinghouse general utility motor is one of the most prominent features of the small motor line, this motor being designed so as to be operated on various devices about the home. The motor can be applied to the sewing machine, buffler, exhaust blower, grinders, small lathes, etc. This company has also placed in the market for the season of 1911 an extensive line of fan motors for office, residence and store use.

DIEHL MFG. CO., Elizabethport, N. J., through several bulletins has announced a line of ceiling and universal electric fan motors for the 1911 season. The bulletin is known as No. 24 and includes various types and designs of fans. It also gives price list and various details as to the design. This company is circulating literature descriptive of the Diehl motors for driving sewing machines and the Diehl motors for exhaust fans. The motors for driving sewing machines are manufactured for alternating current and also for direct current, in sizes from 1/25 to 1/5 of a H. P. and for operation on 110 and 220 volts.

ILG ELECTRIC VENTILATING CO., of Chicago, has circulated numerous bulletins taking up the Ilg fans and blowers. A feature of the literature turned out by the Ilg Electric Ventilating Co. is the large amount of valuable data included. This data is arranged in tables and is very useful in the determination of not only the sizes of fans and blowers but in computations involving air pressure and velocity and the action of air under various temperatures, etc. The complete bulletin contains 72 pages and illustrates a number of types of different designs of fans and blowers.

THE EMERSON ELECTRIC & MFG. CO., 2024 Washington Ave., St. Louis, Mo. This company is prepared to furnish upon request a bound volume containing the various bulletins of the company descriptive of single phase induction motors, multiphase induction motors, direct current induction motors, electric forge blowers, electric furnace blowers, direct connected exhaust fans, dentists and jewelers lathes, buffing and grinding lathes, sewing machine motors, washing machine motors, and special motors for special purposes. The bulletins contained in this volume give complete information on the motors of the various headings given and is indexed in a way which makes the volume a handy reference to small motors of various designs for different purposes.

BARNES MFG. CO., Susquehanna, Pa. Descriptive of the Barns variable speed motor, this company has issued a bulletin and several circulars. The bulletin takes up the details of construction of the Barnes electric motor for both alternating and direct current. The motors are manufactured in two sizes, 1/12 and 1/8 H. P., and are suited to office use and operating dental instruments.

THE HOLZER-CABOT ELECTRIC CO., of Boston, Mass. A complete file of bulletins from the Holzer-Cabot Electric Co. has come to hand and a number of new bulletins are included descriptive of direct current motors and dynamos, plating dynamos, poly-phase alternating current motors, single-phase alternating current motors, and elevator motors. The bulletin gives interesting information in connection with the construction and operations of the motors, numerous illustrations also being given to show methods of connection and features of construction.

ELECTRO-MAGNETIC TOOL CO., of Chicago, Ill. Bulletin No. 2, descriptive of Model No. 5 electric hammer for drilling concrete brick and stone has recently been received. The bulletin contains 16 pages and takes up the various features of the electrically driven drill showing illustrations of the various work which has been performed by them.

THE A. L. SYKES MFG. CO., 129 East Pearl St., Cincinnati, Ohio. Literature has recently come to hand that this company is circulating among central stations and possible buyers of the Quad electric stove and fireless cooker. This literature is in the form of direct letters and presents arguments by which the reader is informed of the service which can be rendered by the Quad electric stove. To the central station, day load arguments are presented and the profit of handling the stove is plain.

THE ECONOMY ELECTRIC CO., 217 Fulton St., Brooklyn, N. Y. Literature descriptive of what is known as the Economy high efficiency electric arc lamp, has recently been issued by this company. The arc lamp is designed for outdoor and in-door use and for multiple on direct or alternating current.

PNEUVAC CO., Blakes Bldg., Boston, Mass., has issued interesting literature descriptive of the Pneuvac electric vacuum cleaner. This cleaner possesses many interesting features. For this cleaner there is claimed frictionless mechanism, powerful vacuum and immense displacement of air. Literature will be sent upon request.

NEW YORK ELECTRIC TOOL CO., 136 Liberty St., New York City. A bulletin has been received descriptive of the portable electric drill, reamers, bench grinders, buffers and other special electrically driven tools manufactured by this company. The bulletin shows numerous illustrations of these tools and gives complete information as to construction and operation.

THE FLOOR SANDING & POLISHING MACHINE CO., Philadelphia, Pa., is advertising floor polishing machines through attractive literature in the way of folders and booklets. The machine itself is a very simple device, composed of a carriage having propelling wheels and a motor mounted on the carriage, and abraiding roll is placed in front of the motor covered with sandpaper or other abrasive material. The machine is propelled by its own power and only requires guiding to operate it. Power is obtained from any electric circuit and the machine operated very economically.

QUARTZ LIGHT CO., 1109 Locust Street, Philadelphia, is circulating interesting information on electric radiators. The radiators are the invention of C. O. Bastian and present many interesting features. They consist of glowers or quartz tubes containing spiral wires. As the quartz is transparent to heat, the heat from the red hot spirals passes through the quartz making the radiator an economical method of heating. The radiators consume 750 watts and the elements last from 2,000 to 3,000 hours.

THE A. J. SEAR CO., manufacturers and specialists in power coffee mills and meat choppers, has an illustrated catalogue descriptive of their products containing useful information and data on these devices to those interested.

THE PROMETHEUS ELECTRIC CO., of 236 East 43rd St., New York, have recently forwarded catalogue descriptive of their current consuming devices. These devices include food and water warmers, water kettles, chafing dishes, toasters, electric ranges, plate warmers, air heaters, curling iron heaters, electric irons, glue heaters, sterilizers, etc. The bulletin contains information descriptive of these products as well as the different capacities and current consumption of each.

VORTEX VACUUM CO., Watertown, New York and Boston, Mass., is circulating a bulletin descriptive of Vortex electric suction cleaners. The cleaner is designed for electric motor operation and also hand operation. Its construction is very simple and its operation effective in all kinds of cleanings about the residence or office.

MANHATTAN ELECTRICAL SUPPLY CO., Jersey City, N. J., and New York, 17 Park Place. Literature has been received from this company descriptive of a complete line of current consuming devices. The line includes latest designs of percolators, chafing dishes, electric cookers, electric irons, heating pads, toasters, disk stoves, glue pots, etc. The company also handles a fan operated from a battery. Information in regard to their electrical devices will be sent upon request.

ROSENFIELD MFG. CO., 585 Hudson St., New York. A folder descriptive of the Magic electric suction cleaner manufactured by this company has recently been received. This cleaner is simple in construction, the suction fan being driven by a motor and the whole machine mounted on two wheels, guided by a handle. The dust is collected in a bag attached to the cleaner. The device is effective in cleaning carpets, rugs, and other fabrics.

CADILLAC ELECTRIC MFG. CO., Cadillac, Mich. Folders descriptive of an electric stove and toaster are published by this company illustrating and describing a small electric stove for use in a sick room or on the dining table It is designed for two heats and is very effective in keeping food warm and for light cooking.

THE TREGONING ELECTRIC MFG. CO., of Cleveland, Ohio, has issued a 36-page catalogue descriptive of electrical specialties. The catalogue although small in size, contains information and illustrations of all the products manufactured by the company as well as the list prices.

THE STONE & WEBSTER ENGINEERING CORP., of Boston, Mass., has reprinted from the Electric Railway Journal and bound in booklet form the description of the Seattle Railroad. The booklet is well illustrated with views showing construction features of road bed and equipment.

THE WESTERN ELECTRIC COMPANY announce that the 1911 Fan Motor bulletin is now ready for distribution. This is listed in the series of publications of that company as bulletin No. 5352. It is contained within a stiff cover of bluish gray, with an attractive design. This bulletin lists "Hawthorn" Fan Motors under the following heads: Desk and Bracket, Oscillating, Residence, Telephone Booth, Battery, Ceiling and Column Fan Motors and Ventilating Outfits. Illustrations and tables of prices are given for each type. A copy of this bulletin will be forwarded upon request addressed to any of the Western Electric houses.

THE HARLEY MACHINE & MFG. CO., of Springfield, Mass., is circulating a booklet descriptive of the Harley Adjustable Electric Light Fixture for use in factories, offices and laboratories.

THE ENGINEERING DEPARTMENT OF THE NATIONAL ELECTRIC LAMP ASSOCIATION has sent out bulletin number 15, on Electric Sign Lighting. The bulletin contains valuable data on performance, economy, equipments and applications of mazda and carbon sign lamps.

THE FORT WAYNE ELECTRIC WORKS, Fort Wayne, Ind., has recently issued a bulletin describing a new electric rock drill recently placed on the market. This rock drill is the result of several years development and experimenting under the most severe conditions of actual working to which such machines are subjected. The bulletin gives illustrations of the rock drill and a complete description. The bulletin will be sent to those who request it from the company.

BANNER ELECTRIC CO., the illumination of the magnificent new Allegheny County Soldiers' Memorial of Pittsburg, Pa., is illustrated and described in an attractively executed booklet just issued by the Banner Electric Company of Youngstown, Ohio. This publication will be of especial interest to electrical and illuminating engineers, owing to the fact that the edifice in question is considered by many to be the most perfect example of artificial illumination in the world. Printed on smoked rhododendron coated paper, with embossed covers, silk stitched, and illustrated with seven views in full color as well as with a number of small thumbnail sketches, the booklet itself presents an artistic and distinctive appearance that is quite in keeping with the illumination which it describes.

THE BOSSERT CO., Utica, N. Y., has recently issued a folder descriptive of Bossert boxes. These boxes are especially designed for open conduit work and when porcelain covered make a very good outlet for drop cords and arc lamps. They are also used for stage and window lighting.

THE STEEL CITY ELECTRIC CO., is circulating bulletin C, describing the universal insulator support. These supports are of malleable iron and are used as clamps for securing insulators to exposed steel frame work for wiring mills, foundries, factories, shops, and similar structures where steel framework is exposed. They are easily attached to steel frame work and by their use electric wiring for arc lamps, motor, dynamo and cranes, etc., can be installed without much difficulty.

THE ALLIS-CHALMERS CO., has issued bulletin number 1446 superceding bulletin 1506 taking up electric hoists. In this bulletin, the various types of hoists manufactured by the company are described. The bulletin is divided into two sections, one taking up the mechanical features and the other the electrical features. Considerable data on the installation of hoists is given and explanations of the operation and requirements.

THE REYNOLDS ELECTRIC FLASHER MFG. CO., of Chicago, Ill., has recently issued a pamphlet descriptive of Reco Script Type Flasher and Reco Chaser Type. The folder presents information in regard to the wiring of different designs with which these flashers may be used.

THE CONNECTICUT TELEPHONE & ELECTRIC CO., Meriden, Conn., has recently received from the press, catalogue number 21. This catalogue contains 32 pages descriptive of intercommunicating telephones for interior use. The various types of instruments are carefully explained and illustrated, the parts being shown and directions given for installation and operation. Considerable space is given to wiring diagrams showing possible arrangements of the various systems.

THE DE-LAVAL STEAM TURBINE CO., of Trenton, N. J., is circulating a 120 page catalogue descriptive of De Laval steam turbines of the single stage type. The catalogue is known as A and presents a discussion of the practical thermodynamics of the steam turbine and of the bearing of the various types of construction upon ultimate efficiency. Numerous illustrations of turbine applications in driving alternating current and direct current generators, pumps, blowers, etc., are presented. The low and mixed pressure turbine for operation on exhaust steam in industrial plants is also treated in this catalogue.

THE GENERAL ELECTRIC CO., has issued the following bulletins covering railway equipment. A reprint of the description of the Washington, Baltimore, Indianapolis, 1200 volt D. C. railroad presented in the General Electric Review, is published in bulletin form known as No. 4808. Bulletin No. 4798 takes up the General Electric straight air brake equipment. From the power and mining department of the General Electric Co., bulletin No. 4810 taking up portable and stationary air compressor sets has also been issued.

THE ALLIS-CHALMERS CO., has issued a reprint of bulletin No. 1510 descriptive of the Allis-Chalmers Direct Connected Reynolds Corliss Engine for heavy duty. Bulletin contains illustrations and descriptive matter on the engine taking up its use together with direct connected generators. Information is also given in connection with estimates for the engines both direct connected and belt driven.

THE CUTLER-HAMMER MFG. CO., Milwaukee, Wis., has issued a booklet of 62 pages describing the line of electric elevator controllers developed by J. L. Schureman & Co., of Chicago and now manufactured by the Cutler-Hammer Co., of Milwaukee. The Schureman type controllers have for many years enjoyed a high reputation among elevator users and the booklet furnishes information as well as a collection of data on elevator apparatus, especially upon elevator controllers.

THE SANGAMO ELECTRIC CO., Springfield, Ill., is distributing Bulletin No. 22 describing portable and switchboard type Graphic Recorders. Several pages are devoted to a discussion of the application of Graphic Recorders to soliciting power, checking input of electrically driven machines, etc. The bulletin is very complete and should prove of assistance to Central Station managers confronted with the day load problem.

A new bulletin, No. 21, also issued by the Sangamo Electric Co., is devoted to a comprehensive treatise on the testing of watt-hour meters by means of the rotating standard test meter. Complete data is given as to the proper calibrating constants to be used in testing every make of meter on the market.

The ampere hour meter for electric vehicles is the title of a pamphlet which is a reprint of a paper read by R. C. Tamphier, secretary of the Sangamo Electric Co., before the Society of Automobile Engineers, at New York City. This

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CONTENTS.

Hydro-electric Power.

As typical of developments for the production of electrical energy in the lower Piedmont section of the South, we present elsewhere in this issue a detailed account of a Southern hydro-electric generating station. With over six and three-quarter million undeveloped water horsepower in the Southern states, the promising increase in number and extent of the various industries and the possible field thus created for the sale of economical power, the success of this type of station is assured. The imperative demand for cheap power in all sections of the country has been the direct cause for the increased efficiency of the reciprocating steam engine, the successfully developed steam turbine, the internal combustion engine, and has influenced in a marked degree the rapid developments in the equipment for generation of electrical energy from water power and its transmission over large areas.

The transmutations resulting from the commercial and industrial wants of this country during the past several years, have taxed to the limit the ingenuity in fields of science, mechanics, and engineering and the end is not yet. In the production of power, the South is now entering a new era and to endeavor to predict the probabilities of the next decade is only to fall short of the mark through lack of sufficient imagination. Certain it is that the lines along which the central station industry is being built indicate this and testify to the remarkable advancement and improvements due to the use of electrical power. The developments looked forward to in electrical generation and distribution, promise to present complicated problems in the handling of varied demands on an extensive system. The bringing together of small towns and villages and the building up of a rural and suburban electric service is the work of today. The electrical field has expanded beyond the congested areas and is now creating diversified demands and generally improved conditions in favor of economic operation of the generating station.

What is to be accomplished in central Georgia under the auspices of the Central Georgia Power Company, is worthy of note. The location of the development holds a commanding position in the State, serving a territory extending from Athens and Atlanta on the north, to Americus and the Altamaha River on the south, and embracing from east to west the Oconee, Ocmulgee and Flint rivers. Every engineering development of this character is the result of an important scheme to serve an economical need and make a liberal return on the capital invested. From the particular engineering and commercial lines along which such a scheme is carried out in the above case, every evidence is present to indicate that it will not fall short of expectations. The generation and transmission features represent a design based upon the latest in hydro-electric engineering and the operating results will furnish valuable data for similar future installations.

Hydro-Electric Plant of Central Georgia Power Company, Jackson, Ga.

(*Written Exclusively for* SOUTHERN ELECTRICIAN.)

BY D. H. BRAYMER.

A RECENT development, typical of the latest practice in hydro-electric engineering in the South, is that of the Central Georgia Power Co., at Jackson, Ga. The dam and generating station is located at the Lloyd Shoals on the Ocmulgee River below the confluence of the South, Yellow, Alcova, and Tussahaw Creek streams. Located at the center of the state of Georgia, midway between Atlanta and Macon and one of the most extensive plants in the South, the development is one which will be of decided benefit to the territory within a radius of 70 miles, enabling established and proposed plants to secure a source of economical power. In developing this description of the Central Georgia Plant, the various features of interest was easily accomplished by a proper construction of dam. The right or west bank rises abruptly to a height of 120 feet at a distance of only 150 feet from edge of the channel, while the east bank is not quite so steep yet the abutment at that bank is only 600 feet from the adjacent edge of the river channel. Thus, with a total length of 1,800 feet of construction work, it was possible to close the valley between high bluffs on either side and back up the water so as to form an artificial lake extending some twelve miles up the several streams, creating a storage reservoir of approximately six and one-half square miles.

The dam itself is of monolithic concrete and of the gravity type, the power house being constructed on the

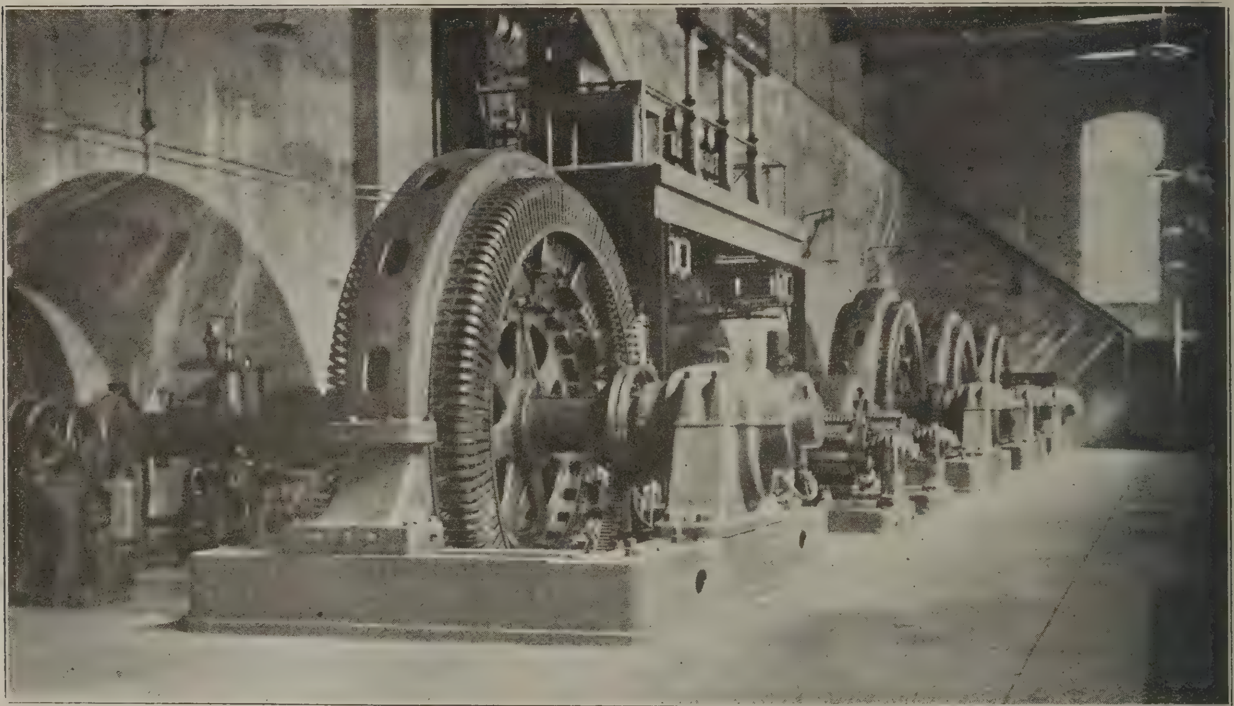


FIG. 1. GENERAL VIEW OF OPERATING ROOM.

will be taken up in order and under the following headings: Hydro-electric features, power house equipment and electrical arrangements, transmission details, substations, and market for the hydro-electric power.

By means of a concrete dam and earth embankments approximately 1,800 feet in length, an operating head of over 100 feet was secured sufficient to assure the development of 24,000 horsepower of electrical energy. Like the other streams in this section of Georgia, the Ocmulgee River is shallow having a fall of not over four feet per mile. The river flows, generally speaking between low banks which slope gradually to hills on either side. The dam for the power plant, however, is located in a valley at a point where the width of stream from shore to shore is very narrow and the banks abrupt. At this point also the slope of the stream is abrupt and the 100 foot head down-stream side and the penstocks placed in the solid masonry as shown in Fig. 3. The masonry section of the dam between abutments is 1070 feet long, varying from 35 to 140 feet above foundations, the maximum height occurring at the power house, situated in the original stream bed. The width at the base of the dam, in direction of stream flow is 101 feet. The spillway which occupies about 728 feet in the dam proper, extends from the east abutment to about the center of the original river channel. Between the spillway and the west shore is located the power house which is 190 feet long and about 46 feet wide.

The west end of the power house is connected to the bank abutment and a 125 foot section of retaining wall, earth embankments 150 feet long with a concrete core wall, being back of the abutment. The construction is similar on the east bank, the earth fill being 500 feet in length.

FIG. 2. GENERAL VIEW OF POWERHOUSE, OUT GOING TRANSMISSION LINE, DAM AND LAKE.

This is built on a curve which carries it over 400 feet up-stream. The foundation is excellent for heavy masonry, as both sides of the valley and most of the river bottom are solid gray granite. The site is six miles from the near est point on the Southern Railway and seven miles from the closest town on the latter. Accordingly, a standard gauge railway six miles in length has been built from the Southern Railway to the site.

POWER HOUSE AND ELECTRICAL FEATURES.

The power house is a two-story structure built of brick and steel, the outer and division walls being of brick 20 inches thick at the first story and 16 inches at the upper story with brick pilasters for the cranes. The floors and roof are of steel beams carrying concrete slabs. On the slab roof is laid a roofing of five ply tar and gravel.

The down-stream side of the station is on a line with the bed of the dam and its profile conforms to the slope of the down-stream side of the dam, thus the upper floor is stepped back one bay beyond the lower. The power house was designed for an ultimate installation of six generator units and three exiter units, direct connected to twin water turbines, of the S. Morgan Smith type. The power house location with reference to the dam, penstock and draft tube is clearly shown in Fig. 3.

At the present time, the installation consists of four main turbines directly connected to four 3000 K. V. A. 2300 volt, 60 cycle Westinghouse generators. Provision, however, is made for two additional sets of the same capacity. The four main turbines each comprise a pair of S. Morgan Smith wicket gate turbines developing 5,500 horsepower. Each generator unit is governed by a Lombard type N. S. 30,000 foot pound governor manufactured by the Lombard Governor Co., Ashland, Mass., which is arranged with motor control so that the operator at the switchboard can start the units, shut them down or change the speed thus permitting easy synchronism of other units in the station. The water wheels are set in steel cases connected with short penstocks, both the casings and penstocks being built in the dam. The face plate of the wheel casing, through which the generator and gate shafts protrude, opens into the generator room as shown in Figs. 1 and 3, and the governor is connected to the gate shaft just outside this face plate of the wheel casing. The exiter equipment consists of two S. Morgan Smith, 535 horsepower turbines, directly connected to two 250 kilowatt exiters located midway between the generating equipment three of the alternators being located on either side in the ultimate arrangement. Provision is also made for a motor driven exiter to be installed if needed. The exiter units are equipped with governors manufactured by the Woodward Governor Co., Rockford, Ill.

Referring to Fig. 3 it will be seen that the main operating floor is that on which the generator equipment is installed, the transformers and high tension switching apparatus being located on the floor above. The operating switchboard of the desk type, is situated on a gallery as shown, directly over the exiting units on the main floor. This gallery is on the dam side of the power house and

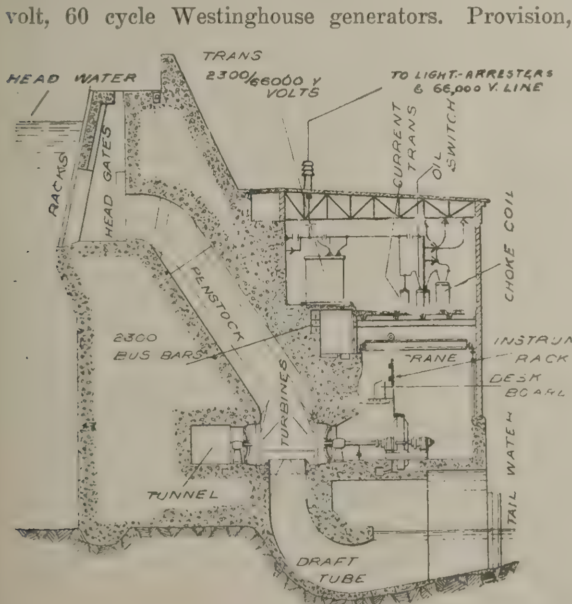


FIG. 3. SECTIONAL VIEW AND LAYOUT OF EQUIPMENT.

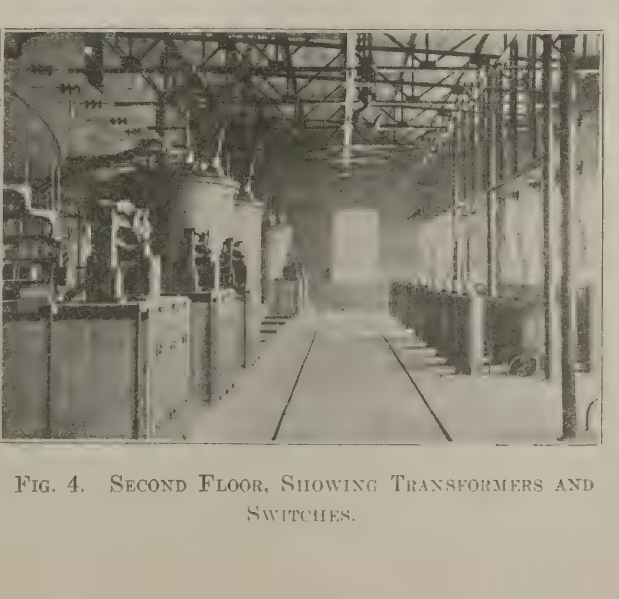


FIG. 4. SECOND FLOOR, SHOWING TRANSFORMERS AND SWITCHES.

contains the lighting and exiter switchboard, the control board and instrument rack as shown. With the four generators installed the output of the station is at present 12,000 kilowatt, the energy being generated at the machines as three phase, 60 cycles at 2300 volts. This voltage is stepped up to 66,000 for transmission.

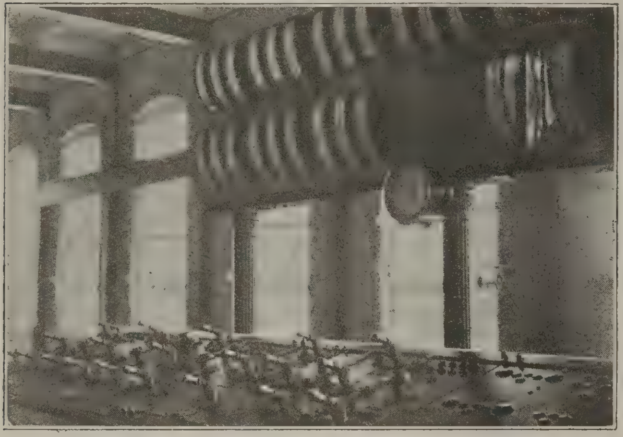


FIG. 5. DESK SWITCHBOARD AND INSTRUMENT RACK.

At present the high tension transforming equipment consists of 4-3000 K.V.A. 2300/66,000 volt, 60-cycle, 3-phase Westinghouse transformers, oil insulated and water cooled, equipped with electric thermostat control; the cooling water pipes being equipped with tell-tale indicators. These transformers are star connected with neutral grounded. The switches are of the remote control type, provided with condenser type terminals on all the 66,000 volt sizes. All generator, transformer and line switches are provided with overload time relays, designed to open the circuit automatically in case of any trouble.

Another feature of interest in connection with this apparatus is the method of treating the oil for transformers and switches. The oil is drawn from the apparatus through a filter of several layers of fine cloth, and then into a closed tank containing a steam coil of seamless tubing. The oil is boiled under a vacuum and the moisture removed by a pump until all traces are eliminated. This is determined by breakdown tests made with a special high voltage testing transformer. The oil is then returned to the particular apparatus from which it was drawn through a system of piping.

A crane runs the length of the operating room and back of the switchboard and gallery is a circular staircase leading from the main floor to the roof. Above the switchboard are located the three 2300 volts buses. These run lengthwise of the station directly underneath 6-3000 K. V. A. 60-cycle, 3-phase, 2300 / 66,000 volt transformers on the floor above. A transfer truck runs the length of the station on the second floor for shifting transformers, with a chain hoist for lifting out the cores. From each generator the leads run in ducts under the main floor to the upstream side of the power house, and then up back of the switchboard to the buses. The generator switches, bus and transformer switches are all located on the top floor in line with the transformers, all switches being remote controlled from the switchboard. As shown by sketch, Fig. 6 the path of the current is from a generator through the leads, to the generator switch, to the bus switch, to the bus bars, to the transformer switch, to the transformer, to the outgoing feeder oil switch with the connections to the current transformers, to the outgoing three-wire feeders. A choke coil is connected on the outer side of each transformer switch. There are two sets of feeders, one leaving the station at each end and carried on the same line of transmission towers. The transmission lines connect with the high tension bus bars through special roof bushings. The latter are four-legged and carry a steel ground wire at the top as shown in Fig. 11. On the roof are two sets of Westinghouse electrolytic lightning arresters, one for each feeder line. The current transformers mentioned are rated at 1,000 amperes, the feeder oil switches, 1,500 amperes, and the choke coils 2,000 amperes.

TRANSMISSION DETAILS.

The energy generated at the power station is transmitted about six miles from the dam over steel towers to Bibb where a switching station is located. At this point the transmission system branches, two lines going to Macon by way of Forsyth and the other two towards Atlanta by way of Griffin. At the present time transmission lines are in operation terminating at three substations, one at Macon, one at Forsyth, and one at Griffin. It is, however, understood that further additions to the system will soon be made and substations located at Barnesville and Monticello, extending the system approximately 23 miles. The distance from the power station to Macon is 47 miles, and that from the switching station at Bibb to Griffin 18 miles making a total transmission distance of 65 miles at present in operation.

As shown in the accompanying illustration the transmission towers are of steel construction with four supports resting on concrete foundations. The lines are run

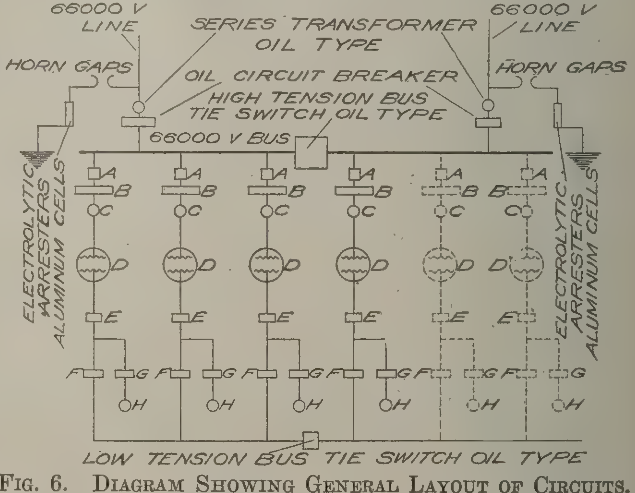


FIG. 6. DIAGRAM SHOWING GENERAL LAYOUT OF CIRCUITS.

in duplicate in order to assure continuous service and enable the switching of current from one line to the other so that work can be done on the disabled line, thus assuring convenience as well as protection. From the power station to the switching station at Bibb the lines are of copper B. & S. gauge 00. From Bibb to the other substations, the lines are of aluminum of a size equivalent to O. B. & S. gauge. The triangular spacing of the lines of the steel towers is six feet six inches, and the towers spaced according to the contour of the region crossed rather than according to any system of spacing. However, the spacing approximates 10 towers to the mile. The design of the transmission system has received careful attention by the consulting engineers and designers of the Central Georgia Plant, with a view to eliminating the troubles common to high voltage systems. The lines have been

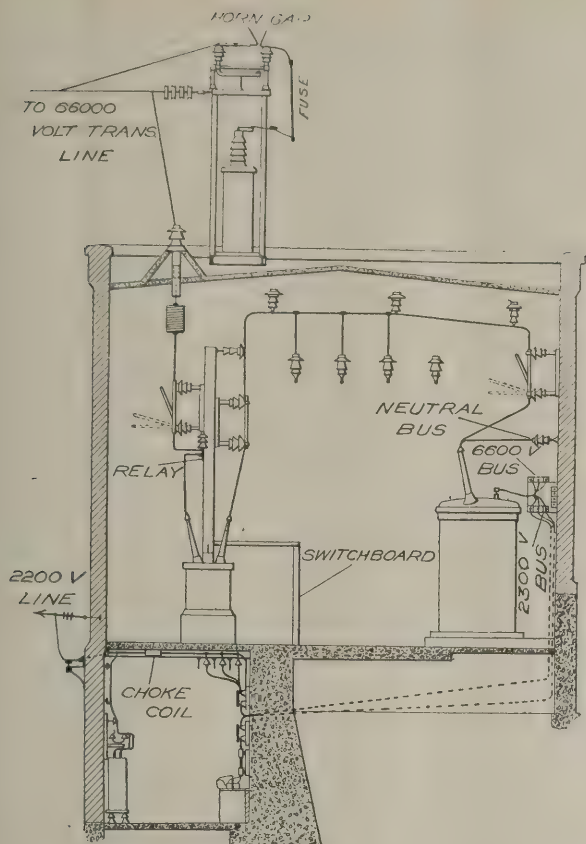


FIG. 7. ELECTRICAL LAYOUT AT MACON SUB-STATION.

designed and constructed with a careful consideration of the tensile strength of conductors, the result giving an appearance of a considerable sag. While the design of this system is more or less experimental, the careful working out of the details makes the operating features of considerable interest and benefit for comparison of operation of other systems where trouble has been met with. A telephone system is installed on the same towers, the wiring

FIG. 9. EXTERIOR OF MACON SUBSTATION SHOWING INCOMING 66,000 VOLT LINES.

being transposed in such a manner as to give good voice transmission features and supplied with special drainage coils to eliminate induction. The uppermost point of the tower as shown in the photograph is the terminal of the ground rod for that particular tower. The height of towers is 80 feet and the insulators used of the four petticoated types especially designed for the transmission voltage of 66,000.

The insulation features of the transmission system have been well worked out as is indicated by the fact that no trouble has been experienced with insulators, either in testing out the line or since.

SUBSTATIONS.

The three substations referred to, those at Macon, Forsyth and Griffin are of practically the same design differing principally in arrangement of apparatus. The Macon equipment is the more extensive and we reproduce here illustrations showing the layout and electrical arrangement, a description of it covering in general the others. In this station there is one floor and basement, the basement ex-

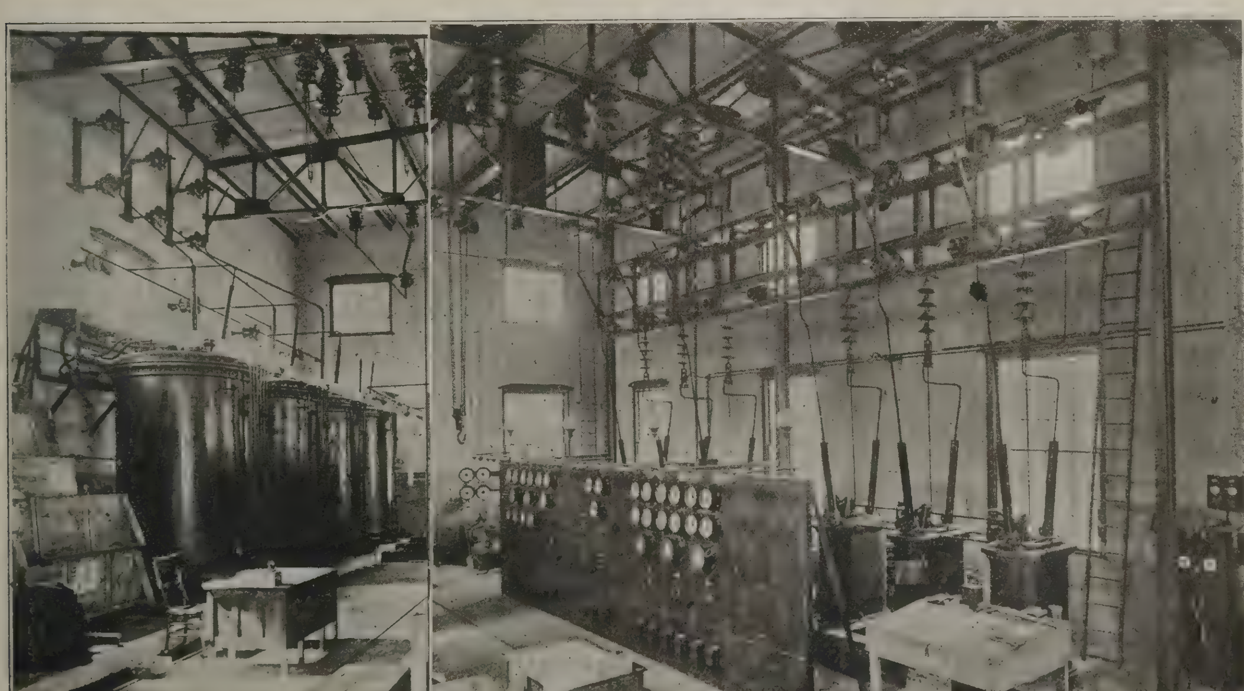


FIG. 8. INTERIOR VIEW OF MACON SUBSTATION.

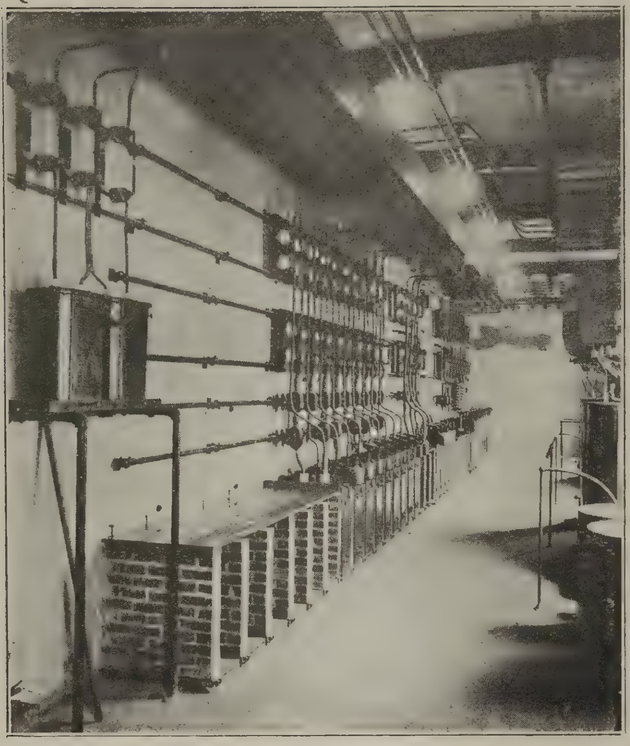


Fig. 10. Low Tension Switches and Fuses, Basement of Macon Substation.

tending only half way across the building. The building itself is of brick and steel construction with concrete floors and wall foundations and also concrete foundations for the transformers and oil switches. The roof is carried on a light steel truss construction and a steel tower surmounts the roof for receiving the incoming high tension line from the power house. The 66,000 volt lines come in on the roof and are connected with a Westinghouse electrolytic lightning arrester set and separated from the line under normal conditions by a horn gap.

The arrangement of apparatus and electrical connections in this station are shown in Figs. 7 and 8. The high tension lines lead through a disconnecting switch to a high tension oil feeder switch which is situated on the floor at the side of the station opposite the transformers. Beyond the oil switch are two disconnecting switches between which a bus tie line connects the two feeder lines, with a disconnecting switch in the tie. Each line then goes to the transformers. Of these there are seven provided for, but only four installed, three for use with one of the feeder lines and the fourth for reserve. These transformers are single phase, water cooled 66,000 to 2300 and 6600 volts with a capacity of 1500 K. W. each. In the low tension line beyond them are oil switches set between a pair of disconnecting switches. One line goes to the 6600 volt bus and the other to the 2300 volt bus and through oil switches to the outgoing feeder line. In the case of the 6600 volt line these are protected by electrolytic lightning arresters similar to those for the high tension line. The low tension switches and bus bars are located in the basement of the building as shown in Fig. 10.

A transfer track similar to that in the main station, runs the length of the building in front of the row of transformers and between them and the switchboard which is located opposite the transformer line at about the center of the building. At one end of the line of transformers are two pumps for circulating water in the transformers.

In connection with all substations the same arrangement of roof inlets and out-door lightning arresters holds as at the main station. At the Macon substation arrangements are made for paralleling the high tension lines at the first tower near the substation when one of the oil switches is out of commission. The location of this tower is so near the substation that switches could be placed on it and thus avoid the complication in the framework on the top of the building for their installation. The switches in this station are all electrically controlled.

Another point in connection with the Macon substation briefly referred to above, is the fact that the transformers have double secondary windings so that 2300 or 6600 volts can be obtained at the same time and these secondary windings have sufficient capacity so that the entire output of the transformer can be taken at either voltage. This was on account of the fact that the power supplied the Macon Railway & Light Company at their power house was 2300 volts and the power supplied to power customers by the Central Georgia Power Company itself is at 6600 volts, as this pressure was allowed in the outskirts of the city where the Power Company's customers will be located.

The Forsyth and Griffin substations have but one circuit entering them controlled by an oil switch. At the branch-off towers, however, this single circuit can be connected to either of the main transmissionn circuits by means of knife switches so that in case of trouble on the particular circuit to which the substation may be connected at the time of the interruption, the substation can be transferred to the other transmission circuit so that a very short interruption will take place. The Griffin substation has water-cooled transformers installed, water being taken from and returned

Fig. 11. Transmission Line Showing Type of Steel Tower.

to a small pond in the vicinity. The Forsyth substation is fitted with self-cooling transformers, as no water was available in its vicinity. The transformers are small in capacity so that they could be built of this type without excessive cost.

MARKET FOR POWER.

The cotton textile industry in central Georgia is already extensive and is characteristic of the leading industries that are making this section one of the most prosperous and rapidly developing parts of the South. In the city of Macon there are four cotton and three knitting mills owned by the Bibb Manufacturing Co., Manchester Mfg. Co., Payne Cotton Mills, Willingham Cotton Mills, The Southland Knitting Mills, the Macon Knitting Co., and the Central City Hosiery Mfg. Co. These companies operate 66,000 spindles 500 knitting and sewing machines and 100 looms. In a radius of less than 35 miles from the power station of the Central Georgia Power Co., are the towns of Macon, Griffin, Barnesville, Forsyth, Jackson, Covington, Social Circle, Monroe, Eatonton, and Hampton operating approximately 30 mills which contain 250,000 spindles, 5500 looms, 100 knitting and sewing machines and use over 10,000 horsepower now generated by steam. While the textile industry may lead in this section it does not monopolize the capital invested. The lines of manufacturing are as varied as they are numerous. The lumber and wood working plants, cotton oil mills, railway shops, fertilizer factories, and metal working establishments number into the hundreds. These plants are causing an increased capital investment and will demand larger amounts of power as they grow.

While the Central Georgia Plant has only been in operation since February 22d, 1910 upwards of 10,000 horsepower have been sold and indications point to the sale of the total capacity in a very short time. The company is prepared for meeting further demands on their system by auxiliary sites which can be developed and connected to their existing system. One of these sites is located on the Flint River near Thomaston, capable of producing 80,000 horsepower, and a second at Milledgeville on the Oconee River capable of developing 50,000 horsepower, giving a total capacity of the connecting systems, including the three developments of approximately 155,000 horsepower. The location of the three sites form a triangle and hold a unique position in relation to the distribution of power to the surrounding territory.

Identified with the Central Georgia Power Company are men who are thoroughly acquainted with the work undertaken and from whom the development of broad and liberal ideas of the relation between service and those served may be expected. A broad policy has been adopted; it is the aim of the company to co-operate with all manufacturers in their territory in an endeavor to give detailed information on power costs and help to keep such costs at the lowest possible point, electrical engineers and experts will be retained by the company to advise those interested in securing electrical power and every case will be carefully investigated and actual estimates furnished. In short the company base their policy on fair play, equitable rates with no discrimination and electrical service in the fullest sense. The officers are: W. J. Massee, president; J. G. Campbell and J. C. Walker, vice-presidents and J. J. Cagney, general manager.

The engineering in connection with the Central Georgia Power Plant was done by Lockwood, Greene & Co., of Boston and J. G. White & Co., of New York. The former firm acted as consulting engineers, making all preliminary surveys and gaugings of stream flow as well as furnishing plans for dam and power house. The J. G. White Co., were responsible for the supervising work and general contracting work, furnishing and executing the detail plans. Mr. G. F. Harley was resident engineer for J. G. White & Co., and deserves credit for the thorough attention given all parts of the work. The dam construction was sublet to and work done by Lane Bros. Co., of Alta Vista, Va.

Principles of Illuminating Engineering.

(Contributed Exclusively to SOUTHERN ELECTRICIAN.)

BY A. G. RAKESTRAW.

IN THE previous installments of this article, the intensity, the distribution, and the diffusion of light, has been discussed and there remains to be considered the subject of quality. The principal factors entering into the quality of light are color and steadiness, and for some special purposes, the actinic value. The color of light is dependent upon the character of the light source, modified to a greater or less extent by the character of the reflecting surfaces and the transmitting media. The subject of color in illumination has been given considerable attention in the recent literature. Many different opinions have been offered as to the proper color required for satisfactory results, and perhaps too much stress has been laid on the importance of slight color differences between different kinds of light. Although, as we shall see, the question of color is one of considerable interest and importance, yet for many purposes, the exact shade is a matter of small importance.

While this article is not written primarily from a scientific standpoint, yet the phenomenon of color is so closely dependent upon the laws of physics, that we can not intelligently study the various effects and actual results, without investigating the laws which govern the production of light. We will therefore take this question up from both its scientific and practical aspects.

The sensation of light is caused by vibrations of great frequency in the ether which impinge upon the retina of the eye. The vibrations may be compared to those of sound. The width, or amplitude of the vibration determines the intensity of the light sensation, just as the amplitude of the sound wave determines the loudness of the note, and the frequency or wave length of the light wave determines the color sensation in like manner as the frequency of the sound wave determines the pitch of the note. The vibration frequency of light waves also affects the intensity to some extent, as the eye is more sensitive to light of certain colors or wave lengths than to others.

There is in nature, practically no such thing as a monochromatic light, or one having only one vibration frequency. Most of our light sources throw off waves of every imaginable length, some of which are visible and some of which are not. This mixture of light waves falling upon the retina produces the sensation of light of a certain color, according to laws which are not thoroughly understood. White light, as we term it, is a mixture, as can be readily demonstrated by decomposing a beam of sunlight by means of a prism, into its constituents of red, orange, yellow, green, blue, indigo, and violet. If the prism is lacking the same thing accomplished in nature may be observed through the medium of the rainbow.

Solar light has been thoroughly analyzed into its component parts and the following table gives the different colors, according to the names usually ascribed to them, with the wave length, the vibration frequency, and the parts per 1,000 of each.

This information is compiled from the observations of Rood and Thompson as recorded in Barker's Physics.

Color	Vibration Frequency	Wave Length.	Parts Per 1000
Ultra red	370 million million	.81 *u*	----
Red	428 " "	.70	54
Orange red	483 " "	.628	140
Orange red	502 " "	.597	80
Orange yellow	510 " "	.588	114
Yellow	516 " "	.581	54
Greenish yellow	---	----	206
Yellowish green	---	----	121
Green	569 " "	.527	134
Blue green	590 " "	.508	134
Cyan Blue	604 " "	.496	32
Blue	634 " "	.473	40
Violet Blue	684 " "	.438	20
Violet	739 " "	.406	5
Ultra Violet	833 " "	.36	----
			1000

In measuring the wave length of light, the unit used is the ten thousandth of a centimeter, and is represented by the symbol *u*. The range of the visible wave length, or spectrum, extends from about .4*u* to .7*u*, while the invisible spectrum, termed the infra-red rays at one end, and the ultra-violet at the other, has been studied from .185*u* to 30*u* or of frequencies of from 10 million million to 1622 million million. These invisible rays are not of interest in the study of illumination, and will receive only passing mention.

The molecular vibration of a light source, is the result of energy being expended upon it, and on account of which we have generated both heat and light. There is a relation between the temperature of a heated body and the frequency of the vibration, and therefore between the temperature and the color of the light emitted. When a piece of iron is heated in the forge it passes through the shades of dull red, cherry red, orange, pale orange, bright yellow, white, and dazzling white. The explanation is, that at the lower temperatures the longer waves are given off producing the sensation of red. As the temperature increases shorter wave lengths, say of the yellow and green are given off and mixed with the others produces light more nearly white, while at the highest temperatures short waves of blue and violet are mixed in with these other colors, producing by the mixture practically what we call white light. In this case each color represents a definite temperature, and the results may be tabulated as follows:

COLOR	DEG. C.	DEG. F.
Dull red	700	1292
Cherry red	900	1652
Clear cherry red	1000	1832
Deep orange	1100	2021
Clear orange	1200	2192
White heat	1300	2372
Bright white heat	1400	2552
Dazzling white heat	1500	2732

The majority of substances, when heated to these temperatures, follow this law of radiation, and are called "black bodies," and this law is called the law of black body radiation. On the other hand, the substances which do not follow this law, are said to give selective radiation, that is, the wave lengths are not entirely dependent upon the temperature, but in part upon some other condition, which we have not as yet discovered. In such cases we can not therefore determine the temperature from the color.

As typical examples of black body radiation we may mention the filaments of incandescent lamps, such as the carbon, metallized tantalum and tungsten, although the last is stated by some authorities to depart slightly from the law of black bodies. These four filaments form a series in which as the working temperature is raised higher and higher the light becomes whiter and whiter, and for reasons which we will take up later, the efficiency is increased, that is, more light is produced for a given expenditure of energy. On the other hand such lamps as the Welsbach gas burner with its incandescent mantle of the oxides of cerium and thorium, is strongly selective, the light being of a distinctly greenish hue. A still more striking example of this is to be found in the mercury vapor lamp, which gives no red rays at all, but whose light is of a strong bluish green color. "Selectivity" is sought after in light sources as it may result in increased efficiency. This, however, is not always the case for we find that a piece of glass heated to incandescence is selective but its "selectivity" is towards the wrong end of the spectrum, as it gives a preponderance of the red rays which are of the least value for visual purposes.

Besides "selectivity," we have also luminescence, by which is meant either a general excess of light is produced than is due to the temperature, or a condition by which, due to internal combustion or other causes, the substance of the illuminant is raised above the temperature of the surrounding medium. If for instance, we could conceive that the filament of an incandescent lamp, due to internal changes, could attain a temperature above that which is due to the passage of the current through it, we would have an example of this condition. Luminescence is not infrequently combined with "selectivity," that is, not only is the flux of light increased beyond what we would expect due to the temperature, but the increase is greater for some wave lengths than for others and we have therefore colored lights. As an example of this we may mention the flaming arc, in which the internal chemical reaction of the metallic salts contained in the carbon, produce vibrations of greater frequency and different wave length than would be due to the temperature. As a result, we get a marked increase of efficiency, and a yellow, or reddish tinted light, according to the metallic salt used.

Besides "selectivity" and luminescence, we may mention fluorescence. By this is meant the property of a medium to change the light falling upon it from one wave length to another. The name is taken from fluor spar, which possesses this property in a marked degree. The change appears to be always in the direction of longer wave length, for instance from blue to green or from blue or green to red. The mercury lamp, as we know, emits no red rays, and if viewed through a red glass appears almost black. If, however, we allow the rays from this lamp to fall upon a fluorescent screen, we can then see the screen through the red glass, proving that some of the blue and green rays have been converted into red. Phosphorescence is a special case of fluorescence, in which ultra-violet invisible rays are converted into visible rays, or in which light rays which have fallen upon the substance are absorbed and in some manner stored up and emitted again. Such a substance, for either or both of these reasons, will shine in the dark. Phosphorescence is so called on account of the behavior of phosphorous, which, however,emits its light as a result of slow chemical reaction, and hence is really luminescent, rather than phosphorescent. Phosphoresence is thus far of no practical value in illumination, but fluorescence has been used to improve the quality of the light of the mercury vapor lamp by helping to supply the deficiency in red rays.

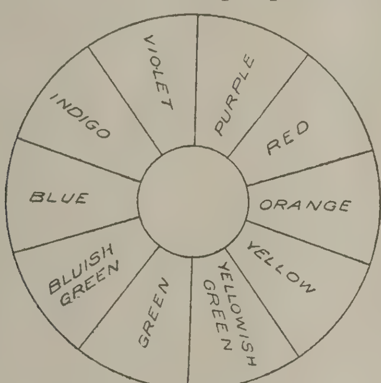


Fig. 1. Scheme for Color Mixtures of Light.

Having considered some of the factors upon which the color of light depends, the second part of this subject will be taken up, the physiological effect of color upon the human eye. Nearly all of our measurements of light or experiments with light are estimated by the physiological effect and practically the entire application of light is for visual purposes. However, due to limitations in the organ of vision, the effect of light upon the retina is not always a reliable measure of its quantity or quality. This is particularly true as regards color. While as we have seen, white light is composed of innumerable wave lengths, yet it appears that there are to the eye practically only three primary color sensations, red, green and violet, and that so far as the eye is concerned, all other colors and shades are produced by mixtures of these three sensations. The eye can not resolve a color into its components, but is able to value the result only, and this again gives rise to limitations. For example the eye can not distinguish between white light produced by a mixture of blue and yellow, from a white light composed of red and green light. These two lights, although composed of entirely different wave lengths, produce exactly the same sensation on the retina. Again, the eye can not distinguish between a pure monochromatic green light, and a green produced by mixing yellowish green and greenish blue lights.

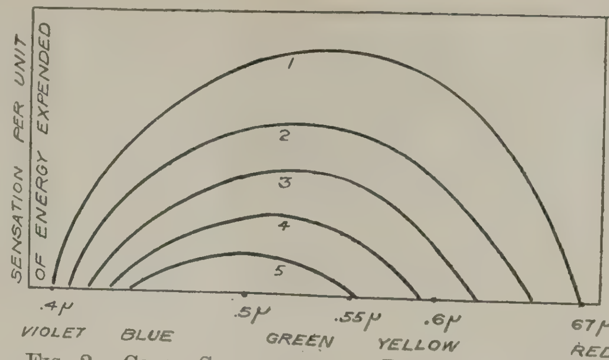


Fig. 2. Color Sensations for Parts of Spectrum.

As an aid to the study of color mixtures of light, Fig. 1, will show an arrangement of colors, in which the mixture of any two lights separated by one space will produce the color between them, while the mixture of any two opposite colors will produce white light. The curves in Fig. 2 by Koenig and Exner, and published in the Illuminating Engineer, show the amount of the three primary color sensations (not colors) which are produced in the various parts of the spectrum. A study of these curves reveals some interesting facts. It is peculiar that in the blue end of the spectrum, the green sensation disappears but that there is quite a perceptible red sensation, even at the extreme violet. Furthermore that there is a strong red sensation in the midst of the green portion of the spectrum, even greater than there is in the red itself. Several other interesting facts may be discovered by studying these curves, bearing always in mind that they have reference to the sensations only, and have no definite relation to wave length.

The relative intensity of light as perceived by the eye, depends not only upon the amplitude of the vibrations, but on the wave length as well. Of course, outside of the visible spectrum, the retina can not perceive the vibrations, even if great, but within the range of the visible spectrum, we find that the eye is much more sensitive to light of certain wave lengths than to others. That is, for a given amount of energy expended, the light sensation varies greatly with the wave length. The color to which the eye is most sensitive is a sort of yellowish green, or canary color, of wave length about .55u. From this point it decreases towards both ends of the spectrum, but more rapidly towards the red than the blue. As a result of this effect, we find therefore that it takes several times the amount of energy to produce an equivalent illuminating effect with a light of reddish color, that with a light predominating in green rays. This fact is of great impor-

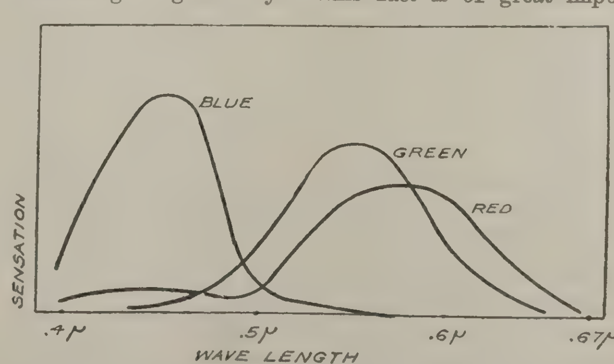


Fig. 3. Showing Varying Sensitiveness of the Eye With Light of Varying Wave Length and Different Intensities.

tance in practical illuminating work, as upon it depends the attainment of highest efficiency in light sources.

Not only does the sensitiveness of the eye to light vary greatly with the color, but the relative effect is not the same with all intensities of illumination. For instance, a red and a blue surface may appear of equal brightness in a strong light, but on decreasing the intensity, the blue will appear brighter than the red. A simple proof of this phenomenon is to observe a vari-colored landscape as dusk approaches. The red and orange objects are the first to fade into a neutral tint and then into a deep blue and then into blackness, while the blue and green retain their tints long after red and black appear as one. Fig. 3 shows some curves which are only approximate, but which will illustrate this point. Curves 1 to 5 represent the relative sensitiveness of the eye to light of varying wave length, and decreasing intensities, showing that the red colors are the first to disappear and that the point of maximum sensibility is shifted with the fading light until with very weak intensities it lies in the blue.

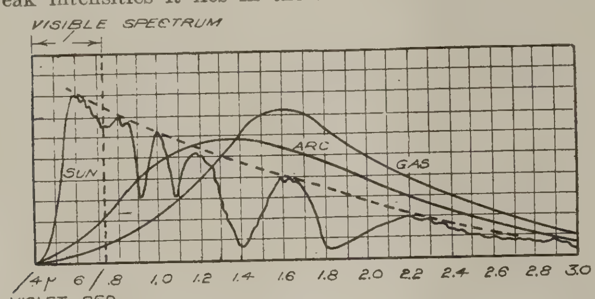


FIG. 4. INTENSITY OF RADIATION OF SUN, ARC AND GAS FLAME.

From this it follows that taking for an example, an incandescent filament, one watt of energy converted into green or yellow light is of more value for purposes of vision than the same amount of energy converted into red or violet light. Therefore, to get the maximum luminous efficiency, we should seek to have as many as possible of the light waves lie in the region of maximum sensibility. This is not possible, nor altogether desirable, for the color of the light in this region being of a yellowish green would not be pleasant for the ordinary occupations of life. We do find, however, that as we raise the temperature of the filament, not only do more and more of the radiations lie within the visible spectrum, but that more of them lie in the regions of greatest sensibility. All of our artificial illuminants, are very faulty in this respect, a mere fraction of the emitted radiation being visible, and the greater part of that being in the regions of low sensibility, that is, in the red. We find that of the radiation emitted by the gas flame, 2.4 per cent. is visible, of the electric arc 10 per cent, of the sun 35 per cent., and of the humble fire fly, nearly 100 per cent.

To express this somewhat differently, we find that according to Dr. Hyde of the engineering department of the National Electric Lamp Association, that the efficiency of the tungsten lamp is about 8 lumens per watt, but that if we could convert the electrical energy into light having the characteristics of sunlight, we would obtain 150 lumens per watt, and if all into light at a wave length of .55u, an efficiency of 800 lumens per watt, which is just 100 times better than we are doing now.

The curves in Fig. 4 show relative intensity of the radiation at different wave lengths, of the sun, the arc, and the gas flame. These are from observations by Langley, as given in Barker's Physics. It will be noted that not only does the height of the peak vary with the temperature of the source, but that its position varies as regards wave lengths and also that the point of maximum radiation of sunlight is exactly at the point of greatest visual acuity of the retina, proving beyond a doubt, the design of both by a supreme intelligence. The efforts therefore in the manufacture of incandescent lamps, have been directed towards securing the operation of a filament at as high a temperature as possible, with results which have culminated in the production of the tungsten and other metallic filament lamps. The open arc lamp, being operated at the boiling point of carbon, gives forth from the crater, light which is whiter and more efficient than any other artificial illuminant. Higher efficiencies than these, have been so far, secured only by luminescence or selective radiation. This subject will be continued further in the next issue.

Testing and Calibration of Watt-Meters.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

BY G. I. MORGAN.

THERE are a number of ways of testing a recording wattmeter. The most primitive of these, but one of the most convenient, is to burn a certain number of lamps for a certain period of time, say an hour, reading the meter before and after the test. The 3.5 watt lamp, of 16 candlepower consumes about 56 watts, and if ten lamps are burned for one hour the meter should indicate 560 watt hours. Any gross errors, such as one of 25 or 30 per cent., can be detected in this way.

For closer work, tests may be made in several different ways. These are divided into two classes. One is known as the revolution method and the other as the test by dial reading. The revolution method always involves the timing of the revolutions of the disc and the computation of the energy that is being recorded by the employment of suitable constants.

The method of dial reading consists in passing through the meter a quantity of power and comparing this measured power, multiplied by the time, with the indications of the dials. This is sometimes the only course when the cover of the instrument cannot be removed and the disc is not otherwise visible. The usual proceeding in calibrating by dial indications is to run the meter under a suitable load, preferably about the average load that is used on the meter in practice, and to note the time required for the first dial hand to make one complete revolution. The power is measured by a portable indicating wattmeter in case an alternating current meter is being calibrated, if a direct current meter is on test, an ordinary volt and ampere meter may be used. The portable instruments are inserted in circuit with the meter to be tested and read at specified intervals, the average being taken, and the power thus measured being multiplied by the time.

The revolution method is the most accurate and is the one most employed and consists in measuring the power and simultaneously timing the disc. The power passing through the wattmeter is proportional to the speed of the disc and can be very accurately represented by its speed, multiplied by a certain constant, called the disc constant. This constant varies with different makes of meters because of the flexibility of the units chosen. The common equation is:

$$\text{Kilowatts} = S.\ K.$$

where S is the speed of the disc and K is the dial constant. It is plain that if S is the speed in revolutions per minute, the constant K would have 1/60 the value that it would have if S were revolutions per second, and similarly, if the power were expressed in watts instead of kilowatts, this would increase the value of the constant K 1000 fold. A common form of constant which is used is the number by which the revolutions made in one hour must be multiplied in order to give the watts passing through the instrument.

In testing an instrument with such a constant it is usually most convenient to note the time that disc takes to make a given number of revolutions. Taking a practical case, suppose that an instrument has a disc constant of 2 and a load is such that the disc makes ten revolutions in seventy seconds, the power passing through the instrument would be equal to,

$$\frac{10 \times 3600 \times 2}{70} = 1028.6 \text{ watts.}$$

This result should be compared with the power measured simultaneously, by accurately calibrated indicating instruments. If the computed power is greater than the measured power, the disc should be made to travel more slowly by adjusting its magnets. The disc constant should not be confused with the dial constant, which is usually printed on the dial face, and which may be altogether different, because of the gear ratio used. When the first dial, indicating 1 K. W. per revolution makes one turn to 1,000 of the disc, then the constant of the dial is the same as the constant of the disc, but, when the gear ratio differs from this, a proportionate number is introduced which alters the dial constant. Thus, when a disc constant is 1.25 and a ratio between disc and dial movement is 1,000, then the constant of the meter is 1.25 also.

If, however, it is desired to have the meter read, directly in watt hours, it is necessary that the dial hand make one revolution to 800 of the disc, which could be done by selecting a proper gear ratio. If the constant of the disc is not given it is possible to determine it by noting the ratio between the disc and dial reading in kilowatt hours. The constant in this case is the number by which the revolutions per hour must be multiplied in order to give the power in watts.

Assume one kilowatt to be flowing through the instrument, then in one hour the K. W. H. hand should make one revolution, and the disc will make a certain number of revolutions, which when multiplied by constants equal 1,000, consequently, the constant equals 1,000 divided by ratio between the rate of disc revolutions and that of the kilowatt hour hand, that is $K = 1{,}000 \div \text{ratio}$. Another way in which the constant may be expressed is, as the time in which the disc will make as many revolutions as there are watts flowing through the instrument, as, watts $= S\ K$, where S is the revolutions per hour. Then the time, t, in hours has the following relation to the constant, K. $t\ S = \text{watts} = S\ K$, that is to say, $t = K$, so that in K hours the number of disc revolutions would equal the watts flowing through the instrument. It is sometimes convenient to reduce the time to seconds and the watts to kilowatts, when the relation becomes $t'' = 3.6\ K$, t'' being the time in seconds required for the disc revolutions to equal the kilowatts. Thus, if a meter had a disc constant of 2 it would in 7.2 seconds make as many revolutions as kilowatts and if the disc constant were ½ it would do this in 1.8 seconds. In some cases it would be very inconvenient to time the disc for such a short period, so the constant is multiplied by 100 or so and the revolutions are divided. Thus the constant 360 and 180 would indicate 3 and 6 minutes respectively.

Because of the friction of the brushes, etc., when the meter is at rest, a certain definite amount of current must flow through the series winding before it will start. This may be of such magnitude that the starting power or torque, as it is termed, may amount to as much as 60 or 70 watts—ample for a 16 candlepower lamp. As soon as the meter is once started, the amount of current necessary to keep it in motion is considerably less, perhaps only one-half. After the armature once starts the retardation due to friction is roughly a constant quantity and on very light loads is a source of large percentage of error. On very heavy loads it is of less importance.

It is a common plan to provide in such instruments an additional source of torque, which shall be constant and will balance the friction torque. This is done by inserting in series with the meter armature a field coil, which is adjusted in its position with relation to the armature, until sufficient torque is obtained to compensate for the retarding effect of friction. This torque is obtained by adjusting the coil until the armature will just start on no load and then gradually moving the coil until its influence on the armature is reduced and it stops.

It must not be forgotten that the torque generated by the starting coil is proportional to the square of the voltage. If for instance an instrument were made to work on a 110-volt system, the torque of the starting coil would be proportional to the number 12,100. If the potential were changed to 120 volts the torque would be proportional to the number 14,400 or 20 per cent. greater, or a raise of 10 volts. Hence it is very important that the instrument is installed on a system whose potential is that for which it is intended.

The errors due to the magnets and friction are almost always such as to make the meter run slow. Magnets that are artificially aged quite frequently show a tendency to strengthen, and friction of any kind always increases with age. Hence the usual trouble with the meter is that it records too little rather than too much.

In testing a meter for very close work it is important to notice whether the delivered watts or supplied watts are compared with the recorded readings of the meter. In commercial work the meter is intended to record the delivered watt hours. Hence, in connecting standard instruments to the meter circuit for the purpose of checking its record, the series or current connections whether for an ammeter or wattmeter, should be on the house side of the meter in order that the current of the potential coils of the meter may not be included in the reading of the delivered power. The voltmeter or potential connections should be made on the line side of the meter in order that the recording wattmeter may not measure the energy of the potential circuit, of which no account is taken by the standard instruments. The drop through the series coils of the meter is usually so small that it can be neglected.

In testing three-wire meters several important precautions should be taken: The meter is supposed to be correct on balanced load. If the load becomes unbalanced, the magnetic effect of the field on armature is not so effective as it would be if it were balanced, and the meter would run slow. One way to remedy it is to balance the load and remove the neutral fuse, in which case the meter is tested as an ordinary 220 volt, two-wire meter.

This is not always a safe procedure, because unless the system is under absolute control someone is likely to upset the balance during the test and endanger the lamps. Another plan is to install two shunts, one in each leg of the three-wire system and transfer a milivoltmeter from side to side or better still, have two milivoltmeters.

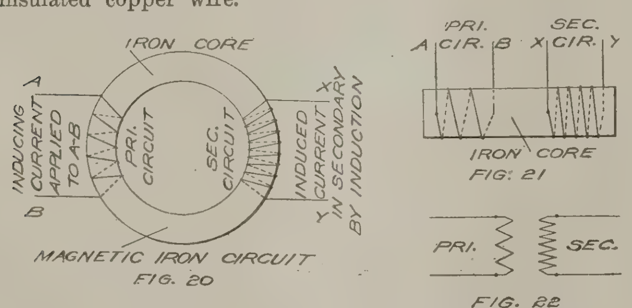
Alternating Current Engineering.

(*Contributed Exclusively to* Southern Electrician.)

By William R. Bowker.

As a continuation of the subject of last issue, transmission problems will be taken up. In the transmission of power, especially over long distances, the whole question resolves itself into the commercial aspect of the problem. This is the reason why high voltages are used in preference to low voltages, and for these and other reasons we have to utilize in practice, different appliances and apparatus, such as transformers, etc.

The principal features of a transformer, for transforming alternating currents, is outlined in Figs. 20 and 21. The practical essentials are an iron magnetic circuit for the purpose of concentrating the magnetic field where it will act efficiently on the secondary windings, a primary circuit composed of coils of insulated wire, and a secondary circuit which consists of many turns of finer, more highly insulated copper wire.



Figs. 20, 21 and 22. Principal Features of a Transformer.

As outlined above, the device is a step-up transformer, that is the voltage is increased at the secondary terminals if the original source of current supply is applied to the ends A B of the primary coils. The higher voltage is accompanied by a lesser current in the secondary coils, the ends of which are marked X Y. Thus, if the number of turns or complete convolutions of coils of wire composing the primary is 100, and the number of complete convolutions of coils on the secondary are 1,000, the voltage at the terminals X Y of the secondary would be 10 times as great as that applied to the terminals A B of the primary. The current in the secondary would be approximately 1/10 the amount of that flowing in the primary coils. Thus if a voltage of 1,000 were applied to the primary terminals A B and this caused a current of 10 amperes to flow around the circuit, the resultant voltage delivered at the terminals X Y of the secondary would be 10,000 and the amperes approximated, one. The power supplied to the primary with the above figures would be 10,000 watts, and that delivered by the secondary approximately 10,000 watts.

By connecting up vice versa, that is the primary or original current applied to X Y, this coil then becomes the primary, and the other coil A B the secondary circuit. The device would then be called a step-down transformer, and the relative voltage and ampere values would be reversed. The size of the wire composing the coils connected to terminals X Y, need only be 1/10 as large as that of the coil A B, for the ratio of transformation is as 1 to 10.

It will be noticed and must be clearly understood that there is no metallic connection in any way whatsoever between the primary and secondary wires or circuits. The mutual action and transformation of voltage and current being caused solely by mutual induction due to the intermediary action of the magnetic field energized or produced in the iron core or magnetic circuit by the alternating current flowing in the primary circuit. There is also no relative movement of any of the assembled parts of the apparatus, everything being at rest. The resultant action is brought about by the variation in strength and reversal of polarity of the magnetic field, due to the rapid alternating of the current applied to the primary circuit.

In Fig. 20 the iron core is shown as being built up of a solid iron ring, while Fig. 21 shows the iron core as composed of a bundle of assembled iron wires. Fig. 21 is the correct construction, for in practice the iron core is never built solid, it being laminated, that is, built up of thin sheets of iron or iron wires assembled in practical form so as to prevent loss of efficiency and undue heating due to eddy currents, generated in a solid iron magnetic circuit. In every day practice we symbolize or represent a transformer by the simple outline as shown in Fig. 22, which illustrates a step-up transformer.

Alternating current generators are usually of high voltage, that is 1,000 and upwards, and when used for incandescent lighting, the voltage has to be transformed down to the practical voltage required by incandescent lamps for public and private use, usually 100 to 110 volts. This is accomplished by placing transformers in convenient locations in the districts where the electrical energy is distributed and utilized. Fig. 23 gives an outline diagram of the circuits with the transformers connected in parallel and the lamps in parallel.

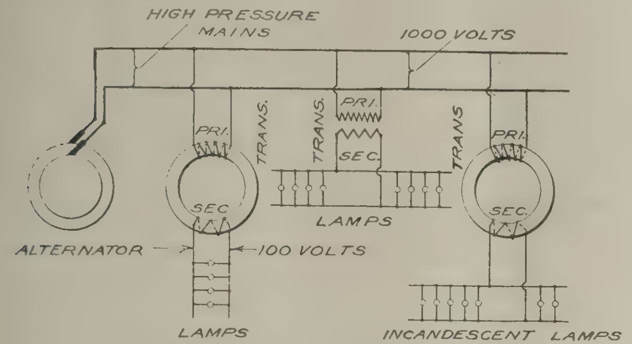


FIG. 23

Fig. 23. Circuits With Transformers in Parallel.

This arrangement requires that the electrical energy be supplied at a constant voltage and variable current both at the terminals of the secondary of the transformer and also at the primary terminals, the alternating current generator having to respond to this demand. The constant potential is absolutely necessary, otherwise the brilliancy of the light emitted by the incandescent lamp will fluctuate, causing great practical inconvenience. Further the variation of current is determined by the lamp load on the secondaries, the greater the number of lamps the greater the amperage required. This necessitates close regulation of the voltage and current delivered by the alternator.

In Figs. 24 and 25 are outlined the simple circuit connections of single-phase transformers on a two and three-phase circuit respectively. In Fig. 24 the first and second phases of the two-phase generator are each connected to the primaries of a single-phase transformer, each by means of two separate circuits A A and B B from the two-phase generator. In Fig. 25 it will be noticed that one terminal A of each of the transformer primaries is connected by a common return wire to the junction J of the generator windings. The other primary terminals B_1 B_2 and B_3 are each connected by a separate main line or lead to a col-

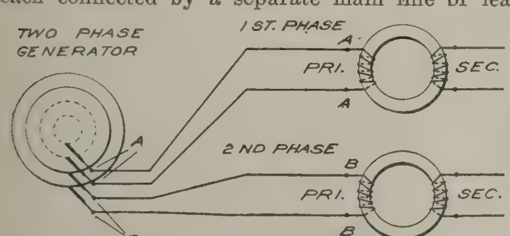


FIG. 24

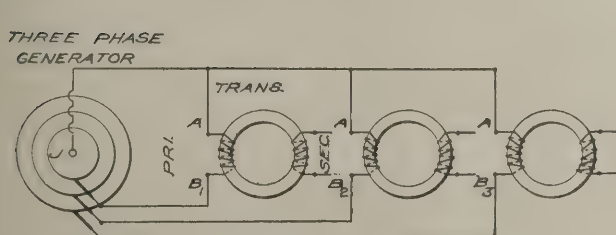


FIG. 25

Figs. 24 and 25. Single-Phase Transformers on Two and Three-Phase Circuits.

lecting brush pressing upon a slip ring which is connected to each phase of the three-phase generator.

Instead of utilizing separate transformers, although separate single-phase transformers afford greater flexibility of service in every day practice where single-phase distribution is adopted, it is more economical so far as iron is concerned to combine the windings on an iron core giving a magnetic circuit common to all. The outlines of

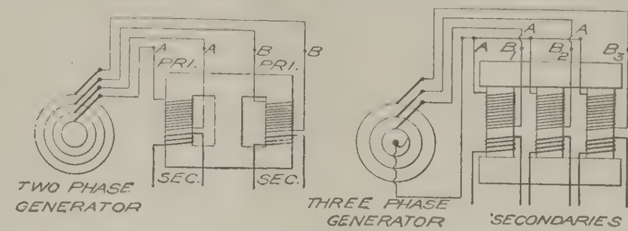


FIG. 26 FIG. 27

Figs. 26 and 27. Transformers With Combined Windings.

this arrangement are shown in Figs. 26 and 27. The circuit connections from the two and three-phase generators are also shown, and should be compared with Figs. 24 and 25.

THREE-PHASE TRANSFORMER CONNECTIONS.

Three-phase alternating current transformers may be connected up in two or more ways. The star method of connections is sometimes utilized in practice, especially when high pressures are employed. Fig. 28 is a diagram showing three transformers star connected on a three-phase circuit.

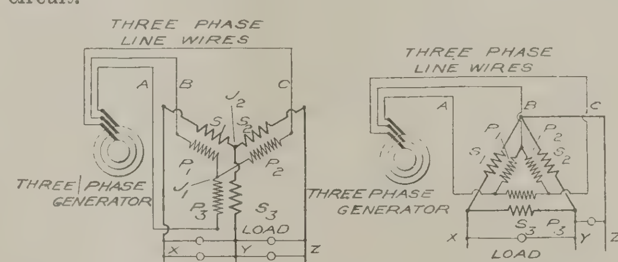


FIG. 28 FIG. 29

Figs. 28 and 29. Star and Delta Connections on Three-Phase Circuits.

The primary and secondary coils of the three-phase transformer are represented respectively by P_1 P_2 P_3 and S_1 S_2 S_3. It is obvious from the circuit connections that there are two transformer primaries between any pair of the external line wires A B C. Thus between A B there are two transformer primaries P_1 and P_3, between B C there are P_1 and P_2, and between A C two transformer primaries P_2 and P_3. Consequently the line voltage or e. m. f. is not impressed upon any one primary winding taken singly by itself. The pressure or voltage across any single one of the primary coils P_1 P_2 or P_3 will be $1/\sqrt{3}$ or 0.577 times the pressure between any two of the line wires, that is the e. m. f. across the primary terminals of P_1 or P_3 transformer would be .577 of the voltage between the lines A B and so on. The primaries acting inductively upon the secondary coils, will induce voltages therein in the ratio of transformation of the primary and secondary coils.

The e. m. f. or voltage between any two of the secondary distribution feeders X Y Z will be $\sqrt{3}$ or 1.732 times the induced pressure or voltage in the secondaries of each respective transformer. Thus the resultant e. m. f. or voltage across X Y, will be 1.732 times the induced voltage or e. m. f. in either S_1 or S_3 considered singly, and likewise similar results across X Z or Y Z. J_1 and J_2 are the junctions of one primary and one secondary terminal respectively of the three-phase windings.

The mesh or delta method of connecting is the one most generally employed in practical three-phase work, and Fig. 29 clearly represents the arrangement of circuits, in which similar letters refer to similar parts as in Fig. 28, the difference between the two methods of circuit connections will therefore be readily seen.

In the star method there are two transformer primaries between any two line wires, while in the method, mesh or delta, there is only one transformer primary between any two of the line wires A B, A C or B C. This obviously gives the condition that whatever the line voltage between any two of the line wires A, B, or C, the primary feeders, it will be of the same value at the terminals of any single one of the primary coils P_1 P_2 or P_3, and the pressure or e. m. f. induced in the secondary coils S_1 S_2 or S_3 will, as in the star method, be determined by the ratio of transformation of the primary and secondary coils. Further, whatever particular value the secondary voltage attains, the same pressure value will exist between any two of the secondary distribution mains or feeders X Y, X Z or Y Z.

The practical advantages possessed by the star method of connecting transformers in circuit is recognized, for the primary windings of each transformer receive but a little more than half the line voltage of the feeds to which they are connected. Another advantage which the star method possesses over the mesh or delta arrangement, is when for secondary distribution, a connection is made to the common junction J_2 of the secondary windings of the three transformer circuits. Considering the primary and secondary currents in this star method of connection, each primary winding of the transformers gets the same current value as that in the respective line, or primary feeder to which it is connected.

The value of the induced current in each secondary winding of the transformer is greater than that in the corresponding primary winding, in the same ratio that the respective secondary voltage is less than the primary circuit voltage. The current value in the secondary distribution mains or lines is the same as in the secondary windings to which they are connected.

As already mentioned the mesh or delta method of connecting is more usually utilized in three-phase practice than the star circuit arrangement, unless the voltage used is very high, or for the reason that certain special systems of secondary distribution make the star connections particularly desirable or practically advantageous. As before stated, the practical utilization of one method of connecting the circuits in preference to the other, will be generally governed by the service requirements.

When the three transformers are delta connected, one may be removed without interrupting the performance of the circuit, the two remaining transformers will carry the load between them. This in practice is very advantageous, for it protects a circuit or service from complete shut down in case one transformer decomes disabled. For this reason also the delta method of connections has become extensively used, especially on the low potential, that is secondary distribution side of the service.

By changing the connections of the primary circuit or high potential side from delta to star, it changes the ratio of the primary line voltage compared with the primary transformer terminal voltage, from 1 to $\sqrt{3}$, that is from 1 to .577, and under conditions when the primary line voltage may be so high that the insulation of transformer coils becomes practically difficult. The three-phase lines connected to the primary circuit of the transformers are frequently connected in star.

It will thus be seen that we can in practice connect the primary side of the transformer in star and the secondary side in delta.

To practically utilize a damaged three-phase transformer, disconnect the terminals of the primary coils of the damaged transformer from the primary line wires, and also the secondary terminals from the secondary distribution line wires and short circuit both the primary and secondary coils by connecting a wire across each pair of primary and each pair of secondary terminals. That is short-circuit each winding, primary and secondary, but do not connect the primary and secondary in short-circuit, one with the other.

As previously mentioned an advantage which the star connection possesses over the delta is that for the same transmission line pressure, the transformer primary is wound for only 58 per cent. of the line voltage. In high potential transmission of electrical energy, this in practice admits of much smaller transformers being built for the high voltages than is admissible with delta connection.

Each primary or receiving circuit if connected in star must be wound for $1/\sqrt{3}$ or approximately 58 per cent. of the line voltage and for the full line current. If connected in delta each transformer primary must be wound for full line voltage, and 58 per cent. of the line current, therefore the number of primary turns in the windings of a star connected transformer is but 58 per cent. of those required for a delta connection.

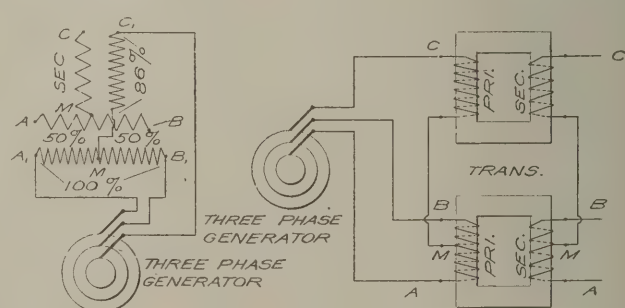


FIG 30 FIG. 31

FIGS. 30 AND 31. T CONNECTION OF TRANSFORMERS.

There are modifications of both the star and delta methods of connections, which are utilized in practice and possess certain advantages under suitable conditions. It is possible in practice to advantageously utilize two transformers in three-phase transformation, one method being known as the Tee (T) connection, outlined in Figs. 30 and 31. It will be noticed that a primary circuit of one transformer is connected between two of the transmission lines A B, while the primary circuit of the second transformer is connected between the third transmission line wire C and the middle point M of the first transformer. The current in each primary of the two transformers is of equal value, likewise the secondary currents are equal. The voltage impressed across the terminals of one transformer, that is the one connected between C and M, is only 86.6 per cent. of the voltage across the terminals of the first transformer, the one connected between A B. If the two transformers are specially designed to work in T connection one will have a watt rating of 100 per cent., while the other need only have a watt rating of 86 per cent. of the value of the first transformer, the combined rating of the two being 1.866, that is 1 plus .866.

If the second transformer is designed for approximately 90 per cent. of the normal voltage of the primary of the first transformer, that is the one that receives the full transmission line voltage, it will work exceedingly well in practice. In fact transformers designed for equal voltages and intended for delta connection can be T connected and utilized to advantage.

Alternating current systems of distribution, by the utilization of transformers possess great flexibility of service. On single-phase circuits, by suitable connections and taps, the transformers can be so connected as to change from any voltage and current to any other voltage and current, within certain well defined practical limits, dependent upon the transformer design and output. In a multiphase or polyphase system of transformer distribution, not only can they attain changes of voltages and current, but the form of the phases themselves can be changed to fulfill almost any desired practical condition.

The power factor of most commercial transformers is low. At no load it varies from 50 to 70 per cent., while at approximately full loads the power factor is very nearly 100 per cent. or unity. For this reason it is better to distribute the transformers on the line, so that they will most of the time carry a load sufficiently high to keep the power factor approaching unity.

A clear understanding of power factor is essential. The actual, real or effective power or watts measured at any time is the number of volts multiplied by the number of amperes given off at that time, while the power obtained by multiplying the average voltage by the average current is always greater than the actual power and is termed the apparent power or watts. Now dividing the maximum value of the actual power by the apparent power, we obtain the power factor of the alternating current circuit.

Power factor = true watts/apparent watts.

The power factor is that quantity which when multiplied by the apparent watts gives the true watts. It will depend upon the nature of the circuit, and the kind of machinery, apparatus, or resistances supplied by it. Self-induction and capacity affect the power factor of a circuit as well as the percentage of load on a circuit. Its value is also affected by the phase displacement, that is the amount of lag, between the current and voltage.

The actual or true watts may be measured directly by means of a suitable wattmeter, and can also be obtained if we know the "ohmic resistance" of the circuit, and the amperes, (virtual amperes) flowing, as indicated by an ammeter for:

$$\text{True watts} = \text{Current squared} \times \text{resistance}$$
$$= I^2 \times R$$
$$= A^2v \times R$$

Where A^2v = virtual amperes squared and R the resistance in ohms. An example is given as follows:

Ammeter reading = 120
Voltmeter reading = 100
Apparent watts = 120 × 100 = 12,000.

Assuming the wattmeter to read 11,520 actual or true watts.

Then power factor = true watts/apparent watts = 11520/12000 = .96.

Similarly if the wattmeter reads 8,000 watts and the average volts and average amperes as indicated by a volt meter and ammeter are 100 and 100, the apparent power is 100 × 100 = 10,000 watts. Therefore the power factor = 8,000/10,000 = .8 or 80 per cent. Now if the current lags behind the e. m. f. we can readily find the actual or true watts, without using a wattmeter, if we know the angle of lag, the virtual volts and virtual amperes as indicated by a voltmeter and ammeter.

For true watts $= E\,v \times I\,v \times \cos\Theta$

$= \text{Volts virtual} \times \text{Amperes virtual} \times \cos\Theta$

Where $\cos\Theta$ = the cosine of the angle lag,

Therefore Θ = angle of lag.

For example: Suppose the voltmeter reads 100 and ammeter 10 amperes, while the current is known to lag 60 degrees. Then angle of lag = 60 degrees = Cos Θ = Cosine of angle of lag, where numerical value of Cos 60 degrees = Θ. Referring to a table of cosines it will be found that the numerical value of this 60-degree angle = .5.

Therefore true watts = 100 × 10 × .5 = 500, and apparent watts = 100 × 10 = 1,000.

Therefore power factor = 500/1,000 = .5
= value of cosine 60 degrees.
= angle of lag Θ

Therefore Cos Θ may be considered to be the power factor of the circuit. Power factor = true watts/apparent watts or Cos Θ = true watts/apparent watts.

Therefore the numerical value of Cos Θ = power factor. For instance suppose the value of the angle Cos Θ = .9; and we find the ammeter and voltmeter reading 10 to 100 respectively. The true watts

$$= I\,v \times V\,v \times \cos\Theta$$
$$= 10 \times 100 \times .9 = 900$$

and apparent watts = 10 × 100 = 1,000. The power factor then = 900/1,000 = .9, but we already have Cos Θ = 9. Therefore Cos Θ = power factor.

This explains why power factor is sometimes defined as the cosine of the angle of phase displacement (angle of lag) that exists between the current and voltage of a circuit. The power factor of a circuit can never be greater than unity.

In both theory and practice the angle of lag can never be greater than 90 degrees. However great the frequency of the circuit or inductance therein and whenever the phase difference, whether lag or lead, is very large, that is closely approaching 90 degrees, the current being so much out of phase in relation to the volts, is almost wattless, sometimes called wattless current. This condition is approached when the current flows through a choking coil or condenser, if the resistances are small.

As the power factor is determined by the cosine of the angle of lag, it is very essential that the numerical value of the cosine of the angle should be as high as possible. The value of the cosine of a 90-degree angle is zero, and the greater the phase difference, that is as the "lag" approaches

90 degrees, the less the power factor becomes, getting closer and closer to zero value. This is an undesirable condition in practice, and has to be strictly avoided.

It is obvious that if the value of the cosine of the angle of lag is unity, its maximum value and only happens when the value of the angle Θ is zero degrees, that is no phase difference or lag, the apparent watts and true watts are equal. This gives a power factor of unity; and while this is theoretically possible, it is never attained in practice, because it is impossible to have a circuit entirely devoid of inductance. A non-inductive circuit is absolutely essential to attain a condition which possesses no phase displacement, a requirement to give us unity cosine and unity power factor.

In every instance it is highly important and desirable in practice to maintain the power factor as high as possible, because with a high power factor the amount of work obtained from the alternating current machinery is then at its greatest value, or the ratio, true watts divided by apparent watts is a maximum.

In practice the utilization of rotary converters in combination with transformers for power distribution possesses advantages under suitable conditions. A rotary converter is a machine that converts or changes alternating current into direct, and is sometimes called a Synchronous converter. If the same machine be mechanically driven, it will deliver both direct and alternating currents and when so used is called a double current generator.

Three-phase transmission of power is very economical, and when utilized by rotary converters to fulfill certain practical requirements, it is often advisable to use a rotary converter wound for a six-phase circuit. This for the reason that a rotary converter designed for six phases has a greater capacity for work than the same machine wound for a three-phase circuit.

Review of Central Station Practice and Developments in England.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

BY CECIL TOONE, AN ELECTRICAL ENGINEER IN ENGLAND.

IN THIS article the writer will take up further lighting conditions in England, continuing from last issue and dealing particularly with street lighting. It is a significant fact that of some 270 areas in the United Kingdom served by central stations with no traction load only 24 per cent. have no electric street lamps and of the remainder a very large percentage have entirely electric lighting in this service. Of the towns having no electric street lamps the largest per cent. have company electricity and gas supply, for 1910 this percentage being about 70. Municipal electricity and gas supply held second place with a percentage of 17.

	ELECTRICITY, CENTS PER KILOWATT HOUR		GAS, PER 1,000 CUBIC FEET.
	LIGHTING.	POWER.	
Year 1904	11.0	5.3	0.82
Year 1910	10.3	4.3	0.79

The average price per unit for electricity and per 1,000 cubic feet of gas for the above areas is as follows: The population, number of consumers and kilowatts of plant involved in these areas are shown in Table 12. The number of areas with no traction load and no electric street lighting were 76 for 1904 and 65 for 1910.

TABLE 12. POPULATION, CUSTOMERS AND KILOWATT OF PLANT IN AREAS WITH NO ELECTRIC STREET LIGHTING.

	YEAR 1904		YEAR 1910	
	Total.	Mean per area.	Total.	Mean per area.
Population	2,392,300	38,000	1,810,000	31,200
Consumers	28,950	414	59,700	948
Connected K. watts	66,700	982	179,000	2,800
Generator K. watts	63,690	885	144,400	2,060

From these figures it appears that the non-existence of electric street lighting is seldom due to excessively high electric and abnormally low gas supply rates. As might be expected the majority of the areas in question are supplied with both electricity and gas by companies but it is curious to note that there are more areas without electric street lamps where the electric supply alone is municipal than where the gas supply alone is administered by local authority. The number is, however, small in both cases. The percentage distribution of ownership of gas and electricity supply, in the areas considered, has not varied greatly during the past six years but, although the number of areas and the population concerned have been greatly reduced, the state of affairs is relatively worse now when compared with the great extensions of electricity supply for other purposes. See Table 12 and note the number of consumers and kilowatts connections per consumer in 1904 and 1910.

CABLES, DISTRIBUTING BOXES, LAMP POLES AND SUSPENSIONS.

Highway and electrical supply authorities now co-operate to a considerable extent, the former affording every facility for the extension and mutually convenient location of underground networks. The latter is glad to supply power for lighting and tools on sewerage schemes, bridge and tramway work, pipe laying and so forth. The cables used on such temporary supplies must of course be heavily armoured and laid in as safe spots as possible.

Laying cables under the pavement involves minimum dislocation of traffic, installation is simplified and subsequent access is more easily obtained. Again, less strong arches are necessary over the manholes or distribution boxes than must be provided when these have to bear heavy road traffic and finally, house service mains are laid more easily from cables beneath the pavement.

The location of street lamp standards is often hampered in English towns by traffic considerations, occasionally by difficulties with owners of property flanking the roadway and most frequently by the unequal size of building blocks and non-opposite street corners. It is generally desirable to locate a street lamp at street corners or at the centre of the streets which cross there. Centre poles enable very good street lighting but they impede the traffic in many small towns, while the variable width of streets and heights of houses in British towns, hampers the application of centre suspension from overhead cross wires. The shadow of passing vehicles is thrown athwart the footpath by any purely central lighting system. Bracket suspension of street lamps from the walls of adjacent houses is considerably employed in small towns, but a good reflector is needed on the wall surface if serious loss of light is to be avoided. Again the variable width of streets in the average provincial town is a handicap to the successful application of the system.

Curb location of poles is most generally adopted in this country, a staggered arrangement being usual, and the poles placed so as to avoid obstruction of traffic. The most recent types of pole consist of a massive cast iron base carrying a light steel upper structure. The cast iron pedestal looks well, withstands collisions and gives the required weight and stability, while the steel stem and neck are light, graceful and strong. Individual or sectional controlling switchgear has hitherto been usually mounted in the pedestal of poles but several recent designs have arranged for this to be placed 10 feet or so above street level in a neat, light, weatherproof shell secured to the pole. The suspending neck and fittings for street lamps, whether arc or metallic filament, are now regularly designed so as to combine artistic effect and mechanical strength with a minimum obstruction of light, a condition which has been considerably neglected in the past.

Arc lamps are generally suspended so as to enable them to sway somewhat in a high wind, the stresses on their supports being thereby reduced. This arrangement is easily secured on lamps provided with lowering gear. In a similar manner, but for a different reason, metallic filament lamps are often flexibly suspended so that the vibration of the poles, caused by the passage of heavy traffic, may not be communicated to the lamps. As already noted, some of the flexible supports marketed for this purpose have proved worse than useless and in very many cases ordinary bayonet holders are employed with no serious percentage of breakages.

GENERAL TENDENCY OF STREET LIGHTING PRACTICE AND COSTS.

The utilization of high efficiency electric lamps in street lighting has administered no appreciable setback to central stations, the tendency being wholly towards increased illumination for a given energy expenditure rather than towards a reduction in the cost of operation. The general rise in supply pressures has not materially affected arc lighting practice and, though series running of metallic filament lamps is still necessary where moderately low candle power units are required, this is easily arranged for in street lamp wiring.

On every hand low pressure incandescent gas mantles and carbon filament lamps are being replaced by groups of metallic filament lamps. Old open and enclosed arcs are being similarly replaced where any candle power much lower than 1,000 per pole is required or by flame arcs where high illumination is needed. Despite its utilization in many important streets, see also special section on London developments, high pressure incandescent gas lighting does not make much headway and the flame arc lamp which suffered by its complexity and short burning hours, during the early stages of its development, is now rapidly supplanting all rivals in cases where fair competition is afforded and units of 2,000 or more mean spher. candle power can be conveniently employed.

Towns provided with trolley electric tramways naturally employ arcs more liberally than others who have to install special standards for lamp suspension. A common arrangement is now to suspend an arc lamp from every alternate or every third trolley wire pole, supplementing the general illumination so obtained by a pair of 50 or 100 watt metallic filament lamps mounted on reflector brackets low down on each pole.

The Nernst lamp and the small enclosed arc lamp are rapidly falling into disuse being replaced by suitable groups of metallic filament lamps. It is found that groups of 3, 5 or 7 lamps in 50 to 100 watt tungsten sizes give a much higher and more uniform illumination in many cases than has hitherto been obtained by the use of fairly large open arcs. Wherever flame arcs can not be afforded there is a decided tendency to convert other types of arc lamps when necessary to groups of metallic filament lamps. The low current magnetite arc which appears to have found considerable favour in the States is practically unknown in this country.

TABLE 13. SUPPLY AREAS WITHOUT TRACTION HAVING ELECTRIC STREET LIGHTING.

	Supply areas without traction having Electric Street Lighting.										No. with no Elec. St. Lighting.
	Arc.			Filament lamps.			No.				
	Open	Encl	Flam	Carbon.	Met. Fil.	Nernst.	Arcs.	C.F.	M.F.	Nernst.	
Year 1904	44	32	-----	118	-----	34	23	73	270	156	76
Per Cent	16.3	11.8	-----	43.6	-----	12.6	8.5	27.0	100	57.8	28.1
Year 1910	98	64	52	89	139	43	45	111	62	150	65
Per Cent	36.4	23.7	19.3	33.0	51.5	16.0	16.7	41.1	23.0	55.5	24.0

Table 13 shows the great change wrought by the employment of metallic filament lamps and flame arcs in street lighting but fails to adequately represent the rapidity with which carbon filament lamps, Nernst lamps and small enclosed arcs are yielding place to metallic filament types. This defect is largely remedied by analyzing in greater detail the changes in practice during the period 1904 to 1910.

At the present moment many towns have under trial a motley collection of arc lamps and metallic filament lamps but uniformity is being gradually approached. For units of less than 500 candle power and even as high as 800-1,000 candle power osram and tantalum lamps are largely employed while for more powerful units 8, 10, 12 or, rarely, 15 to 20 amperes, flame arcs are used. The multiglobe fittings adopted in American towns, one lamp per globe and 3 to 5 lamps per standard, are rarely used in this country and then mainly by private consumers, large shops, etc. Cluster fittings are now available for anything from single or twin 50 watt filament lamps up to 4 or 6 300-candle power lamps or 3 1,000-candle power units.

Where gas lamps have been converted, metallic filament lamps are commonly mounted within the old lantern but in new installations it is becoming common to mount the lamps free of all enclosure, their average life being thereby increased. The cost of converting from low pressure incandescent gas to metallic filament lamps, using the existing poles and lanterns, is very moderate, generally ranging from $15 to $20 per post, including all labor and materials incidental to the conversion and placing of the equipment in thorough working order.

Street lighting is invariably paid for out of public funds in English towns and the various charging systems adopted come broadly under the following headings:

1. Lump Contract.
2. Charge for energy supply and maintenance of lamp.
3. Charge for energy alone; maintenance not undertaken by supply company.
4. Charge for a certain amount of light per annum.

Naturally the last system is the best, involving as it does a direct charge upon the commodity or result desired. All questions of metering and maintenance are avoided and the supply company is automatically encouraged to install reliable and efficient types of lamps. A lump contract being a more or less speculative investment to both parties often necessitates a contingency allowance which ultimately may prove clear profit to the contractor. Methods (2) and (3) obviously induce the supply company to obstruct, or at least to regard passively, the installation of high efficiency lamps. Method (2) offers no encouragement to contractors to maintain lamps in perfect condition while method (3) generally involves a separate maintenance contract—in most cases a costly and unsatisfactory course. All the methods noted are in considerable use in this country.

Contracting for a certain quantity of light, method (4), involves continual photometric measurements to ensure that the conditions of the contract are being fulfilled. Foot-candle measurements can not be conveniently made for this purpose and it is generally specified that the mean candle power of the lamp, in directions along the street, depressed 20 degrees and 50 degrees respectively from the horizontal, which mean candle power closely approximates the mean hemi-spherical candle power of the unit, shall not be less than a certain minimum and that lamps of at least this candle power (thus measured) shall be placed a certain distance apart and at a certain height above street level. Such a system has been found very satisfactory in the Westminster district of London during the last five years. Weather conditions appreciably affect the results obtained and it is generally agreed that, when an individual lamp is temporarily below par, the mean of its candle power and those of the adjacent lamps on either side of it, shall be regarded as the criterion of the conformity of all three to contract terms. It is usual to impose a penalty per lamp per day for insufficient illumination, but in some instances this penalty has been fixed absurdly high so that tendering firms have had to add a risk-covering amount to their offers.

The actual charge per street lamp per annum, assuming constant type throughout, has not greatly decreased during recent years and in some instances it has increased owing to higher cost of labor and miscellaneous stores. Usually, however, increases in the running cost per annum are traceable to increased illumination required and given. Comparatively few towns adopt a charge per kilowatt hour for their street lamp supply but where this system is followed a distinctly cheaper service is available than was the case six years ago. In 29 such towns in 1904, the mean price per kilowatt hour was 6.28 cents and in 46 towns in 1910, the mean price per kilowatt hour was 5.22 cents, a 17 per cent. reduction.

Where a fixed charge per annum is levied on each street lamp distinct from a fixed charge per lamp in domestic service since the burning hours per annum are now closely constant and known in advance, the amount usually varies between $10 and $15 per column fitted with incandescent filament lamps and between $75 and $100 per arc lamp. Naturally these amounts vary considerably with the type and size of lamp employed and with the burning hours per annum. Among filament lamps, ½ ampere Nernst burners, 2-50 watt metallic filament lamps and single or double 16 or 32 candle power carbon filament lamps are favorite units while, among arcs the 7½ ampere or 10 ampere open, the 10 ampere or 12 ampere enclosed, the 8 ampere—12 ampere flame and the 5 ampere enclosed arc, becoming rare, are most frequently employed. Though until within the last 5 years one-fourth ampere Nernst and 8 candle power carbon lamps were common in small streets, lighting units of less than 16 candle power are now rarely employed and 32 or more candle power is a more general minimum. In large towns the street lamps burn from dusk to dawn but in smaller communities they may be extinguished at 2 a. m., midnight or even 11 p. m., two thousand burning hours per annum is a common allowance when estimating for English street lighting.

The mean charges per lamp per annum are:

FILAMENT LAMPS.

Year 1904. $14.41 the mean of 68 towns.
Year 1910. $14.65 the mean of 97 towns.

ARC LAMPS.

Year 1904. $94.25 the mean of 108 towns.
Year 1910. $84.05 the mean of 112 towns.

The average charge for filament lamps has risen slightly while that for arc lamps is decidedly reduced. This fact can be explained by the greater relative increase in candle power and the smaller relative increase in efficiency, when metallic are substituted for carbon filament lamps, than is usually the case when flame arcs replace other types. Further, the renewal charges on metallic filament lamp installations have been heavy until recently. Lamps, such as are now marketed, have proved their ability to approach 2,000 burning hours in heavily traveled city streets and this increased longevity, together with the reduction in prime cost of high efficiency filament lamps, should cause a substantial decrease in the mean cost per annum of operating the same, probably to $10—$12 per 100 watts per year.

STREET LIGHTING IN LONDON.

The total area of Greater London is very much more subdivided for purposes of electric supply than is the case where gas supply is concerned. Thus two large gas companies supply the larger and more important part of the district covered by twenty-nine electrical undertakings. Until quite recently there was no trace of co-operation between the number of electrical undertakings which not competing with each other to any appreciable degree, had yet to compete with the same gas company. The natural result was that the large gas companies, with their great resources and elaborate business organization, secured a huge advantage which is, to a large extent, still maintained, for co-operation between central stations in publicity matters is developing very slowly. Local show rooms, permanent or periodical are, however, effecting great improvement. The above state of affairs naturally handicaps the extension of supply to private consumers more than it affects street lighting.

Though some 30 per cent. of the London electric supply districts are wholly without electric street lighting the consumption of energy for this purpose in the remainder has more than doubled during the last six years entirely refuting the erroneous rumor, which has gained currency in some places, that London is becoming a gas lighted city. This rumor is based chiefly on the substitution of high pressure gas lamps for arcs in Finsbury, the City of London and parts of the City of Westminster.

Three arc lamps installed in front of the Mansion House in 1907 gave 3,960 candle power and were adopted in preference to five high pressure gas lamps of 1,220 candle power. The cost of the arcs being $3 \times \$62.50 = \$187.50$ against $5 \times \$75.00 = \$375$ per annum. In spite of these results which could be repeated, at least as favorably to electricity, by comparing the latest flame arcs and high pressure gas mantles and in spite of the findings of a deputation sent to report on the lighting of various Continental cities, the City of London Corporation have recently adopted gas lighting in certain important streets without allowing electrical companies at all a fair showing.

Recently, however, an electric lighting scheme has replaced high pressure and low pressure gas lighting in certain of the more important streets in the City of London. The whole scheme is of comparatively small extent, involving some 75,000 candle power, equivalent to about 40 or 50 kilowatt. Its installation is entirely due to the enterprise of the City of London Electric Co. which has borne the whole cost of the equipment, solely to demonstrate the superiority of electric lighting. The area concerned in the new developments includes some of the busiest city streets, and in Cheapside, for instance, the day traffic is so dense that the installation of the new lamps had largely to be carried out between midnight and 7 a. m. and at week ends.

The whole scheme may conveniently be divided into the three areas: (a) Cheapside and Watling St. area. (b) Farringdon St. area. (c) Paternoster Row area. In Cheapside and Watling St., centrally suspended high candle power arcs are employed, there being no room for centre poles. Farringdon St., however, is much wider and centre poles are used on the various traffic shelters, islands or refuges. In the Paternoster Row district, only quite narrow streets have to be lighted and the present installation merely substitutes metallic filament lamps and efficient reflectors for low pressure gas mantles. Further special conditions pertaining to each lighting area are as follows:

In Cheapside and Watling St. four arcs in each thoroughfare are suspended at crossings so that the cross roads between the two main streets are lighted by powerful arcs at each end, additional illumination being provided, where necessary by metallic filament lamps. In Cheapside there are arcs placed between the cross street lamps. These auxiliary arcs burn only till midnight, those at the crossings burning from dusk to dawn. Between the Watling St. arcs, 300 candle power metallic filament lamps suffice to raise the net illumination to a suitable value.

Throughout the area concerned, side streets and courts and passages are lighted by metallic filament lamps arranged on wall brackets or pavement standards. The narrowness of many of the smaller thoroughfares and the existence of shop sign-boards of various descriptions, has complicated the problem of obtaining an even illumination at low cost but the results attained leave nothing to be desired.

THE OLD AND THE NEW INSTALLATIONS IN LONDON.

The following table analyzes the new and old lighting equipments as fully as is necessary for the purpose of this article. It is to be noted that the improved illumination provided in the main streets often enables a considerable reduction in the number of lamps required in the side roads. Thus the arcs in Cheapside and Watling St. partially light the cross-roads connecting these main arteries and about a dozen gas lamps have been dispensed with, in side roads and courts branching from Farringon St., by reason of the increased illumination derived from the electric lamps in the latter. Again in the Paternoster Row area, 11 low pressure gas lamps in the Row were replaced by 9 electric lamps fitted with high efficiency reflectors, and it was then found possible to abolish four other gas lamps in side courts leading off Paternoster Row, so that 9 electric lamps are actually doing the work of 15 gas lamps. Though the nominal candle power now provided is somewhat less than that displaced, the illumination has admittedly been improved by the change. A point of vital importance is that, whereas the rated candle power of electric lamps is closely maintained during a long life, the nominal candle power of gas mantles is little more than an arbitrary rating and is certainly maintained for only a short period.

NEW ELECTRIC LIGHTING AREA IN CITY OF LONDON STREETS.

	New Installation	Old Installation.
Length of Streets Lighted in feet	7530	7530
Number of Lamps; Arcs	23 (mean 3000 c. p. each)	20 (mean 1200 c. p. each)
Met Fil	41 (mean 100 c. p. each)	--------
Gas	--------	94 (mean 260 c. p each.)
Total No. Lamps	64	114
Total Candle Power of Lamps	72985	48,235
Mean distance between lamps in feet	327½	376½
Mean can le power per lamp	1140	423
Increase in Total Candle power	24,750 or 51.3%	--------
Increase in Candle power per lamp	717 or 170%	--------

In the city of Westminster, of some 1,157 arcs employed by the City authorities only 71 or 6.2 per cent, have been replaced by high pressure incandescent gas mantles, although the streets concerned are important, the total demand involved is very small. The tenders of the competing gas and electric companies for the supply and maintenance of light as follows, on five year contracts, were:

	ELECTRICITY.	GAS.
90 candle power, load factor 45 per cent.	$24.40	$13.80
3,000 candle power....................	136.00	107.00

Clearly the acceptance of the gas company's offer was justified by the better terms thereof but the electrical company was handicapped by the terms of the contract which stipulated no definite streets to be lighted but left it at the option of the local authority to require any or all streets within a given area to be supplied while permitting no such latitude to the tendering company. Whereas the gas company had already mains laid in all the streets where lighting was likely to be demanded, the electrical company had to safeguard itself against being required to make considerable extensions of its cable system to supply districts in which no other load could be easily obtained and this without any guarantee that the contract would be renewed in their favor at the completion of the present five year period.

Central Station Distribution for Large Territories.

BY WILLIAM B. JACKSON.

That the central station idea is becoming recognized as applicable to large territories with scattered population, is the opinion of William B. Jackson, of the firm of D. C. & Wm. B. Jackson, Chicago, presented in a paper read at the meeting of the American Institute of Electrical Engineers February 10, 1911, at New York. A few years ago the advantages of electric light and power as distributed from big stations were considered to belong to cities and the larger towns alone. These benefits may now be extended to sparsely settled regions at a reasonable cost by means of unified systems of electrical distribution.

The advantages of such a system as a substitute for disconnected small stations located in the cities and villages of the territory correspond roughly to isolated plant of the large city, may be summarized as follows: (1) Saving in power house equipment made possible through taking advantage of the diversity of different communities by serving them from the same transmission system. (2) Lower power generating cost per kilowatt-hour due to larger power plants and improved load factor. (3) Less investment in power plants per kilowatt capacity on account of larger plants as compared with smaller. (4) The possibility of decreased percentage of spare apparatus by appropriate arrangement of power plants. (5) Saving in cost made possible by centralized management, general superintendence and other general expenses. (6) The possibility of providing rural and suburban service that could not be profitably reached by a local central station. (7) The possibility of large corporations providing power service which would be too extensive for small companies to undertake. (8) The development of water powers for electric service.

The savings made available by these factors may be set opposite the losses due to transmission transformers and lines, and the cost of transmission line maintenance, interest, etc., to determine whether a unified system or a number of separate plants can most economically serve a territory. However, it should be remembered that only by covering the country with systems serving groups of cities and villages from relatively large power houses properly located, is it possible to serve rural districts generally at a reasonable cost. To provide electric service for a rural district alone is rarely economically possible.

The original impetus to this movement for far reaching transmission systems was imported by the development of hydro-electric plants, of which a transmission system is an essential part. The development and perfection of various transmission machinery, caused by the large increase in the number of hydro-electric plants in recent years, has made possible corresponding developments in the transmission of electric power from steam plants. One of the most vital points to be considered before arriving at the decision as to whether a unified system is economically preferable is that of the diversity factor.

DIVERSITY FACTOR CONSIDERATIONS.

The question of diversity factor as between various communities which are provided with electric service from a single transmission system is quite complex. By diversity factor is here meant the ratio of the sum of the maximum peak loads of separate plants which would serve the individual communities to the maximum peak load that would occur if the plants were combined. The condition may be illustrated by a consideration of the load curves of four central stations in the Northwest. One of these, (Plant 1), serves a city of 50,000 inhabitants with mostly business and residence lighting service and has a maximum output of over 900 kilowatt; the second, (Plant 2), serves a city of 20,000 inhabitants having a good lighting and commercial power load together with the local street railway service, and has a maximum output of 1,250 kilowatt; the third, (Plant 3), serves an agricultural town of 4,000 inhabitants and has a maximum load of approximately 105 kilowatt; and the fourth, (Plant 4), provides only business lighting and power service, and has a maximum load of over 790 kilowatt. These are highly dissimilar in their characteristics and give the following result as regards diversity factor:

	Maximum Individual Largest Peaks During The Year.			Coincident Peak During The Year.		
	Kilowatts.	Date	Time	Kilowatts.	Date	Time
Plant 1	920	Jan. 22	8 P. M.	970	Dec. 23	5. P. M.
" 2	1250	Nov. 12	9 P. M.	1190	Dec. 23	5. P. M.
" 3	104	Nov. 15	6. P. M.	74	Dec. 23	5. P. M.
" 4	794	Dec. 27	5. P. M.	784	Dec. 23	5. P. M.
	3068			2838		

There is therefore a difference of 230 kilowatt between the largest coincident peak and the sum of the maximum peaks, which represents a diversity factor of 1.09. This seems a surprisingly small advantage from the combination, but it would allow a corresponding reduction in machinery to carry the peak load in a unified transmission system over what would be necessary if the maximum peaks were coincident, and would correspondingly improve the load factor over the average of the separate plants. The reduction in peak here indicated, is equal to more than twice the maximum load of the smallest plant referred to.

When plants (1) and (2) only are combined, the time of their largest coincident peak is the same as in the foregoing case so that for these two plants there is a difference between the coincident peak and the maximum peaks of 190 kilowatt and a diversity factor of 1.10. This saving in peak capacity amounts to 21 per cent. of the smaller maximum peak and a combined plant would have only 79 per cent. of the smaller peak added to the larger.

Considering plants (1) and (3), the greatest coincident peak is formed by 920 kilowatt and 89 kilowatt occurring at 8 p. m. on Feb. 19, and the maximum peaks are as heretofore given. With this combination there is a saving in peak capacity of 15 kilowatt, which leaves the diversity factor little different from unity, but amounts to about 15 per cent. of the peak output of the small plant. When plant (3) is combined with plant (2) there is a saving in peak capacity of 51 kilowatt which amounts to 49 per cent. of the maximum load of the small plant.

Two large groups of towns, for which the aggregates of maximum peaks are about 10,000 kilowatt, show the following diversity factors: One of the groups, which comprises towns having rather uniform characteristics, shows a diversity factor of something over 1.10, while the other group in which the towns have diversified business characteristics, shows a diversity factor which is larger than 1.18. All of the data I have available tends to show that diversity factor as between towns is highly variable and in some cases may be large, while in others it may be relatively small.

Considering the first illustration presented, the saving in peak capacity arising from a combination of the plants might not cover the additional generating plant necessary to supply a reasonable maximum transmission loss. This, however, would be influenced by the number of power plants operated in the unified systems, and their locations, as well as by the design of the transmission circuits.

In the case of the illustration of plants (2) and (3) and assuming that plant (2) is to be enlarged to supply both communities, with an accompanying abandonment of plant (3), there is then a saving in peak capacity of 51 kilowatt. After allowing for the added generating plant required for the maximum loss in the transmission line to the smaller community, the saving in cost of equipment afforded by the diversity factor when making the enlargement of plant (2) amounts to between $5,000 and $7,500, which could be applied toward providing the transmission circuit. The power required for the small system could be generated at a low figure since about 50 per cent. of its load would go to improve the load factor of the unified system without increasing the maximum load.

Referring to the last illustration mentioned above, there would be a saving in plant capacity on account of diversity factor of over 1,800 kilowatt, which, expressed in terms of investment, would amount to, say, $250,000. This can be considered as off-setting plant made necessary by transmission system, since plant released from peak load service in a growing system stands in lieu of additions to capacity to take care of new business.

FEATURES OF LOAD FACTOR.

Improved load factor accompanies increased diversity factor since increase of the latter decreases the peak load without changing the average load. Referring to the next to the last illustration of diversity factor heretofore given, the weighted average of the annual load factors of the several towns may be taken as 22 per cent. Since the diversity factor between the towns is 1.10 the load factor for all of the towns served together will be 24.2 per cent., while if the diversity factor had been 1.18 as is the case in the succeeding example, the load factor would become 26 per cent. Thus for unified electric systems there is a saving in operating cost per kilowatt-hour owing to improved load factor as well as on account of the improved operating economies of larger generating plants.

Commercial Application of Scientific Phenomena.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

BY EDWARD LASCAR GROSS, CHEMICAL ENGINEER.

MANY of the present commercial enterprises have found their beginning from some scientific phenomena which for a long time were but interesting laboratory experiments. This is true of the great electrical and chemical industries of the world, and their remarkable progress during the last few years is due, in a great measure, to the establishment of research departments, whereby many of these phenomena have been viewed from an economical and commercial aspect with a view to turn them to practical worth.

The great dye manufactories of Germany are founded on the discoveries made by a young chemical student who had the ability to view a newly observed phenomenon from the practical as well as the scientific side. The scientific facts which many of us have time after time seen demonstrated, have merely been viewed by us as demonstrations of nature's laws and without our really considering to what practical use they could be turned.

As an interesting example of this, consider the phenomenon of super-cooling of liquids. If we take a clean glass flask, partly fill it with water and close the neck of the flask with a plug of cotton, the liquid may be cooled, by some artificial means, to a temperature of a few degrees below its freezing point, and yet remain in the liquid state. This is called super-cooling and the water is said to be super-cooled. Now, if we carefully remove the plug of cotton and drop a tiny crystal of ice into the flask, the water will instantaneously turn into a solid piece of ice. One would hardly imagine a commercial application of this experiment, yet it has been done. There is a hot water bag on the market which depends on this super-cooling for its operation. The hot water bag is placed in boiling water for a few minutes, the cap tightly screwed on, and the bag laid aside for future use. When its services are suddenly demanded, it is merely necessary to unscrew the cap, expose it to the air, replace the cap on the bag and a gentle heat is immediately given out for some considerable time.

The bag contains a salt, probably sodium acetate, which is a solid at ordinary temperatures. When the bag is placed in the hot water the sodium acetate is melted, thus absorbing a quantity of heat equal to its latent heat of fusion. On removal of the bag from the hot water, the salt remains in the liquid, or super-cooled state in the air-tight bag. By removing the cap, a portion of the liquid evaporates, a tiny crystal of acetate forms, and it solidifies or freezes, thus giving out as sensible heat, its stored up, or latent heat of fusion. This is a simple device but clearly illustrates my point.

It is in the field of electricity, however, that the most wonderful achievements have been made, as the telegraph, telephone, incandescent light, electrical generators, and lately that most marvelous of all, wireless telegraphy. It is an interesting and fascinating occupation to make up a list of some of nature's phenomena, no matter how simple and valueless they may appear and then try to figure out some way or method of application by which they will prove of practical worth and of benefit to mankind. By the study of the mathematical laws of heat and electricity, by observation of the laws governing the discharge of electricity through gases and the ionization thereof, by the study of the action of those rays of light which lie outside the visible spectrum, etc., wonderful results will be obtained and we may soon hope to see the direct conversion of the latent energy of coal into electricity, the production of light without heat, the discovery of new elements and combinations thereof.

Let us pick out a certain electrical experiment which has time and time again been observed but of which no practical use has been made. Let us look at it from a commercial aspect and see whether or not it does not immediately take on a different light, in that it awakens the desire to try and find out for ourselves, a use for it. I refer to Peltier's effect.

In the year 1834, Peltier made the discovery that on the passage of an electric current through a thermo electric junction, that is, a junction of two different metals, there will either be a development of heat at the junction or an absorption, according to which direction the current is passed. The Peltier effect differs from the well known Joule heating effect, in that the Joule effect is proportional to the square of the current, and is independent of the direction of the current, while the heat developed at the junction of two metals by the Peltier effect is proportional to the first power of the current and depends on its direction. The Peltier effect can best be demonstrated and its magnitude measured by means of the following apparatus.

A and D are two glass globes connected by the glass tube G, in which a drop of liquid H, is placed as an indicator. The metal rods A A and B are rods of two metals which pass through corks which fit air tight in the necks of the bulbs, in such manner that the junctions E and F are at the center of the globes or bulbs. The globes being of the same capacity and the parts of the rods A A and B which are within the globes, being of the same size and resistance, the development of heat according to Joule's law is the same in both globes, so that the increase of pressure due to the warming of the air by the Joule effect is equal in both, and hence the index does not tend to move in either direction.

The Peltier effect is different in the two globes, since in one the flow of current is from the metal A to B, at one junction, and at the other, B to A. Therefore heat will be developed at one junction. The air in the bulb will become heated and its pressure raised, at the other junction heat will be absorbed, the air cooled and the pressure in the globe reduced, thus causing the index to move over toward the globe in which heat is being absorbed.

By making a small hole at the junction of a bismuth and antimony bar, in which a drop of water and the bulb of a small thermometer were placed, and the whole cooled to zero, Lenz found that when a current was passed from bismuth to antimony, the water was frozen and the thermometer indicated 3.5 degrees C. Another method of showing this effect is by interposing an iron wire between two copper wires and surrounding the first with water at zero degrees, and the second with ice at zero degrees. On passing a feeble current it is found that as much ice melts at one junction as is produced at the other.

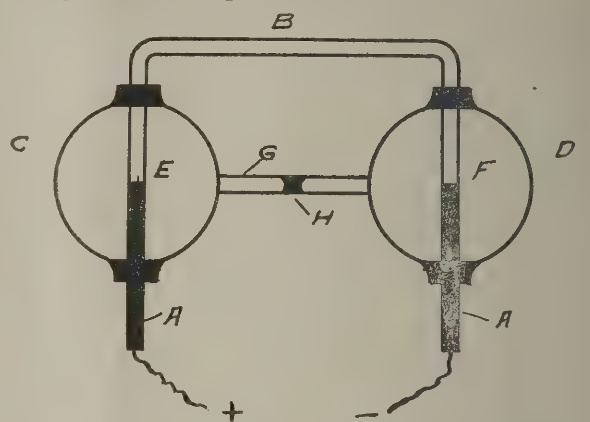


FIG. 1. APPARATUS DEMONSTRATING PELTIER EFFECT.

As stated, the heat due to the Joule effect is proportional to the square of the current, C, to the resistance R, and to the time t, and is independent of the direction of the current. The Peltier effect is proportional to the strength of the current and to the time, and is reversible in its direction. Let the Peltier effect be called H, then the heat developed will be H C t and that due to the Joule effect, C^2 R t. Then in the experiment with the two globes, we have for the total heats developed in each globe, h equals C^2 R t plus H C t and in the other, h′ equals H C t — C^2 R t, from which H equals h-h′/2 C t. Therefore the greater the term 2 C t, or the strength of the current, the less will be the Peltier effect, so that it can only be shown with feeble currents.

The following table gives the magnitude of the Peltier effect for a few metals. The current is supposed to pass from copper to the metal mentioned in the first column, and in the second column is given the quantity of heat liberated, or absorbed, by one ampere in one second at the junction, expressed in calories.

Metal.	Calories Per Coulomb.
Iron	-1.7×10^{-4}
Platinum	$+0.9 \times 10^{-4}$
Silver	-1.1×10^{-4}
Nickel	$+12.1 \times 10^{-4}$
Zinc	-1.6×10^{-4}

Consider the case of nickel to copper Here there is an absorption of 12.1×10^{-4} or .00121 cal. per coulomb of electricity. 1 Coulomb equals 1 ampere for 1 sceond, 1 Calorie equals amount of heat required to raise the temperature of 1 gram of water 1 degrees C., and 80.2 cal. per gr. equals latent heat of fusion of ice. Then 80.2/.00121 equals 66,281 coulombs; that is 66,281 coulombs when utilized as Peltier's effect, or 1000 amp. flowing for 66.2 seconds give a refrigerating effect equal to 1 gram of ice.

At first glance this does not appear to be a very economical manner of producing refrigeration, especially in view of the fact that small currents must be employed in producing the Peltier effect. By taking into consideration the fact that very low voltages might be employed, and that a large cable composed of thousands of strands could be taken, the cable unwoven at its ends into the component strands and each one fused to a like number of strands of another cable of a different metal, thus making a great number of junctions, does there not appear a possibility of utilizing a large source of current as a thermo electric refrigerator?

It is not the purpose of this article to give an exhaustive analysis of this phenomenon but merely to bring out the fact that these interesting laboratory experiments when considered both from the theoretical and practical view points, may, and do lead to certain lines of study and research which make possible the great strides in the advancement of service and the progress of humanity.

Some Important Features of Patents.

(*Contributed Exclusively to* Southern Electrician.)

BY MAX W. ZABEL.

IN THE articles following this one the writer desires to take up some of the peculiar features of patent law, continuing the general subjects appearing in previous issues. The matter under present discussion will be an automobile patent law peculiarity. Public opinion will not tolerate monopolies at the present time and justly so. There is one monopoly that is not affected and that is the monopoly conferred by a patent. That of course is a just monopoly, in that the patent is a contract between the inventor and the public by virtue of which the inventor discloses something to the public which they did not before possess and in return for which the public grants to the inventor a monopoly for a limited period, seventeen years, in which to make, use and sell the invention. The United States grants no extension of time after the seventeen years except by a special act of Congress, and that seems at the present time almost impossible to obtain.

From what has been said, it will occur to the reader that if a commercial enterprise or industry is based on a patent, that is a fundamental patent controlling such industry, that contracts made between the various integral entities of the industry will be sustained in the courts. For instance in the case of all of the various automobile manufacturing concerns who form the component parts of the American Licensed Automobile Manufacturers, their industry is based entirely on the Seldon patent which covers broadly the adaptation of a gasoline engine to a road vehicle. As these manufacturers are licensed under this patent, naturally the terms can be made anything that is desired, and these concerns so long as the Seldon patent is running may make contracts in restraint of trade on account of the monopoly accorded this industry by the Seldon patent.

Now the peculiarity in this situation is this, that the Seldon patent did not issue until 1895, and consequently will not expire until November 5, 1912. Yet this patent was filed in the Patent Office in the year 1879, consequently remaining in the Patent office more than sixteen years. In this case as in some others, it has happened that the inventor is ahead of the times with his invention and that an invention not commercially of value at the time it is made, may in fifteen or twenty years become extremely valuable. In such case, ordinarily, the inventor would lose, if his patent had been issued at or near the time it was filed, say within the normal time of a year or two which is ordinarily consumed between the time of filing an application and the issuance of a patent.

After the application papers are filed in Washington, the Patent Office replies with suggestions and possibly rejections, and the inventor has one year, formerly two years, during which he must make reply thereto. If all the matters have not been cleared up, the Patent Office again replies with further suggestions and the inventor again has a further year, to which so long as the prosecution in this way is without fraud, no definite limit is set during which the patent must issue after the application is filed.

The Seldon invention was originally conceived and an application filed thereon in 1879 and by amendments to and fro between the inventor and the Patent Office was not finally allowed until more than sixteen years later, and the patent finally issued November 5, 1895. Now, if the inventor had allowed this patent to go to issue in 1879 or in the early eighties, the seventeen years would have run out before one automobile might have been equipped with his invention. He, however, delayed the final issuance of the patent by honestly prosecuting it before the Patent Office for sixteen years and the patent was issued in 1895 at the beginning of the automobile season, so that the patent has seventeen years to run from that date, or until November 5, 1912. Consequently this inventor is able to enjoy the fruits of his invention.

Of course, in the progress of the invention through the Patent Office, the inventor must not have been guilty of fraud in delaying the issuance of the patent, as otherwise the patent would be invalid. It may seem strange that a patent should control the automobile field, and this patent be issued at such a late date as 1895, but it must also be borne in mind, considering the state of the art, that what would not amount to an invention in 1895, did amount to an invention in 1879, the filing date, at which time there was hardly any art relating to gasoline vehicles.

The invention consisted at that time in providing a vehicle with an engine of the compression type, provided with one or more cylinders having a power shaft, connected to run faster than the propeller shaft, in combination with an automatic clutch or disconnecting device, all mounted upon a suitable carriage body. This combination meant invention in 1879, but would not have required invention in 1895, yet, the application having been filed in 1879, the patent granted him thereon has only recently been adjudicated entirely valid by the Circuit Court of the southern district of New York and the inventor therefore has a patent covering the entire automobile field. In the next issue another feature of importance will be touched upon along this line.

The Traffic, Commercial and Maintenance Sides, of the Telephone Businesss.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)
BY L. O. SURLES.

IN THIS article the writer will endeavor to cover some of the details in connection with the sub-station and its installation of interest to maintenance men. As the sub-station is removed from the central office, it is important that it be installed with the utmost care, so that the upkeep will be a minimum. Some instrument men do not realize this important part of their work and are careless in omitting the features which though seeming of a trifling nature, still bear their part toward a perfect installation. Then, too, the relation which the instrument man bears to the subscriber as a representative of the company is an important one, for the reason that the subscriber is the unit of revenue to the company and his wishes regarding the installation must be given consideration. Again, the courtesy accorded him by a representative of the company will go a long way towards winning his respect and good will for the company.

Various types of apparatus are required to meet the variety of demands of telephone subscribers and to supply these numerous demands the market provides sub-station sets and concomitant equipment to please the most exacting subscribers. To the subscriber, the beginning and end of the telephone business is the equipment on his premises which is better known to the telephone man as subscribers' sets, of which there are two distinct types: the wall set and the desk set. This does not take into consideration the special types such as pay stations and toll station equipment. These types may be secured for either common battery or magneto systems, and differ little as regards the respective circuits of each system. That is, the fundamental talking circuits.

In the magneto system, a variety of signaling circuits are in use, more particularly on party lines; however, details of these circuits will be taken up under another section of this paper. Before going deeper into the subject in hand, the principal elements of the sub-station will be discussed. The specifications demanded in the standard of each part will be covered without reference to the history of same further than the underlying physical features which are vitally essential to its proper operation.

THE RECEIVER.

The receiver as the basic instrument of the entire telephone industry, will be taken up first. The function of the receiver now used, consists in taking from the line the undulatory waves of electricity impressed thereupon by the transmitter causing them to vary the field of a permanent magnet in which is suspended a diaphragm capable of vibrating with the field changes. Therefore the best receiver is the one in which the magnetic, electric and acoustic properties are such that the sound waves emitted by the diaphragm correspond closest in amplitude, energy and shape to the electric pulsations of the line. The receiver must be so designed that the coil, diaphragm and magnet are in the proper relation to secure this result.

For a long period, manufacturers adhered to the original type having a single pole permanent magnet, but the more recent bi-polar design has proved so far superior to the single pole that the latter has probably passed into history. However the design may have changed, little change has occurred regarding the relation of the coil, the magnet and diaphragm. Kemster Miller in his Telephone Practice says: "Aside from actual efficiency, many considerations of a purely mechanical nature enter into the design of a good telephone receiver. It should be durable, and capable of withstanding the rough usage to which it will necessarily be subjected by careless or ignorant users. It should be of such construction that its adjustment will not be changed by mechanical shocks or by changes in temperature. Failure to provide against this latter effect is one of the chief sources of trouble in telephone work. It should be of such external configuration as to enable it to be conveniently placed to the ear. The chamber in which the diaphragm vibrates should be small and of such shape as not to muffle the sound. The binding posts should be so securely fastened in as to prevent their becoming loose and twisting off the wires inside the receiver shell; and the construction should be so simple as to render the replacement of any damaged parts an easy matter." To obviate the expansion and contraction difficulty, affecting the adjustment of the diaphragm, a cup of non-magnetic metal of very nearly the same temperature coefficient as that of the diaphragm is provided which fits within the hard-rubber or composition shell and supports the diaphragm at the proper distance from the face of the magnets and yet be in such position that the cap will secure it in place. Concealed binding posts have come into favor with some manufacturers, which eliminates any exposed parts of metal, but it is doubtful if this type has any advantage over that having exposed binding posts.

The office of the magnet is to create such a field as will maintain all the magnetic force in its most sensative condition or state of magnetic equilibrium. Therefore, the permanent magnet must be a generator of sufficient electromotive force and have the body necessary in relation to the air gap and diaphragm as "will maintain the latter in its most susceptible" condition. Hence the dimensions of the magnet will depend upon the thickness and permeability of the pole pieces and diaphragm and the length of the air gap. For the information of the uninitiated it will be well here to explain that permeability is that property which permits of a magnetic body accepting and retaining a large amount of magnetism.

The pole pieces form a portion of a magnetic circuit which is affected by the changes in the line current. The pole pieces must have a section in proportion to the permeability so as to be in the most susceptible condition at all times. To make the whole as sensative as possible the air gap must be as short as to allow the diaphragm to make its great latitude of vibration without touching the pole pieces and thereby preventing its magnetic adherence thereto. Last but by no means least, the diaphragm must consist of a sufficient body of the most permeable material as will not affect its acoustic properties.

Troubles are few on the receivers at present in use, the principal source of damage being that to the diaphragm which is subjected to the probings of the curious and careless persons who when they cannot hear well, poke pencils and other pointed instruments into the opening in the earpiece, hoping thereby to shake up something which will help it. Then too, the diaphragm becomes rusted by perspiration from the ear which affects the operation sufficiently to require changing occasionally. Attempts to remedy these troubles by other means than removal of the diaphragm are wrong.

Central Station Welfare Work.

The final meeting of the Public Policy Committee of the National Electric Light Association was held March 28, and the report which has been prepared through a series of long conferences was unanimously adopted. The recommendations and suggestions were put in definite shape for presentation to the member companies at the May convention in New York. The committee during the past winter, has been devoting considerable attention to the various aspects of welfare work as related to the central station industry and has felt it important that all notions of philanthropy or charity be entirely eliminated in the suggestion of such relations. Following recent American and European precedent in some respects it has studied to work out various plans which may be adopted separately or comprehensively by any company in membership. Several of the companies already have in force some of the schemes proposed, but it is not assumed that every company will wish to adopt every form of relationship outlined in the report. The plan includes accident insurance, sickness insurance and death benefits, service annuities, profit sharing, employees savings and investment funds, and life insurance, although with regard to the last item it is suggested that the companies limit themselves to providing their employees with all possible information in connection with safe-low-cost life insurance, and do not put in force any plan of their own.

The coming report will give in detail the methods by which provision can be made under each of the other heads. By unanimous vote the term "pension" has been dropped, and the service annuity adopted as the recognition of an automatic recompense for continuous service, and the committee is of the opinion that member companies should provide such annuities for every male employee reaching the age of sixty-five, and every female employee of sixty years after continuous and satisfactory record of ten years of service. The details of profit sharing are also very interesting, based upon the idea that it is better to have those engaged in the industry as partners rather than employees and that preferably profits of the employee based upon his wage scale should reach him in the securities of his company and that dividends upon such securities should be paid in cash, in the manner customary with other security holders. Details are also given with regard to savings funds and investment funds, with the object of promoting thrift amongst employees and, where feasible, combining the plan of the profit sharing, it having been found that the two work out very satisfactorily together. The report goes into considerable detail and no summary could well do justice to the care and pains with which each point has been considered.

The personnel of the committee is Mr. Charles L. Edgar, chairman, president of the Edison Electric Illuminating Company, Boston, Mass., Messrs. Nicholas F. Brady, vice-president of the New York Edison Company, Charles A. Stone, of Stone and Webster Corporation, H. M. Byllesby, whose company is also operating and managing numerous central station properties, Henry L. Doherty, president of the Denver Gas and Electric Company, W. W. Freeman, president of the National Electric Light Association and vice-president of the Brooklyn Edison Company, Samuel Insull, president of the Commonwealth Edison Company, Chicago; Joseph B. McCall, president of the Philadelphia Electric Company; Samuel Scovil, vice-president of the Cleveland, Ohio, Electric Illuminating Company, and General George H. Harries, vice-president of the Washington, D. C. Railway and Electric Company, Mr. Everett W. Burdett, counsel of the Association and Mr. Arthur Williams of the New York Edison Company, vice-chairman of the committee. The committee has also enjoyed the active co-operation of Mr. Thomas E. Murray, president of the Association of Edison Illuminating Companies and Messrs. W. H. Blood, Jr., and R. S. Hale.

It is believed that it is the first time in the history of the country that an association representing so many corporations and representing over ninety per cent. of the investment and earnings in the industry for which it stands, has taken up such a subject in this comprehensive and thorough going manner, and the report itself will be awaited with the utmost interest by all connected with public utilities and by economists in general.

Congress of Technology at Boston.

The Congress of Technology held at Boston on April 10 and 11 in celebration of the semi-centennial of the signing of the charter of the Massachusetts Institute of Technology was a pronounced success. President Maclaurin of the Institute opened the sessions by an address on "Some Factors in the Institute's Success." He attributed that success primarily to the method of instruction, now everywhere accepted, but not long ago a debated and somewhat scorned venture.

The daylight hours of the second day were given over to the presentation of papers on various aspects of applied science. These papers were grouped in six divisions, and the times of reading were so arranged that the general public, a large number of whom had received personal invitations, were enabled to hear papers in several divisions on topics in which they were particularly interested. Every session was very largely attended, and as the papers dealt not with educational or technical abstractions but were on the contrary striking and vital reports from the actual field of industrial work, the large audiences gained a better conception than would otherwise have been possible of the fashion in which applied science has remade the life and habits of the world within the last half century.

The papers were given by Technology alumni and members of the faculty and the range of accomplishment which the papers reported was a splendid certificate of merit and efficiency going to the credit of the men trained at the Institute. These reports covered the widest range and represented the characteristic undertakings of the engineer in the broadest sense of the word "engineer."

The temper of the great meeting was significant in showing a sharp consciousness of a new era created by applied science; of the important part that has already been taken by graduates of the Massachusetts Institute; and of the pressing need, especially from the point of view of the interest of Massachusetts, that the Institute should be immediately equipped with the additional means for enabling it to continue in the future as it has in the past.

Convention of Southwestern Electrical and Gas Association.

The seventh annual convention of the Southwestern Electrical and Gas Association was held at Houston on April 27 to 29. A new feature of the Houston meeting was the inauguration of the first electrical show in the Southwest participated in by the manufacturers of the United States who are members of the association. The exhibits were numerous and interesting including the latest devices in departments of electric lighting, street railway and gas.

The papers read at the convention showed up the spirit of the association and served as an indication of the work being done by the men who represent the important industries in the Southwest. The following subjects were presented and discussed:

"Industrial Development of Fuel Gas," by R. G. Soper, secretary Dallas Gas Company, Dallas, Tex; "Investigation and Care of Return Currents," by George H. Clifford, general manager Northern Texas Traction Company, Fort Worth, Tex.; "Boiler Economy and the Application of Fuel Gas Analysis," by M. L. Mibbard, engineer, San Antonio Gas and Electric Company, San Antonio, Texas; "Cause and Prevention of Accidents," by C. W. Kellogg, Jr., manager Texas securities department, Stone and Webster, Dallas, Tex.; "Light Weight Cars, Their Construction and Operation," by R. T. Sullivan, general superintendent Houston Electric Company, Houston, Tex.; "Steam Consumption in Water Gas Plant," by L. B. Moorhouse, superintendent gas department, San Antonio Gas and Electric Company, San Antonio, Tex.; "Development of Electric Power Business," by P. A. Rogers, commercial agent Dallas Electric Light and Power Company, Dallas, Texas; "Practical Tests for Railway Equipment," by H. Fink, Jr., mechanical engineer San Antonio Traction Company, San Antonio, Texas; "Napthalene," by W. H. Riblet, superintendent of manufacturing, Houston Gas Company, Houston, Tex.

The entertainment features were well planned and enjoyed, including the big Rejuvenation of the Sons of Jove.

Electrical Vehicle Interests in Boston.

The second conference and dinner of the electric vehicle interests in Greater Boston was held at the Hotel Thorndike, Boston, April 3. Definite plans were decided upon for an electric vehicle campaign, and many of the co-operative plans of the Boston Edison Electric Illuminating Company for helping the electric vehicle interests place more machines in Boston's territory were explained, adopted and will be pushed with vigor.

Forty electric vehicle representatives and members of the Boston Edison Company were present. Professor Dugald C. Jackson of the Massachusetts Institute of Technology explained in more detail than at the meeting a month earlier how the Institute, with funds provided by the Boston Edison Company, will prosecute its investigation of electric vehicle questions. Professor Jackson called attention to the fact that nearly every delivery system where horses and wagons are used has developed in a haphazard way, and has spread out here and there as business has grown. Nobody knows anything about the efficiency of the horse and wagon, and it will be a part of the Institute's work to collect comparative data between the efficiency of horse and wagon and electrically driven wagon. There is considerable general information on this subject. Everybody knows that the electric wagon takes up less room, is easier to operate and control and is cleaner, safer and quicker than the horse and wagon. Numerous specific cases can be cited to prove this; the Institute will determine these things exactly and establish the facts through investigation.

E. S. Mansfield for the Boston Edison Company outlined plans for the development campaign which will include: A booklet that will be sent to all electric vehicle manufacturers and their agents throughout the country giving information about this development campaign; a booklet for local agents of electric vehicles in Greater Boston; a handsomely designed brochure in ten colors about pleasure vehicles; a handsome, dignified booklet showing types of business vehicles electrically operated that have agencies in Boston; and large advertisements in the Boston daily papers.

N. E. L. A. Convention at New York.

The hotel committee of the National Electric Light Association, with Frank W. Smith, as chairman, is taking the initiative in convention work by issuing its circular on hotel provision for the convention to be held at the United Engineering Societies Building, May 29—June 2. The circular of the committee is an elaborate piece of work and includes a list of fifty-four hotels with their location, telephone number and the fullest details as to accommodations and prices. In addition to this the circular, which bears on the outside an admirable vignette of the Engineering Building, embodies also a colored outline map of Manhattan Island showing the location of the building and of every one of the hotels listed, so that members can see at a glance the relative distance, and convenience, of all the accommodations. The map includes also lines of elevated railroad and subway with the stations indicated. A large attendance is now expected and virtually assured. Mr. Smith is anxious that all who intend to be present will avail themselves of the data thus furnished and will return to him the reply postal card which will enable the appropriate reservations to be made.

Charles H. Hodskinson, master of transportation of the National Electric Light Association, is also taking active steps to organize his important work in advance of the convention. At the time of the St. Louis convention last year, when the membership was 5,500, the registered attendance was 2,780. Since the membership has now reached 7,521, on the same basis there will be from 3,500 to 4,000 present in registered attendance.

The increase during the current Association year has, therefore, been already in excess of 2,000 and the indications justify the belief that by the time of the annual convention next month even the very large growth of 1910 will have been exceeded and that a total of 8,000 members will be reached. The growth is due to a variety of causes and the new list given in the Bulletin this week, not only includes several central station companies but large lists from newer company sections such as those in New York, Joplin, Missouri and Pittsburg, Pennsylvania. At the present moment company sections are being organized at Scranton, Pennsylvania, and Birmingham, Alabama, and are expected to be in operation before the end of the month. It would appear that the Association has now become the largest electrical society in the world. The officers expect confidently in another year that the membership will be at least 10,000.

This implies heavy transportation and Mr. Hodskinson has therefore formed the following active committee, which is taking up its duties in co-operation with Mr. Hodskinson. As soon as the details have been arranged as to trips, rates, etc., they will be announced, and it is possible that other names may be added to the committee:

R. H. Ballard, Southern California Edison Co., Los Angeles, Cal.; W. J. Barker, Denver Gas and Electric Co., Denver, Colo.; E. J. Bowers, Kansas City Electric Lt. Co., Kansas City, Mo.; J. A. Britton, Pacific Gas & Electric Co., San Francisco, Cal.; F. A. Coupal, Buffalo General Elec. Co., Buffalo, N. Y.; E. Creed, Toronto Electric Light Co., Toronto, Canada; J. E. Davidson, Pacific Power & Light Co., Portland, Ore.; P. Doty, St. Paul Gas. Lt. Co., St. Paul, Minn.; J. B. Eaton, Rochester Ry. & Lt. Co., Rochester, N. Y.; G. A. Freeman, Commonwealth Edison Co., Chicago, Ill.; F. H. Gale, General Electric Co., Schenectady, N. Y.; A. F. Giles, General Electric Co., Atlanta, Ga.; W. J. Grambs, Seattle Elec. Co., Seattle, Wash.; M. S. Hart, Consumers Elec. Lt. & Pr. Co., New Orleans, La.; H. A. Holdrege, Omaha Elec. Lt. & Pr. Co., Omaha, Nebraska; H. M. Hope, Stone & Webster Corporation, Boston, Mass.; F. N. Jewett, Wagner Elec. Mfg. Co., St. Louis, Mo.; A. H. Manwaring, Philadelphia Elec. Co., Philadelphia, Pa.; A. Maughan, Utah Light & Ry. Co., Salt Lake City, Utah; J. C. McQuiston, Westinghouse Bureau of Publicity, East Pittsburg, Pa.; A. A. Serva, Fort Wayne Electric Works, Fort Wayne, Ind.

Iowa Electrical Association.

The Eleventh Annual Convention of the Iowa Electrical Association held at Davenport, April 19 and 20 was one of the most successful in the association's history. A number of interesting papers were presented and the discussions plainly showed the wide interest and co-operative spirit in the work. The following subjects were presented: "Waterloo Transmission Records" by Ira L. Craig; "Underground Distribution in Medium Size Cities" by H. B. Gear; "Refrigerating Advantages and Disadvantages" by G. W. DuMont; "Flat Rates for Small Demand Consumers" by A. H. Ford; "The Electric Automobile" by F. H. Golding; "Method of Securing and Properly installing Power Load" by H. G. Glass; "Ornamental Curb Illumination" by R. M. Parker; "Industrial Heating Loads" by I. D. A. Cross; and "Public Policy" by Geo. Carson.

The work of the convention was well supplemented by appropriate entertainment features including theatre parties and a smoker. The Sons of Jove were in evidence and a successful rejuvenation held.

Meeting of Georgia Section of N. E. L. A.

The first meeting of the executive committee of the Georgia Section of the N. E. L. A. was held at Hampton Terrace Hotel, Augusta, Georgia, on April 6th. The members of the committee in attendance were John S. Bleecker, of the Columbus Railway Co., Columbus, president; W. R. Collier, of the Georgia Railway & Electric Co., Atlanta, vice-president; H. M. Corse, of the Columbus Railway Co., secretary and treasurer; and Burdett Loomis, of the Ware County Light & Power Co., Waycross; and R. C. Mayo, of Augusta-Aiken Railway & Electric Co., Augusta.

Since the formation of the Georgia Section last fall, it has increased its membership remarkably and now has listed as regular members upwards of 40 active Southern central station men. The work done at the executive meeting was considerable and many important matters were brought up which will influence the growth of the Section in the future. The data in connection with this meeting is not at hand at the present writing but will be published in the June issue of SOUTHERN ELECTRICIAN.

Florida Telephone Association.

The annual meeting of the Florida Telephone Association was held at Tallahassee, Florida, April 12. On account of the absence of the president, the meeting was presided over by Dr. W. L. Moor, the vice-president. The association was informed of the dangerous illness of its president, Mr. W. G. Brorein, of Tampa, whereupon suitable resolutions of sympathy and regret were prepared and telegraphed to Mr. Brorein.

After a discussion of a number of matters of interest to the telephone industry of Florida by a number of the delegates the program was taken up. This program consisted in the presentation of papers on various subjects as follows:

"Rural Telephone Development," by L. K. Smith, Gen. Manager, Gainesboro Tel. Company, Carrollton, Ga.; "How Rural Telephones Effect the Revenue From Local Subscribers' Stations and Toll Lines," by W. H. Adkins, Gen. Con. Agent, Sou. Bell T. & T. Co., Atlanta, Ga.; "Selective Ringing on Party Lines," by W. V. Lathrop, Manager, Peninsular Tel. Co., Bradentown, Fla.; "Preservation of Poles and Crossarms," by L. A. Vaughan, Supt., Peninsular Tel. Co., Tampa, Fla.; "The Manufacture of Telephone Apparatus," by E. H. Bussey, Western Electric Co., Atlanta, Ga.

The State legislature of Florida was in session at the time of the meeting and owing to some legislation adverse to the States' telephone interest having been introduced, the greater effort of the convention was diverted toward combating this legislation. A permanent legislative committee was appointed and after a lengthy discussion of ways and means whereby the telephone properties of the State might be best protected, the association adjourned subject to the call of the president. After adjournment an automobile ride over Tallahassee and the surrounding country was tendered the association.

On account of the damper thrown on the association by the illness of its president and the absence of several of its most influential members, it was the opinion of the association that the meeting held was of a temporary nature and that the formal meeting should take place when called by the president. No new officers were elected.

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.

50 K. W. STATION EQUIPMENT.

Editor Southern Electrician:

(211) "Kindly ask the readers of Southern Electrician to give me information as to the necessary equipment for our small central station. We have formed a company to furnish lights to a small town of 800 inhabitants. Already contracts have been signed for 25 street tungsten lights and 500 residence incandescents. The information required is as follows: The proper voltage for the transmission system, distance from hydro-electric plant to town being 2 miles. It is altogether possible that another small town may be annexed to the system, making the total number served about 1,600. If this takes place the 50 k. w. equipment would act as an auxiliary or for supplying a day power load. The voltage chosen for transmission should be such as will be economical in case the plant is doubled or trebled in equipment capacity. What size of wire should be used for transmission? How many poles to the mile? What is the best distribution voltage for town 220 or 110 volts and what size transformers should be chosen? For the city lights what is the best spacing of poles, type of reflector and size of tungsten lamp? Is it advisable to urge the use of tungsten lamps in residences and adopt flat rate charge. It will be necessary for our company to carry electrical supplies; kindly indicate in what quantities it is best to buy for the load connected. Kindly furnish a sketch of electrical circuits at power station, including switches, instruments, fuses, etc."

E. L. & P. Co.

SEPARATE CIRCUIT FOR HEATING AND COOKING.

Editor Southern Electrician:

(212) "Kindly request your central station readers to advise what the percentage the electric heating and cooking load of any residence should be of the total monthly k. w. consumed, to advise a separate circuit and meter. Should the meter be installed by the company or by the property owner? If by the company give rate for the load when lighting rate is 10 and 12 cents per k. w. hr. Give data to substantiate statements."

A. E. D.

OPERATION AUTOMATIC TELEPHONES.

Editor Southern Electrician:

(213) "I would be pleased if some of your readers would enlighten me regarding the principle of the operation of the so-called Automatic telephones. I have an idea which I desire to develop and such information would be of help in solving a problem which I am working on, if one or two features are brought out which I believe is embodied in the automatic from my present idea of them."

Reader.

RAISING P. F. BY SYNCHRONOUS CONDENSER.

Editor Southern Electrician:

(214) "In our power plant we have one 500 k. w. alternator carrying a load consisting of 3-phase induction motors on an average of 140 amperes at 2,300 volts, delta connection. The wattmeter reading is 400 k. w. giving a power factor a little over 70 per cent. The voltage is stepped up to 6,600 and transmitted about 3½ miles where it is stepped down to 440 volts. It is our intention to replace an induction motor of 50 horsepower carrying a load of about 38 horsepower by a self-starting synchronous motor. What size motor must be installed to carry the 38 horsepower load and also boost the power factor to 85 or 90 per cent? I would like the details and method of determining the size."

T. C. M.

60 CYCLE MOTOR ON 133 CYCLE CIRCUIT.

Editor Southern Electrician:

(215) "Kindly advise if it is possible to operate a 60 cycle motor successfully on a 133 cycle circuit and visa versa. Also please explain the particular features of design that are different in motors intended to operate on these frequencies."

M. S. C.

HIGH TENSION TRANSMISSION TOWERS.

Editor Southern Electrician:

(216) "I would like to obtain information relative to the advantages of transmission towers having conductors suspended from upright insulators over the design in which the conductors are attached to inverted insulators. Perhaps your readers who are connected with each of these systems can contribute suggestions from their experience."

A. H. C.

ELECTROLYTIC LIGHTING ARRESTERS.

Editor Southern Electrician:

(217) "As a reader of Southern Electrician, I desire information on the following conditions: Last fall we installed a set of Westinghouse electrolytic lightning arresters, Type A, 11,000—13,200 volts, on ungrounded neutral. After being installed a couple of weeks, every time we charged them a coil or two in the machine was lost. Some changes have been made, electrolyte C being installed. On recharge with this change and an increase of voltage to full potential, two coils were again lost. It is claimed that if the film is not properly built up when the arrester is bridged a heavy momentary current will flow which will blow fuse and trip circuit breaker. We have a 10 ampere fuse and in no case was the fuse blown or circuit breaker tripped when burnouts occurred in the generators due to charging arresters. The arresters have been charged since by the same method and everything has worked all right. The writer desires a detailed explanation of why the burn-outs took place. Upon examining

the coils in the last case after removing from the machine I found the wire roasted from end to end as though there had been a decided short circuit. Both coils were in the same phase. Last fall with the first type of arrester some of the coils would be found punctured to the frame of the machine. The generators are 450 and 600 k. w. 10,000 volts, 3-phase, 60 cycles."

W. R. K.

Unanswered Questions.

DISTRIBUTION SYSTEHS.

Editor Southern Electrician:

(202) "We have a central station of 5,000 K. W. capacity and considering running a transmission to a small town one mile distance. The load will consist of street lighting and a possible office and factory lighting load for 15 buildings averaging four stories and approximately 10,000 square feet of basement area. A power load for the factories, six in number, is also possible, with an average of 100 horsepower. What system of distribution and transmission would be considered most economical and best suited to the demands, direct current, three-wire, or alternating current, single, two or three phase? Our station equipment is 2,200 volt, A. C. with rotary converters." H. A. L.

SINGLE-PHASE LOAD ON THREE-PHASE SYSTEM.

Editor Southern Electrician:

(206) Kindly publish information from your readers in regard to the use of the balance coil to get single phase connection on a three-phase system. I would like to get information and comparisons of this method of taking single-phase load from three-phase generator as against placing load across any one of the three phases."

A. F. L.

COST AND DESIGN OF ELECTRIC SIGNS.

Editor Southern Electrician:

(210) "I shall appreciate information from engineers in the field of illuminating engineering as to the average cost of an electric sign made up of two plain words of twelve letters, the sign to be operated by a flasher. The sign will read J. J. Brown, Shoes. I would like also to know the approximate cost of a design for the same sign of an oblong style to give a rat chaser effect. If data can be given of a general nature on the installation cost, apparatus cost and operation of such a sign per letter or per lamp it will also be appreciated." H. H. C.

Induction Generator, Remarks on Question No. 185.

Editor Southern Electrician:

"In regard to the answer to Question 185 in your March issue by Mr. Siedell, I agree with him to some extent. His statements on power factor are, however, erroneous. The induction generator operating on an inductive circuit would tend to adjust itself, that is, the power factor required by the external circuit, exactly coincides with the internal power factor of the induction generator. This requires that the power factor either of the external circuit or of the induction generator vary with the voltage, so as to permit the generator and the external circuit to adjust themselves to equality of power factor. This subject is a very broad one, and I will not go into it in detail. I will however, give features referring to the operation of the induction generator.

An induction motor runs as a motor, at a speed less than the speed of the rotating magnetism in the stator iron, that is, synchronous speed. When the motor load is decreased, its speed approaches synchronous speed, and the intake of power from the alternating current mains falls off more and more. If the rotor is driven by an external source of mechanical power, it may be speeded up to synchronism, in which case the intake of power becomes zero except for core loss in the stator iron.

If now the rotor is speeded above synchronism by the external source of power, the stator windings deliver power to the alternating current mains, provided the alternating current generator remains connected to the mains to fix the frequency. When an induction motor is so used, it is called an induction generator. The magnitude of output in current by the stator, depends upon the speed at which the rotor is driven. The reason for this is as follows: When the machine is running below synchronous speed, the relative rotation of the rotor and stator fields is that the former is slower than the latter, that is, if the slip is 5 per cent. it is equal to rotating the rotor backwards at 5 per cent. of full speed, with a fixed stator field. Now if the speed of the rotor be increased to, say, 5 per cent., above synchronous speed, it will be equivalent to running the rotor forward at 5 per cent. of full speed with a fixed stator field. During this change from below synchronous speed to above it, there will be changes in the rotor current. Just as the rotation of the armature of a direct current dynamo first in one direction then in another produces a current flowing in one or other direction corresponding to the changes in direction of rotation, so the rotor currents in the above case will flow in one direction when the machine is rotating below synchronism, and gradually die down as the rotor reaches synchronous speed, at which speed there will be no rotor current as the rotor winding cuts no flux.

If mechanical power sufficient to raise it above synchronous speed is supplied, the rotor current will again rise but this time in the opposite direction, due to the change in the relative speed of rotor and stator. This reversed rotor current will give rise to a reversed stator current, just as in the case of a transformer supplying current to the secondary in the reverse direction will cause the primary current to reverse also, and if a sufficient E. M. F. and current is supplied to the secondary, the primary will actually give current back to the line. Our induction motor now does so; for while we do not supply electrical energy to the secondary to cause it to act like a reversed transformer, we supply mechanical energy which, owing to the relative action of the two moving fields, causes it to give power back to the line.

"The relation of the E. M. F.'s is as follows: As a motor, the watt current input which is in phase with the supply volts, is in opposition to the back E. M. F. of the stator, but when the motor is driven above synchronous speed the reversed (secondary) rotor current sets up a corresponding reversed (primary) stator current, and this reversed primary current is now in opposition to the supply pressure and therefore in phase with what was formerly the back E. M. F. becoming an active voltage. The reversibility of the induction motor is now evident. It should also be noted that the machine as a generator possesses all the characteristics of the motor; its maximum output and speed variation between no load and full load remain the same, so that by drawing the curve of output as a motor we have the output of the machine as a generator. This is shown in the figure 1. The machine is not, of course, self-exciting, the magnetizing component of the current has to be supplied from an external circuit; indeed, unless the stator of the induction motor is actually connected to a circuit in which there is a current it can never become a generator, as the rotor current is due to the stator current and not visa versa. Consequently there must be first a stator current and the generator action consists in reversing the rotor and stator active E. M. F's. It is, therefore, necessary to have a synchronous alternator sufficiently large to supply the wattless magnetizing current and to set the frequency. It should be noted in connection with induction generators of this type that the frequency is independent of the speed, and that the output is proportional to the speed up to a certain point, just as the output of an induction motor is proportional to the slip, and subject to the same limitations, as the curves in the figure apparently show.

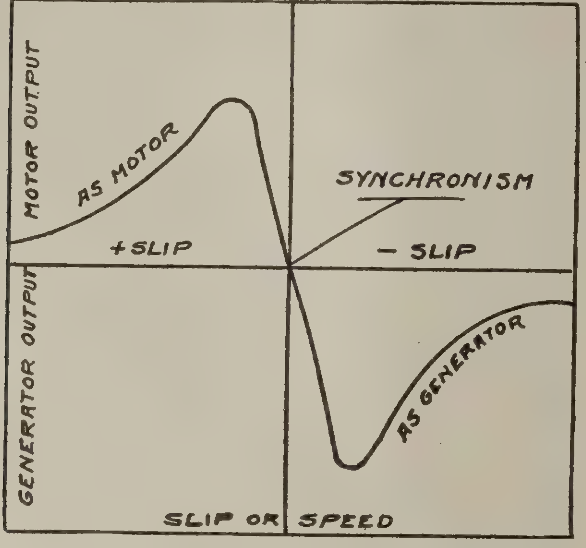


FIG. 1. OUT-PUT AS MOTOR AND AS GENERATOR.

"Mr. Heyland, however, whose work and thorough knowledge of this subject, grasped the fact that the high E. M. F. necessary to send the wattless (magnetizing) current through the stator winding is due to the self-induction of these windings. In point of fact the same magnetizing current could be sent through the windings by only a few volts, were the current direct instead of alternating, the balance being necessary to overcome the back E. M. F. of self-induction; indeed, the voltage necessary to drive the magnetizing current through the winding falls off in proportion to the reduction in the frequency. He therefore hit upon the idea of supplying the magnetizing current at the low frequency of the rotor current instead of at the line frequency. As had been already pointed out the frequency of the rotor current is, under full load, small, equal to that due to the slip only, hence in the case of a 50-cycle machine having 5 per cent. slip at full load the frequency of the rotor current will be about 2½ cycles per second. This will be the same whether the rotor revolves 5 per cent. below synchronous speed, as a motor, or 5 per cent. above synchronous speed, as a generator.

In the Heyland self-exiting machines, both motors and generators, the low frequency rotor current is supplied not by the transformer action of the motor, i. e., supplying the magnetizing current to the stator at full voltage and frequency and then the low frequency rotor current induced therefrom by the transformer action of the motor, but it is supplied direct to the rotor at a low frequency, by means of a commutator which acts really as a kind of frequency changer. These low frequency rotor currents supply the working field of the motor, so that instead of the stator supplying the working flux, the rotor does so, thus the stator only has to deal with the watt component of the output, and (if a generator) the wattless currents due to inductive apparatus on the circuit. The most elementary type of Heyland self-exiting non-synchronous motor or generator is shown diagrammatically in Fig. 2, where A, B, C, are the stator windings, D the rotor with a squirrel cage winding, and brushes on the short circuiting rings. If the machine is intended to operate on high pressure circuits a transformer is necessary for low rotor E. M. F.

"If the pressure is such as is usually used for local lighting and power circuits, a tapping off the stator winding, as shown, is necessary. If the rotor revolves and there is also a current in the stator winding producing a rotating field, the frequency of the current passing from the tappings on the stator windings into the rotor by the way of the brushes, will be proportional to the rotor speed. It will be equal to the stator frequency when the rotor is at rest, and practically a direct current when the rotor revolves in synchronism with the stator field, and at 5 per cent. slip between the rotor and stator, the frequency will be 5 per cent. of the frequency of the stator current.

"Moreover, if the speed of the rotor is 5 per cent. less than synchronism, the direction of the currents in the bars of the rotor winding is in a certain direction, as the rotor speeds up towards synchronism the frequency gradually falls, and the current becomes continuous. As the rotor begins to run above synchronism the current becomes alternating again, but this time in the reverse direction, as already explained, when describing the action of the induction motor above synchronism. It must not be forgotten that the actual rotor currents due to the rotor bars cutting the stator field remain the same as they would in the ordinary induction motor. The magnetizing current passing

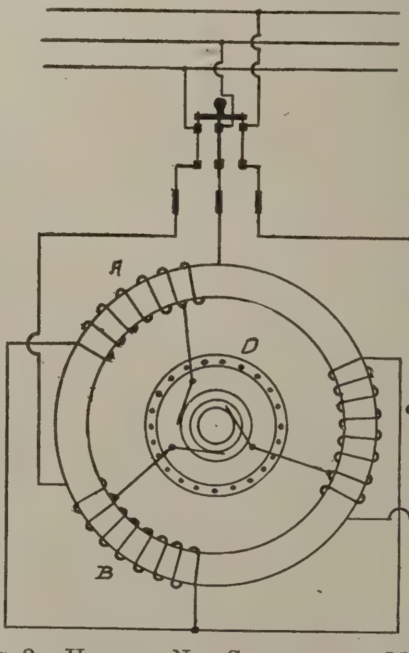
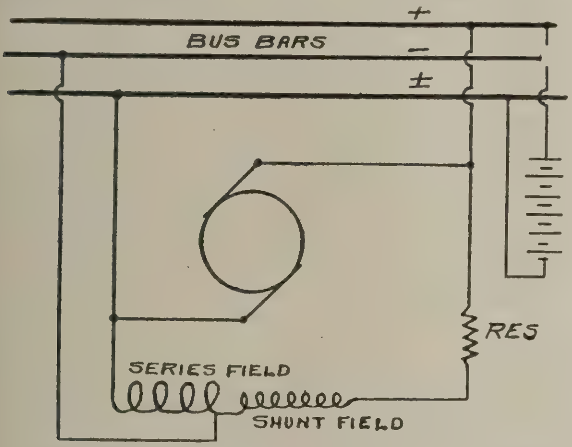


FIG. 2. HEYLAND NON-SYNCHRONOUS MOTOR.

into the rotor through the brushes is separate and distinct, just as in the case of the ordinary induction motor the stator magnetizing current is quite distinct from the watt current, the high frequency magnetizing current in the stator being simply replaced by a low frequency magnetizing current in the rotor. It is now apparent that, as in the case of the ordinary induction motor, the magnetizing current and ampere turns are those necessary to produce the rotor flux plus leakage flux, while in the case of a compensated machine, the amperes and ampere turns are those necessary to produce the rotor flux only, hence in constructing an induction motor the ampere turns on the stator field are less, and the ampere turns on the rotor are increased by the amount necessary to produce the rotor flux. FRANK ZUCH.

Charging Storage Battery, Answering Question No. 188.

It is very appropriate to use a compound wound generator in charging storage batteries, as the e. m. f. generated is practically constant which is essential in charging batteries. It is necessary, however, to connect the batteries between the equalizer bus-bar, and the opposite bus, rather than between the outside bus-bars, so that in case the dynamo should slow down, or the storage-batteries dis-



GENERATOR CONNECTIONS FOR CHARGING BATTERY.

charge back through it, the current will not pass through the series field, and reverse the magnetization of the machine. The diagram of connections is shown in Fig. 1. This would make the machine practically a shunt wound dynamo, as the series and shunt coils are connected across the armature leads. If no equalizer is used the diagram is applicable also, taking current from the armature leads and having the field coils shunted. In the case of a short shunt connection the series field coil can be entirely eliminated. FRANK ZUCH.

Induction Generator, Discussing Question No. 185.

Editor Southern Electrician:

I have noted the answers to Question 185 recently published and will say that the description of the induction generator by Mr. Reed given on page 81 of your February issue is short and not clear. The induction motor operating above synchronism does not give a leading power factor as he says in line 5 of page 81. Also owing to the fact that it requires a magnetising current from an external source and would not improve the power factor of the circuit, it is of no advantage when used on a circuit carrying an inductive load. He is entirely wrong in his statements between lines, 13 to 16, beginning, "It raises the power factor, etc."

The explanation in the March issue is in the main good, but to make it more clear I give the following: An induction generator is a non-synchronous induction machine and will carry a load, but it must be connected to a circuit and speed increased beyond synchronous speed. The periodicity is independent of the speed, and the output is proportional to the speed up to a certain point just as the output of an induction motor is proportional to the slip up to a certain point and subject to the same limitations.

W. R. BOWKER.

Charging Storage Battery, Reply to Question No. 188.

In reply to the question by W. T. R. in your April issue, a 110-volt direct current compound wound generator can not be used to fully charge a 60-cell battery. The voltage is not high enough. It will take 60 x 2.5 volts or at least 150 volts to charge 60 cells in series.

To charge the 60-cell battery, cut the battery in halves, that is, 30 cells in series, and group as two sets in parallel, that is, a multiple series arrangement. Take the two separate batteries of 30 cells and connect the two positive terminals together and the two negative terminals together. This will then give one free positive lead and one free negative lead. Disconnect the series winding entirely from the brushes or terminals of the dynamo and connect as a plain shunt wound generator. Test out the positive and negative brush of the dynamo and to the positive connect the positive lead of the battery, the negative to negative of battery. Place a rheostat in the field circuit of the generator and charge battery for several hours until each cell shows about 2.5 volts and milkiness of electrolyte due to escaping bubbles of gas in the acid. The specific gravity of acid should also register about 1,200. W. R. BOWKER.

Connection to Magneto and Common Battery Lines, Answering Question No. 196.

Editor Southern Electrician:

Referring to Question No. 196 in the April issue I beg to give the following: It is possible to connect a single telephone to either a local magneto, or common battery line by using a two pole double throw switch to connect the instrument to the desired line. The instrument should be of the magneto type, preferably 1,000 ohm bridging. In order that the ringer coil will not cause a permanent signal in the common battery office a two micro-farad condenser should be wired in series with it, which will be an open circuit to the direct current but will allow the alternating ringing current to pass through it freely.

The batteries should, of course, be retained in the instrument for talking purposes, and the generator would be used for signaling on the magneto line. On the common battery line, the signal at the central office would be thrown by removing the receiver from the hook. The above scheme is often carried out by telephone men in cutting over a magneto exchange to a common battery system, and, as stated, the only change in wiring necessary being to wire a condenser in series with the ringer coils.

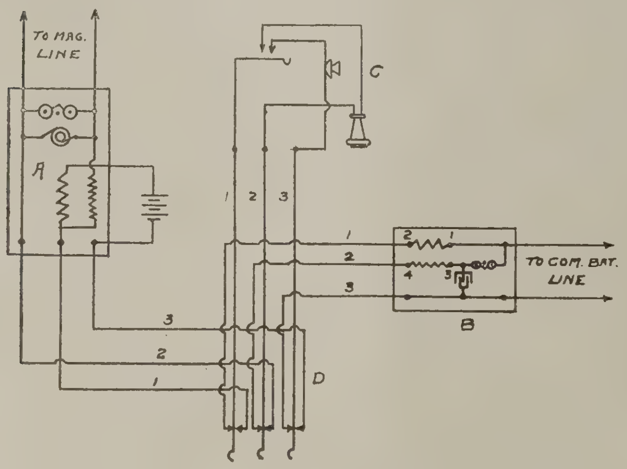
R. E. HENDRICKS.

Connection to Magneto and Common Battery Lines, Answering Question No. 196.

Editor Southern Electrician:

"I note that a party desires a circuit by which a single telephone may be used on either a common battery or magneto line. Although the inquirer does not so state, I will presume that the talking set is of the desk type. Such an arrangement is often used where it is desired to obtain direct connection with the toll switchboard, the same as with the local switchboard. Sometimes subscribers have a private magneto line with which connection is alternately desired with it and the local line to the exchange.

"As it is stated that the Bell type of instrument is used where the circuit is to be put in use, I shall confine myself to the prevailing types of each class of instruments, although modifications may be made by which the circuits of any standard make of instrument may be adapted to this use. A three-pole double-throw baby knife-switch may be used to change the connections, but the handiest and neatest device for the purpose is a listening key or night-bell switch which depends upon the cam action to throw the circuit over, this provided with three sets of make and break contacts.



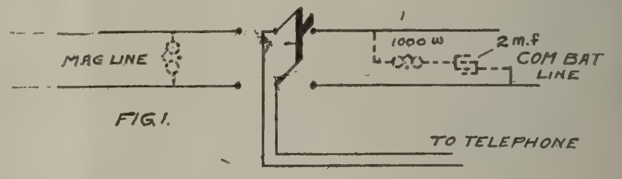
"Again, the three conductor cord from the switchboard may be connected to the desk-stand and two jacks arranged adjacent so that by merely inserting in one or the other, the shift is made. The circuit for either arrangement is shown herewith, in which, A is the magneto bell box, B the common battery bell box, C the desk-stand, and D the switching element. The operation is evident by a study of the circuit. It is best to let the key stay in normal position and connected to the line most used, that there will be no tension on the springs except when necessary."

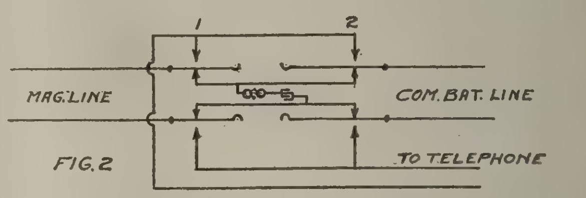
L. O. SURLES.

Connection to Magneto and Common Battery Lines, Answering Question No. 196.

Editor Southern Electrician:

"Referring to question 196, page 159, your April issue, take an ordinary magneto telephone, preferably of the bridging type and 1,000-ohm ringer. Insert a 1 or 2-M. F. condenser in series with the ringer, of 1,000 ohms resistance then connect the telephone to the blades of a D. P. D. T. switch as shown in the enclosed sketch, the magneto line to one end of said switch and the common battery line to the other. By throwing the switch, the telephone can be used on either line. If for any reason it is desired never to leave either line open, extension bells may be bridged across them, and the ringer in the telephone discarded. A relief switch may also be used with key as shown in Fig. 2, the key lever in the switch being so arranged that whenever the telephone is connected to one line, the extension





bell in the switch is connected to the other, and vice versa. The magneto telephone will give entirely satisfactory transmission over the common battery line provided a receiver in same is poled, that is, connected so that the current on the common battery line flows through same in the proper direction to strengthen the poles of the magnets on the diaphragm instead of weakening same."

H. R. VAN DEVENTER.

P. F. of Circuit, Answer to Question No. 198.

Editor Southern Electrician:

Power factor depends almost entirely on the resistance, inductance and capacity in the external circuit and is therefore independent of the voltage, field strength or the amount of load. It does depend, however upon the character of the load. All electric circuits possess a property called induction, by virtue of which they resist a change in the current strength. Since alternating current is constantly changing in direction, it is therefore opposed by an electro motive force varying with the nature of the circuit. This e. m. f. is not in phase with the impressed voltage but lags 90 degs. in time value behind it or one-fourth of a cycle. This is shown in Fig. 1, which represents the time relationship of impressed and inductive voltages.

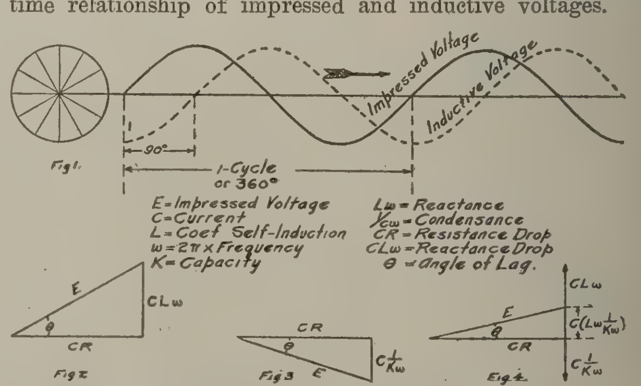
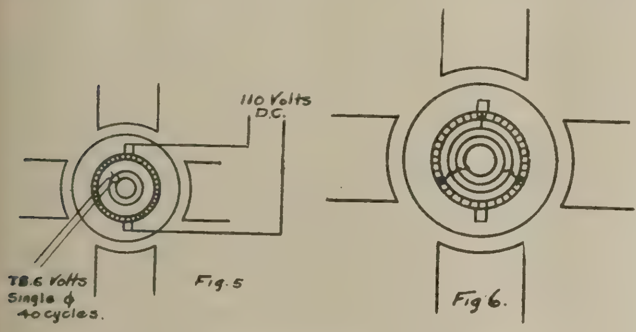


FIG. 1. TIME RELATIONSHIP OF IMPRESSED AND INDUCTIVE VOLTAGES.

The effect of capacity is the same as that of inductance except that the opposing e. m. f. is 90 degrees ahead of the impressed e. m. f. instead of behind it. The effect therefore of either induction or capacity in a circuit is to throw the current out of phase with the impressed voltage causing a reduction in power, hence the term power factor. The power factor is the ratio of the real to the apparent watts, or the ratio of the resistance drop to the total voltage, or geometrically it is the cosine of the angle of lag. Figures 2, 3 and 4 show the voltage relation of circuits containing inductance, capacity and both. Observe that in the latter case that the capacity neutralizes a portion of the inductance and it is the difference that is used in making the construction. In practice we find that incandescent lamps have almost 100 per cent. power factor, motors vary from 80 to 85 per cent, and the magnetizing current of transformers, 50 per cent. or lower. These combine to determine the power factor of the external circuit.

A. C. Generator from D. C. Motor, Ans. Ques. No. 200.

Any D. C. generator or motor may be converted into an alternator and if power driven may furnish both A. C. and D. C. current at the same time or it may be used as a rotary. The current in any D. C. machine alternates each time the conductor passes under a pole, and is converted into direct current by the commutator.



A. C. Generator from D. C. Motor.

If, therefore, we consider for example a 110-volt motor, 4-pole, 1,200 r. p. m. as shown in Fig. 5 and take off two taps from the winding in quadrature as at A and B, and connect these to collector rings, we will get a single phase A. C. current at 78.6 volts and 40 cycles. If we take off three taps as shown in Fig. 6, at A, B, and C or at A, D, and C, we will get a 3-phase current of the same voltage and frequency. This is true whether the machine be power driven or running as a rotary from the D. C. side.

A. G. Rakestraw.

Impregnated Coils, Answering Question No. 199.

Editor Southern Electrician:

Answering question No. 199 by H. E. J., I wish to say that the so-called "impregnated coils" are treated in the following way: The coil is wound as usual and then one or more coils are placed in the impregnating machine, which is a rectangular box or iron cylinder which may be closed air tight and with connections to a vacuum pump and a tank of the impregnating varnish or compound and is arranged so it may be heated to any desired temperature. As complete a vacuum as possible is then produced by operating the vacuum pump, the impregnating compound is then admitted, keeping the vacuum as complete as possible and all well heated but not hot enough to injure the insulation on the coil. When the coil is well covered with the compound the valves leading to the tank of impregnating compound and the vacuum pump are closed, the coil is kept hot and the compound allowed to soak through the coil, after which it is drained off and the coil allowed to dry.

In some systems the vacuum is changed to an air pressure as soon as the coil is covered with the compound, claiming that by this means the compound is more thoroughly forced through every part of the coil. The advantage of impregnated coils is that forming a high vacuum removes the resistance to the flow of the impregnating compound to every part of the coil caused by the air and insures uniform impregnation, whereas without the vacuum the compound would have to force out the air from between the layers of wire and threads of insulation which it could not do as perfectly, so the saturation of the coil could not be so perfect.

H. M. Beal.

Impregnated Coils, Answering Question No. 199.

Editor Southern Electrician:

"In looking through the March issue of the Southern Electrician the writer has noticed question 199 by H. E. J. asking for brief information on the subject of impregnated coils. It is perhaps superfluous to explain the older and up to a few years, more commonly used system, of insulating by means of baking varnishes. This consisted of taking ordinary cotton covered wire, painting or dipping it with some form of insulating varnish, and then baking it at a sufficiently high temperature to set the varnish. Although this system has given very good results in the past, the impregnated coil possesses many advantages, with the result that the latter system is gradually supplanting the older method.

In the vacuum process the coil is wound up in the regular way, using either single or in some cases double, or even triple covered cotton wire, depending on the spacing between turns desired. This coil after being wound is placed into one tank known as the impregnating tank, where it is throughly dried out under a vacuum. In another tank the impregnating compound is being liquefied. Both tanks are steam jacketed, and are cast of a special mixture of air furnace iron of very great density and high tensile strength. The heating medium is steam, which is admitted to the jackets of both tanks, in the one case being necessary to melt the compound, and in the other to supply sufficient heat for drying out the coils to be treated.

"The compound which is generally used is a special preparation which at ordinary temperatures is a hard dense solid, and in fact requires temperatures considerably over 300 degrees Fahrenheit to be liquefied sufficiently to flow from one tank to the other. As already stated, while the compound is being liquefied in the one tank, the coil is being dried out under a vacuum in the other. For this purpose, the vacuum pump and the condenser are necessary, the former being required to create and maintain the vacuum in the tank in which the coils are being dried, and the latter condensing the moisture which is driven out of the coil.

"The object of drying under a vacuum is apparent, the great advantage being that every particle of moisture and even the air is removed from the remotest pore of the winding. After the material is fairly dried and evacuated and the pores of the cotton winding are perfectly free of every obstructing medium the valve between the tanks is opened and the previously liquefied compound is drawn by the vacuum into the impregnating tank and penetrates the pores of the coils under vacuum, submerging them entirely and sealing all of the pores completely. After the entire charge is drawn over the connecting valve is again closed, and the air pressure is turned on in the impregnating tank. The object of this is to hasten the process, and to get even a more thorough penetration by the compound than is possible with the vacuum alone.

"After the coils have been subjected to pressure for a sufficient length of time, the connecting valve is again opened, and with a reduced air pressure in the tank the surplus compound in the impregnating tank is forced back into the other tank, in this way draining off the impregnated coils thoroughly. These are then removed from the impregnating tank, and all that is necessary is to allow them to cool. The cooling results in the setting of the compound, which when cool is a solid mass cementing all of the wires together into a solid perfectly insulated coil.

"The advantages of the coils so treated are numerous. Not only is a better insulation obtained, but the life of the coil is much longer. In the first place, the compound used, as shown by tests, will sustain a high voltage without overload and furthermore the danger from short circuit, due to moisture, is much less as the compound is absolutely waterproof and even oil proof. The coils furthermore do not heat up as much, for the reason that there are no spaces between wires, which in the ordinary coil act as insulators and prevent the conduction and radiation of heat. Further advantages are in the case of street railway work where the motor is subjected to more or less jar and shock. With the impregnated coil there is no chance for the lose wires to rub or chafe, as they are all firmly cemented one to another. There are also many other advantages of the system, of which lack of space will not permit a discussion. The best evidences of the success of the system are the numerous plants, which are now in operation throughout the country. It is safe to say that there is not a single prominent manufacturer of electrical apparatus, who does not now use the system on some part of his products. It is also safe to say that 90 per cent. of the street cars and electric vehicles now in operation in this country have somewhere or other impregnated coils in their make-up. If further information is desired on this subject in any of its phases, the writer will be pleased to furnish such either direct or through these columns.

E. G. RIPPEL.

Impregnated Coils, Answering Question No. 199.

Editor Southern Electrician:

The superiority of the electric coils impregnated by the vacuum process is now generally recognized, because by this method all moisture and air are removed from the innermost recesses of the coils, while in the impregnating chamber being dried under vacuum. After the removal of the moisture and air from the coils and while they are still under vacuum, the impregnating compound is drawn over from the storage tank through steam jacketed pipes, so as to prevent any solidification or cooling of the compound and thereby enabling the coils to become thoroughly saturated with such compound. The vacuum is then broken and air applied at from 60 to 75 pounds pressure, in order that the compound may be even more thoroughly forced into every interstice of the coil.

A perfect and uniform impregnation is impossible by the tank method, as there is no means of eliminating the moisture and air from the material from which the coil is made, and such moisture and air must be removed before a thorough impregnation can be had. By drying and heating the coils in the vacuum chamber before drawing over the impregnating compound no injury is done to the coil or its insulating material, because the air and moisture are removed at a much lower temperature than can be done in the atmosphere. Then, too, the process only consumes 10 hours or less, according to the number of coils, as compared with two or three days by the open tank method.

In view of the conditions under which coils are impregnated, it is obvious that the apparatus must be of suitable construction, in order to withstand the fluctuations of pressure and temperature during the drying and impregnating operation.

F. H. MASON.

Switching Transformers, Answering Question No. 201.

Editor Southern Electrician:

In answer to Question 201, in the March issue regarding the proper operation of transformers, I would say that if it is possible to connect the transformers referred to, either to the high tension or low tension bus bars for exciting only, it should make no difference which method of switching is used as far as current is concerned. The only current used to exite transformers is that consumed to maintain a magnetic flux in the core. As the ratio of the transformers in the case in question is 30 to 1, this current would be 30 times as great when exited from the low tension as from the high tension side. The power consumption is in either case the same. I would however consider it good operating practice wherever possible to connect the transformers first from the source of supply, that is from the primary side.

If the transformers are so connected that connecting the secondaries in, throws the load on, the primary should by all means be connected in first. This is because it is a good rule to do all heavy switching on the low tension side in order to prevent surges in the high tension side as much as possible.

TRANSMISSION PROBLEM, ANSWERING QUESTION NO. 207.

In reference to Question 207 in the April issue. The power factor of the system in question could be raised by installing either synchronous rotary converters or synchronous motor generator sets in the substation and over exiting the fields of these machines. If the frequency is 25 cycles, a rotary converter would probably be better on account of operation and better efficiency. At 60 cycle, the question is one of more or less personal preference, as 60 cycle rotary converters are now made which will give satisfactory service. Some engineers however prefer a motor generator set for this frequency.

In regard to balancing the line by the installation of lighting circuits, this depends largely on the size and nature of the load. If the lighting load is small compared to the remainder of the load, it could be taken from the 6,600 volt main without serious unbalancing. If the lighting load is large and scattered, the different installations could be taken from the different phases and the load balanced in this way.

C. E. Chatfield.

H. P. of Motor Load, Answering Question No. 205.

Editor Southern Electrician:

"In regard to the measurement of power factor of induction motor load, I will advise that in most cases a balanced condition exists in the windings. The power factor will therefore be practically the same in all phases and can be measured by a single phase wattmeter. This measurement will be sufficiently accurate except when close measurements are desired. The power will be 3 times that indicated for one phase."

W. A. Bates.

Stanley Watt-Meter, Answering Question No. 208.

Editor Southern Electrician:

"In answer to question 208, from E. D. D., in the last issue of Southern Electrician, I beg to submit the following information:

"On the name plate of the Stanley meters will be found, among other descriptive data, the number of seconds to be used in the test constant of the meter. This is given as "Secs. 15," "Secs. 20" or whatever the number may be. Now the meter disk will make 60 / S revolutions per min. under a load of 100 watts. S meaning the number of seconds as marked on the name plate. To illustrate this take for instance a meter marked "5 amp." "15 secs." This meter would make 60/15 or four rev. per min. under a load of 100 watts or 20 rev. under its full load of 500 watts. A meter marked "10 amp." "20 secs." would make 3 revolutions under 100 watts and 30 rev. under its full load of 1,000 watts, etc., for the other sizes.

"In testing these meters with a Westinghouse standard, which is quite extensively used, a direct comparison of the number of revolutions can be made, thus: The standard meter, when set for 5 amperes, will make 5 revolutions per minute, under a load of 100 watts, therefore, for every 5 revolutions of the standard, the 5 amp. Stanley will make 4 revolutions. This holds true for any load, and similarly, a 10 or 15 amp. Stanley marked 20 secs. would make 3 revolutions for every 5 of the standard when set at 5 amps. or 6 revolutions to every 5 of the standard, when the latter is set for 10 amp., which would be the proper value. This can be worked for all sizes of meters and the revolutions of the Stanleys easily remembered by the following formula: R. P. M. = 60 × watts / S × 100 where S = the number of seconds as marked on the disc."

J. H. Jacobucci, Manager.

Fuses For Induction Motor, Answering Question No. 209.

Editor Southern Electrician:

In regard to size of fuse for an induction motor, expressing the rating in terms of the full load current I submit the following formula: Instead of fuse being rated in full load current it should be based upon the current per line, the fuse being a size to stand 25 per cent. additional current. This is the specification of the National Electric Code and is suitable except in those cases when starting devices are not used, and when the fuses are located in the line and in circuit when the motor is started. In this latter case the heavy starting current of a 50-horsepower motor operating on 220 volts will require a fuse two or three times the amperes per terminal.

Assuming a power factor of .85 per cent. and efficiency of motor 90 per cent., the amperes for terminal are as follows:

$$A = \frac{\text{H. P.} \times 746}{\text{Eff} \times \text{V} \times \text{P. F.} \times \sqrt{3}}$$

$$= \frac{50 \times 746}{.90 \times 220 \times .85 \times \sqrt{3}} = 128 \text{ amperes.}$$

A fuse for 25 per cent. excess should be selected whose range is sufficient to carry approximately 160 amperes.

H. L. Williamson.

The Candle Power and Lumen.

Editor Southern Electrician:

"I have read with interest the educationally valuable paper of Mr. Rakestraw in your March edition, and feel that I should call attention to an error therein which, if uncorrected, might lead to confusion. Mr. Rakestraw, in referring to a table of intrinsic brilliancies contained in his article on page 102, says as follows: 'Since one candle power equals 12.56 lumens, it will be seen that one candle power per square inch is equivalent to about 1,800 foot candles.'

"It would seem that Mr. Rakestraw has here fallen into the error of assuming that there is some numerical relation between 'candle power' and 'lumen,' which is certainly not the case as they are units of entirely different nature and are not, therefore, commensurable. The candle power is a unit of luminous intensity and the lumen a unit of luminous flux. Mean or average candle power, however, is a flux unit and in the case of mean spherical candle power, the numerical relation to lumens is the figure given by Mr. Rakestraw, that is, one mean spherical candle power equals 12.56 lumens. This figure, however, can not be used to express the relation between the brightness of a surface in candle power per square inch and the emitted flux density in foot candles. This relation is as follows, making the usual assumption that the surface in question emits light in accordance with Lambert's Law of the Cosine: Candle power per square inch = Lumens per square foot / 3.1416 x 144 = Foot Candles / 452. In other words, one candle power per square inch is approximately 450 foot candles or one quarter of the figure given by Mr. Rakestraw. For the solution of the above formula and discussion of the relation of brightness to flux density, I would refer those interested to the following: Carl Hering, Electrical World, Sept. 26, 1908 and E. B. Rosa, Transactions of the Illuminating Engineering Society, June, 1910."

J. S. Codman.

New Apparatus and Appliances.

Duncan Watthour Meters and Transformers.

A direct current watthour meter meeting satisfactorily service conditions is manufactured by the Duncan Company. This company has always believed in furnishing a meter of the highest possible torque so as to combine two very essential qualifications, accuracy and long life. It is claimed that Duncan watthour meters are in use today that have been in service for nearly ten years, and have not yet had their jewels renewed, which shows a remarkable condition. The sapphire cupped bearing is made from genuine oriental sapphire.

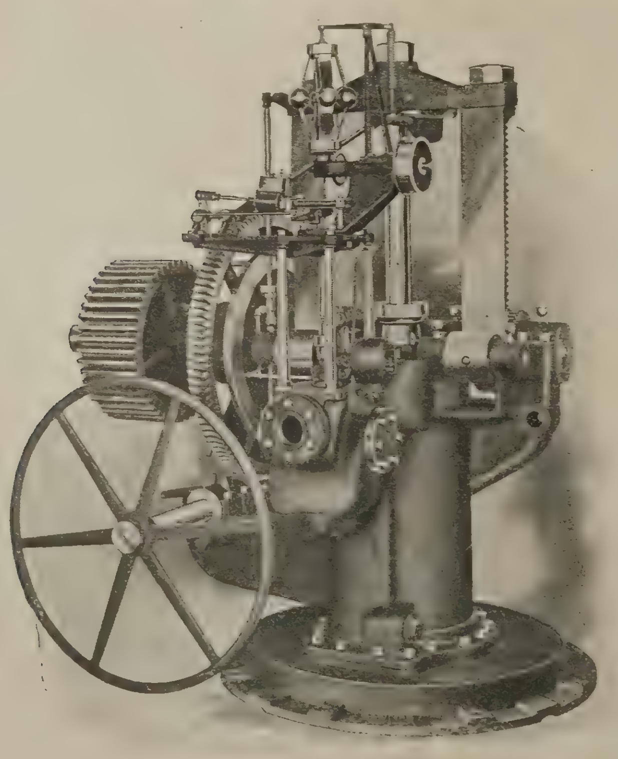
The Duncan transformer has been three years on the market, and its make-up, efficiency, and characteristics have proven most successful. Silicon alloy steel is used for the core and pure electrolytic copper for windings which is given in support of the low core loss, small drop and good regulation of these transformers.

The company is prepared to make prompt shipments from
The company is prepared to make prompt shipments from
large stock at Lafayette, Indiana, and from the Piedmont Electric Company, Asheville, North Carolina. The transformer bulletin, which tells more about transformers will be sent upon request.

Lombard Governors.

The accompanying illustration shows a type of water wheel governor manufactured by the Lombard Governor Co., Ashland, Mass., and installed as a part of the equipment at the Central Georgia Power Company's plant at Jackson, Ga., described in this issue.

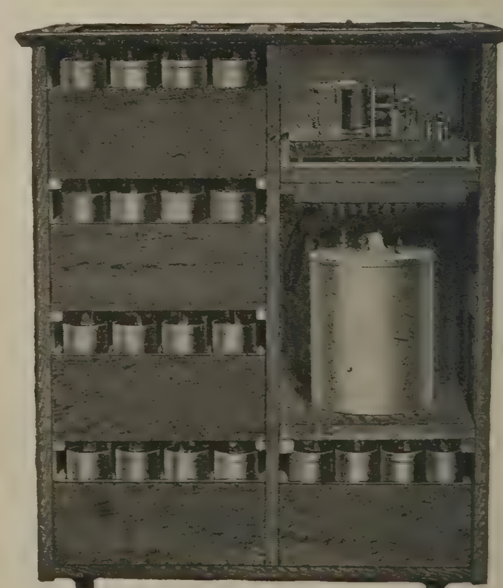
These machines are endowed with seeming intelligence, as they detect the first deviation from normal speed before human intelligence would be able to comprehend it and acting instantaneously they move the ponderous gates of the water wheels with the utmost ease, to the proper position to bring the speed back to normal. These results are accomplished by permitting oil, under heavy pressure, to flow into one end or the other of a cylinder within which there is a piston connected by means of simple mechanism, with the gates of the water wheel. The whole success of the governor depends upon the very effective and sensitive mechanism which controls the flow of oil to the cylinder. One portion of this mechanism is an exceedingly sensitive centrifugal device which responds instantly to changes in speed and thereby moves a very small valve. Another portion of the mechanism consists of a very large valve which is under the mutual control of the aforesaid small valve and also the large piston in the cylinder which moves the water wheel gates. Still another portion of the control mechanism consists of a device whereby the movement of the main piston of the governor is arrested at a predetermined point after a change in speed occurs, in order that the water wheels may have sufficient time to return to their normal speed.



LOMBARD TYPE N. S. GOVERNOR.

The Warner Pole Changer.

The accompanying illustration shows the design of the Imperial Warner pole changer with cabinet. By its construction, the drawers of the cabinet for accommodating the dry cells may be withdrawn for inspection or testing without interfering with the operation of the pole changer as the terminal strip is installed on the back of the cabinet directly below the pole changer shelf.



WARNER POLE CHANGER.

The Edison battery used for operating the vibrator is centrally located in the second compartment on a removable shelf and may also be withdrawn from the cabinet for inspection without interfering with the operation of the vibrator. This method of withdrawing the closed circuit battery offers an additional convenience when renewing the cell. The imperial is equipped with a Warner pole changer of a design such that no current is consumed from the power battery when the pole changer is not in circuit. It is equipped with a relay, which bridges the condenser across the secondary circuit only when the operator is signalling. By this method no current is consumed from the power battery except when signalling. The device has been in service for more than fifteen years and it is claimed that there are now over 15,000 in operation.

Burn-Boston Battery.

A new type of liquid battery has been placed on the market by the Burn-Boston Battery Co., Boston, Mass., which takes the place of dry batteries, or glass jar salammoniac batteries, caustic solution batteries, and in many uses of storage batteries. The cells are square, contained in water-proof vessels made to fit the same space as a dry battery. The voltage is 1.5 and the internal resistance about the same as the ordinary dry cell with the ampere hours per annum claimed at many times that of the best open circuit battery. The vessels contain a liquid which will not freeze and has no corrosive action. The cells are sealed like dry batteries so that the solution will not spill or evaporate.

Burn-Boston Battery.

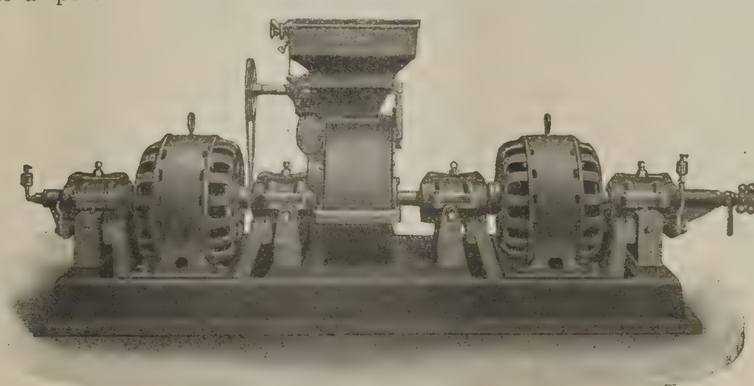
The features and claims for the battery are of the very strongest character, it being stated that they deteriorate only 5 per cent. per annum while not being used. Cells were shown at the Automobile Show nearly two years old which all tested 20 amperes. As sole ignition for a 4-cylinder automobile six small batteries were exhibited which had run 14,000 miles over a year's period, used with an economical type of spark coil with no battery attention. The batteries are suitable for automobile use, motor boat ignition, stationary gas engine ignition, inter-communicating telephone systems and gas lighting.

Robinson Attrition Mill.

An improved motor driven mill for grinding feed has been marketed by the Munson Brothers Co., of Utica, N. Y. The mill is constructed in such a way that motors can be direct connected, thereby eliminating all belting and troubles due to the friction of bearings and belts. It is claimed that the first cost of installing the direct connected mill is smaller in comparison with the ordinary pulley driven mill, that is when the expense of counter shafts, pulleys, belting and boxes and the necessary cost of mill at work therewith is considered.

The accompanying illustration gives an idea of the appearance of the mill when installed. One of the most essential features in the construction is the adjustment. The grinding head or disk is fitted solid to the motor shaft, and the motor is carried in a cradle which is bolted rigidly to the bearings. The inside bearing support or fork is constructed as a universal swivel joint. The outside bearing support is also provided with set screws which admit of a vertical and lateral adjustment. This being the case the grinding heads or disks can be easily and accurately trammed by the adjusting screws in the outer bearing support and the whole motor moving with it maintains the same relation between the armature and the field while the bearings of course will be in perfect alignment. The mill can be located anywhere in the building and as there is practically no vibration to the mill when running no special foundation is required providing the floor of the building is strong enough to support the weight of the mill.

For those central stations who are endeavoring to secure an off peak load in agricultural sections, this mill should serve as an introduction of the benefits and wide applications of electricity and result in a valuable day load.



The Attrition Mill.

The Manufacture of Transmitters and Receivers.

The average telephone user gives very little thought to the why and wherefore of the transmitter and receiver. He thinks of the telephone as a national and personal convenience, but seldom has any conception of what the instrument really is. The manufacture, inspection and testing of these instruments, therefore, forms an interesting story, and the accompanying illustration shows some of the processes involved.

The transmitter is a most delicate piece of apparatus, and several of its parts must be held to such close dimensions that the Western Electric Company has been confronted with the problem of making not only the telephone instruments but much of the necessary testing apparatus and measuring instruments. Such instruments as those used to measure the thickness of the mica, which is held to within three ten-thousandths of an inch, were made in the company's own shops.

FIG. 1. FINAL ASSEMBLY OF TRANSMITTERS.

FIG. 2. TESTING TRANSMITTERS.

Another important operation is the manufacture of the carbon granules contained in the transmitter button. These granules must have exactly the right degree of hardness, otherwise the tone of the transmitter will be affected. They must be of uniform size, otherwise the transmitter would have a tendency to pack, and, in addition, just the right amount of carbon granules must be used. The carbon is measured in a cup having a steel cut-off, which insures the correct volume. In order to see that the carbon is running with the right ratio of weight to volume a certain percentage of the buttons are weighed by means of a delicate balance, and a close check is kept on them.

The front and back electrodes are also made of carbon. Each is as highly polished as a steel mirror, and each one must have just the proper degree of hardness, otherwise pitting would result from the passing currents, which would affect the transmission and might result in packing.

In testing most telephone apparatus, such as generators, drops, and relays, it is possible to measure their efficiency in concrete terms and with practically no human factor entering into the results of the tests. Since the primary function of a transmitter is to transmit the human voice, it becomes necessary in testing their efficiency to make use of the human voice, and thus the human element enters. The volume and articulation test is made over a circuit which is the equivalent of an actual line two hundred miles in length. The operator standing at the receiving end signals back to the man testing the transmitter, telling him whether the volume and the articulation is satisfactory. In order to eliminate carelessness as far as possible from this test, the inspectors do the talking and receiving in pairs. In the morning one does the talking while the other is receiving, and in the afternoon the operation is reversed. By long training at this work these men are able to pick out a variation in efficiency to a fraction of 1 per cent. Any transmitter that does not measure to the standard transmitter must go back for readjustment.

Besides the transmission test, the transmitters must also survive what is known as the mechanical inspection, which includes a minute, detailed inspection of every one of the piece parts going to make up a section of the instrument, each group of parts as assembled, and finally the completed instrument.

The receiver is another delicate piece of electrical apparatus. The steel from which the magnets are made must be carefully chosen and then comes the proper tempering and magnetizing of it. Formerly skilled men were employed to determine when the steel was heated to just the proper temperature for emersion, but after years of experiment a way was devised and placed into effect by which "human error" was eliminated. Today the temperature of the annealing furnaces is kept at a predetermined uniform heat by means of an electrical indicator. By placing the steel in the furnace for a prescribed time the exact conditions for producing the fine degree of temper are obtained.

Another important member of a receiver is the vibrating diaphragm, whose thickness must be held to within two thousandths of an inch. The space between the ends of the pole pieces and the diaphragm must be held to a dimension as close as .015 inches, for any greater dimension would decrease the efficiency of the receiver, and any less dimension would make the instrument so delicate that hard usage would put it out of commission. The receivers are given the same rigid talking and mechanical tests as those given to the transmitters mentioned above.

The Thomas Meter.

The Thomas Meter is designed for measuring the rate of flow of gas or air. The operation of the meter depends upon the principle of adding electrically a known quantity of heat to the gas and determining the rate of flow by the rise in temperature of the gas between inlet and outlet of the meter. Referring to Fig. 1 a cross section of the meter casing is shown which constitutes the portion of the apparatus inserted in the pipe line carrying the gas, or air, to be measured. In the center of this meter casing is an electrical heater and on either side of the heater are screens of fine resistance wire, known as thermometers. These two screens constitute in reality, two arms of a Wheatstone bridge and variations in temperature between these two screens, resulting in variations of resistance, cause a galvonometer needle to swing to the right or left of a central point, this movement of the galvonometer needle resulting in increasing or decreasing the amount of electrical energy fed into the heater.

The meter is so adjusted at the start that a fixed difference of 2° Fahrenheit between the entrance temperature and the exit temperature of the gas or air is maintained. Let us assume, for example that a weight of gas or air equivalent to 50,000 cubic feet per hour is flowing through the meter and that the entrance temperature of this gas, or air, is 60°F. The amount of electrical energy required to raise the temperature of this quantity of gas, or air, 2° is known, and the meter is so adjusted that a requisite number of watts will be supplied to the heater installed in the meter casing. So long as the flow of gas, or air, remains unchanged the watts input will continue the same, but if more gas flows the meter will be called on to supply more watts and, conversely, if the flow of gas decreases the watts input will also decrease. Hence what the meter really does is to measure the watts input and since the relation between a certain watts input and a certain flow of gas is known, it is possible to tell at any time the amount of gas flowing by merely noting the watts input. As a matter of fact, the recording mechanism of the meter translates watts input into standard cubic feet of gas, so that you can get a direct reading without calculation of any kind, but the principle of the meter is as described above, namely, a measurement of gas or air based on the amount of electrical energy required to maintain a difference in temperature of 2° between inlet and outlet of the meter.

The meter will measure gas or air at any temperature and at any pressure and is not affected by fluctuations of pressure or temperature. This is because in heating gas or air we have to do with weight not volume. Whether a pound of air occupies 10 cubic feet or 100 cubic feet the amount of electrical energy required to raise its temperature 2° is the same, and whether it is moving rapidly or slowly through the meter, a pound is a pound, and in raising its temperature 2° just so much energy will be required and no more. Here we are dealing with a temperature difference of 2°, if the gas enters the meter at 60° F its temperature will be raised to 62°. If it enters at 100°F its temperature will be raised to 102°, so that as stated above, neither temperature nor pressure have any effect on the accuracy of the meter's measurements.

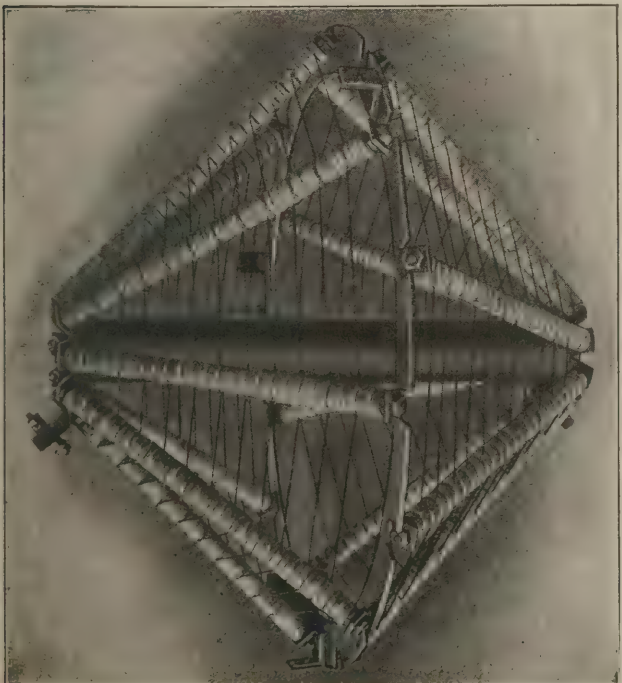


FIG. 2. HEATER LOCATED IN METER.

To sum up, the Thomas Meter is essentially a machine for measuring the heat energy required to raise the temperature of an unknown weight of gas, through a known range. It consists of two parts, a heater unit, installed in the pipe line, and an automatic device for maintaining a constant temperature difference. Electrical energy is used as the source of heat because electrical energy can be measured more accurately than can any other quantity. Electric resistance thermometers are used to maintain the known temperature difference constant not only because they are very sensitive and accurate, but also, because they can be very easily made to regulate the heating energy so as to correspond to the flow of gas.

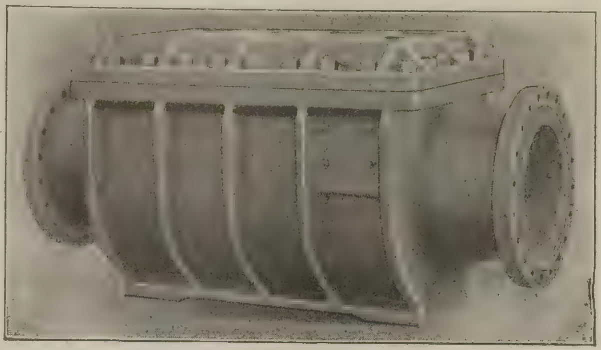


FIG. 1. METER CASING CONTAINING HEATER AND THERMOMETER.

The most important features of the meter are: (1) There are no moving parts inside the gas main. (2) It measures weight of gas instead of volume and will read directly in standard cubic feet regardless of temperature or pressure, its operation being independent of temperature or pressure and of fluctuations in same. (3) Meters of very large capacity occupy but little space and since the different parts are connected electrically they can be located at any distance from each other. The recording mechanism, for instance, may be placed in the general offices of a gas company, which may be a mile or more from the gas works.

The principal applications of the Thomas Meter are (1) measuring illuminating gas, (2) measuring natural gas, (3) measuring blast furnace gas, (4) measuring compressed air, (5) measuring air flow in ventilating or forced draft systems.

The meter was invented by Prof. Carl C. Thomas and manufactured by the Cutler-Hammer Mfg. Co. of Milwaukee, Wis.

Refractory Cements.

After several years devoted to research work on refractory cements to overcome troubles familiar to engineers having experience in proper maintenance of brick settings of furnaces, the H. W. Johns-Manville Co., New York, are now offering to the trade, a line of cements called J-M refractory cements for the following purposes: Furnace setting of various types, cupolas, lining brass furnaces, assayers crucibles, oil burning, tilting and rotary furnaces and for patching and facing bricks in place in the fire zone under various conditions. These cements are rated to resist temperatures as high as 3,000 deg. F. This company has also produced a coating for walls known as J-M brickline cement, which prevents clinkers from adhering and to seal the pores of the brick.

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.

ALBERTVILLE. It is understood that the J. B. McCrary Co., of Atlanta, Ga., has the work of planning an electric light plant for Albertville. It is understood that the equipment will consist of an 80 horse power engine and generator.

BIRMINGHAM. It is understood that E. L. Hitdon desires prices on the installation of a lighting plant for a $20,000 dwelling.

DECATUR. The franchise of the Decatur Light, Power & Fuel Co., which has recently expired, has not been renewed and it is reported that the city council is contemplating the construction of a municipal plant.

DOTHAN. The city council has recently voted on the erection of a $90,000 light and water plant for the city of Dothan. The present plant is valued at $30,000, and according to the estimate of the city engineer, it is netting approximately $1,000 monthly.

EUFAULA. It is reported that $50,000 will be expended for the construction of an electric light plant.

GADSDEN. It is understood that surveys are being made for the proposed plant of the Little River Falls Power Co. This plant will be of a capacity to furnish power for manufacturing purposes in Gadsden. R. A. Mitchell is interested and can give other information.

TROY. A $50,000 electric light plant is to be erected in Troy by the Standard Chemical & Oil Co. The new plant is to be erected at the new mill of the company two miles north of Troy and of a size to develop 1,400 H. P. Fox Henderson is president of the company.

Arkansas.

JONESBORO. The Spring River Power Co. has been formed with a capital stock of $100,000. A power plant will be erected for furnishing power and light to towns in the surrounding district.

LITTLE ROCK. The Arkansas Kerasolar Light and Fuel Co. has been granted a charter with a capital stock of $10,000. The incorporators are A. Danville, J. L. Richardson and J. W. Hall.

SCRANTON. The town council of Scranton has been petitioned by A. P. Kineaid & Sons, of Paris, Ark., for a franchise to construct an electric light plant. It is understood that if the franchise is granted, they will purchase a complete electrical equipment for furnishing light and power.

Florida.

FORT LAUDERDALE. The Fort Lauderdale Ice & Light Co., recently reported in these columns as having been incorporated with a capital stock of $50,000, is to install an electric light plant. The president is H. R. Brown.

FORT MEADE. It is understood that C. O. Rogers, of Wauchula, Fla., is promoting a company to erect a power plant to generate electricity for light and power.

ST. PETERSBURG. The installation of a 250 K. W. generator and a 350 H. P. boiler and engine is being contemplated by the Pelham Public Utilities Co. for their plant. The manager of the company is William Cook and other information can be obtained from him.

TAMPA. It is understood that C. W. Alton, of Anderson, Ind., is interested in the building of an electric railway from St. Petersburg to Tampa.

Georgia.

ATLANTA. A charter has been granted to the Austell Power Co. with a capital stock of $300,000. It is announced that the company proposes to develop and operate a power plant convenient to Atlanta. The incorporators are C. C. Bruckner, G. W. Mason of Atlanta, and G. E. Zimmerman of New York.

AUGUSTA. The Augusta Railway & Electric Company and the Augusta-Aiken Railway Company of Augusta, Ga., have arranged for the following extensions and improvements to their power houses and systems: Estimated cost, approximately $500,000. The power house extension is planned for two 2,500 K. W. steam turbines, one of which, with the necessary boilers and auxiliaries, will be installed this year. A seven and one-half (7½) mile transmission line will be built from the power house in Augusta to the power house of the Augusta-Aiken Railway Company, near Clearwater, S. C., and a 500 K. W. motor generator set will be installed at this point, and a 300 K. W. set in the present substation near Aiken. Under an arrangement with the city, the wires in the city of Augusta will be placed underground on three of the principal streets, involving the laying of about three (3) miles of conduits. In connection with this underground work, the company will also install ornamental poles on Broad street, Augusta, for carrying its trolley wires and feeders and also clusters of tungsten lamps for street lighting. An extension of about one mile of single track will be made and the reconstruction of a large amount of the present tracks is planned. Contracts for the above work has been awarded to J. G. White & Co., engineers and contractors, 43 Exchange Place, New York.

BARNESVILLE. According to reports, the city is considering the issue of bonds to the extent of $50,000, the proceeds to be used for extension to the municipal electric light plant and water works.

COLQUITT. The citizens have voted to issue $22,000 in bonds, the proceeds to be used for the construction of an electric light plant and extending the water works system.

ELLIJAY. The Ellijay Light and Power Co. has recently been formed and desires prices on supplies and a complete electrical equipment for a plant to operate 25 street lights and 500 incandescents. Prices desired f. o. b. Ellijay. Address E. T. Wilson, general manager.

FAIRBURN. Bonds have been issued to the amount of $10,000, the proceeds of which are to be used for the construction of an electric light plant.

GRIFFIN. The city of Griffin, which owns its own electric light plant, will close it down and use the current furnished by the Central of Georgia Power Co.

MACON. It is understood that all the necessary funds with which to construct an interurban line from Macon to Atlanta has been secured. W. J. Massey is president of the Atlanta, Macon Interurban Co., and it is proposed that some definite plans will be released soon. The right of way has been secured and property bought by the company. The line will cost approximately $6,000,000.

McDONOUGH. It is understood that J. B. McCrary Co., of Atlanta, Ga., has been engaged by the city council to prepare plans for the installation of an electric lighting system.

OGLETHORPE. It is understood that the city has under consideration the installation of an electric light plant and water works system.

PERRY. It is understood that Perry is arranging for a system of electric light.

ROME. According to present plans the Blue Ridge Electric Co. will build a dam 150 feet high near Cartersville and construct and equip a plant to generate 30,000 H. P. for furnishing power to Rome, Dalton, Calhoun, Rockmart, Cedartown, Acworth and Marietta. The plant will be located on the Etowah river.

TALLULAH FALLS. The work on the power plant of the Tallulah Falls power plant is progressing rapidly. The contracting work is being done by the Northern Construction Co., and the concrete work has been let to Condon & Milner, of Knoxville, Tenn. This work amounts to approximately $400,000.

WAYNESBORO. It is understood that the city has under consideration the issue of $40,000 in bonds for the construction of waterworks and an electric light plant.

Kentucky.

BOWLING GREEN. The Kentucky Panama Coal Co. has been organized with $1,000,000 capital stock by Inkerman Bailey of 96 Broadway, New York City. It is understood that the purpose of the company is to develop the coal lands in Hopkins and Muhlenburg counties in Western Kentucky. Electrically operated mining machinery will be purchased.

CORBIN. It is understood that a water works system is under consideration. The secretary of the Board of Trustees is W. N. Steel and other information may be obtained from him.

DAWSON SPRINGS. It is reported that plans are being prepared for the water works system. The consulting engineer is J. W. Holmes, Supt. of the Paducah water works.

JEFFERSONTOWN. Plans are practically complete for an electric power plant to be erected at Jeffersontown. It is understood that W. J. Semonin, president of the commercial club, is interested.

LOUISVILLE. The new Henry Watterson Hotel to be erected at a cost of $650,000, will have its own electric light, power and refrigerating plant.

LOUISVILLE. It is understood that the foundation of the power plant of Kentucky Electric Co. has been given to Merrill-Ruckgaber Co., of New York. The plant will cost approximately one million dollars.

LOUISVILLE. It is understood that $600,000 in bonds of the Kentucky Electric Co. are being sold in the Boston markets. The proceeds will be used for the construction of the company's new plant.

LOUISVILLE. Plans are being prepared for improvement to the Capital Hotel by Fred Erhart. The improvements will include an electric light and ice plant at a cost of approximately $20,000.

LACENTER. This city is contemplating the installation of a water works system but as yet no definite plans have been announced.

NORTONVILLE. The Nortonville Traction Co. has been incorporated with a capital stock of $100,000. The incorporators are F. E. Mohr, of Columbus, Ohio; Frank G. Hoge, Nortonville; and T. F. Callaid, of Hopkinsville, Pa.

SOMERSET. The properties of the Somerset Water, Light & Traction Co. have been formally transferred to the United Water, Light & Traction Co. The latter company purchased this property at receiver's sale and it is understood that extensive improvements and enlarging of the system will take place. The president of the new company is H. Waddle, and the manager is J. L. Waddle.

Louisiana.

ALEXANDRIA. According to reports, the Alexandria Street Railway Company's system has been purchased by J. White and others and that the company will be reorganized and improvements made to property.

HOMER. The town council has under consideration the acquiring of the electric light plant owned and operated by E. E. Sawyers.

SHREVEPORT. The city officials have taken up the matter of a reduction in the price of electrical energy for private consumers and for commercial lighting with the Shreveport Gas & Electric Light & Power Co. If the arrangements are not made satisfactorily it is voted that steps are to be taken for the issue of $250,000 in bonds and the establishment of a municipal electric light plant.

Missouri.

BETHANY. Plans are under consideration for making extensions and improvements in the municipal electric light and water works system.

HALISTER. The Ozark Water & Power Co. has plans underway for the construction of a dam across the White river. It is the present understanding that the company proposes to build a large power plant and supply electrical energy to towns in the surrounding territory. R. A. Morrison, of St. Louis, Mo., is interested in the project and W. J. Szwhez is the chief engineer.

Mississippi.

BOLTON. On March 19, a fire destroyed the electric light, power and water works plant. It is reported that steps are being taken to rebuild the plant as the town is at present without water and light.

JACKSON. An isolated plant is under consideration for lighting the capitol building. Other information can be obtained from the secretary of Governor Noel.

TYLERTOWN. An application has been made to the city council for a 25 years franchise by O. L. Sand, to construct and operate an electric light and water works system.

North Carolina.

DURHAM. According to reports a site near Durham has been purchased by the Southern Power Co. for the erection of an auxiliary plant to supply electricity to Durham and vicinity. The plant which is proposed will have an output of approximately 10,000 H. P.

RALEIGH. The Piedmont Traction Co., J. D. Duke, president, at Charlotte, has filed with the secretary of state an amendment of the charter that increases the capital of the corporation from $100,000 to $1,500,000.

RALEIGH. The Yadkin River Power Co., of Raleigh, N. C., has been chartered with a capital stock of $40,000,000. It is understood that the Blawitt Falls hydro-electric power plant in Richmond county will be taken over, the plant completed and electric energy supplied for operated public utilities and interurban railroads. C. E. Johnson, of Raleigh, N. C., is president, and E. C. Potter, of Boston, Mass., is treasurer.

SALISBURY. It is understood that over half of the capital stock of the street railway electric light and gas companies of Salisbury, Crawford and Spencer, N. C., has been purchased by W. J. Oliver, of Knoxville, Tenn. The amount involved is approximately $1,000,000. It is further understood that Mr. Oliver will make extensive improvements and additions to the property.

SALISBURY. The Virginia Power Co. has been recently organized for the purpose of developing water powers on the New River. It is understood that about $1,000,000 will be invested. J. J. Mott, of Statesville, N. C., is interested.

TARBORO. The citizens will hold a special election May 1st to vote on $25,000 in bonds for a proposed water works.

Oklahoma.

BOLEY. The Boley Light, Power & Mfg. Co. has been incorporated with a capital stock of $20,000. The directors are J. O. Williams and J. R. Reynolds, of Marshall, Texas; D. J. Turner, J. H. McArley and others of Boley.

BOSWELL. The citizens have recently voted to issue bonds to the amount of $35,000 for the purpose of installing an electric light plant and water works system.

BRAN. It is understood that the city is contemplating the granting of an electric light franchise and an issue of bonds to the amount of $25,000 for the purpose of constructing a water works system.

FRANCIS. A municipal electric light plant will be installed at Francis.

OKEMAH. According to reports W. H. Dill is to construct a concrete dam at the falls near Okemah to cost approximately $40,000. A power plant will be constructed and electrical energy transmitted to near by towns.

OKLAHOMA CITY. The Oklahoma City Traction Company has recently purchased the operating lines, franchises and all other property of the Oklahoma Interurban Traction Company, and has just issued $1,000,000 first mortgage bonds, with St. Louis Union Trust Company, of St. Louis, Mo., trustee. The company has several miles of street railway now operating in Oklahoma City and expects to construct considerable new mileage in the near future. The company has an indeterminate franchise covering all streets and alleys in Oklahoma City, and also a ninety-nine year franchise for lighting in the Southern portion of the city. L. E. Patterson, of Oklahoma City, is president of the company.

South Carolina.

EDGEFIELD. An election will soon be held to vote on the issuing of $20,000 in bonds for an electric light plant.

FOUNTAIN INN. The Onoree Power Company has arranged to furnish light to the town of Fountain Inn. Twenty-five arcs will be used for street lights and private parties have also contracted for lighting. The electrical apparatus and supplies will be furnished by the power company from their office at Wellford, S. C.

NEWBURY. It is understood that the Power Shoals Power Co., of Newbury, has secured the right to increase its capital stock from $50,000 to $100,000. The company proposes to develop water powers in Newbury county.

SUMTER. A company has been incorporated with a capital stock of $200,000 known as the Sumter Lighting Co. The incorporators are I. C. Strauss and E. H. Moses.

LEXINGTON. The citizens have recently voted to grant the Lexington Electric Light & Power Co. a franchise to supply electrical energy in Lexington. The president of the company is W. W. Barr.

ORANGEBURG. It is understood that the present capacity of the local water, light and power plant has become too small and that additions will be made. Additional engines and generators will be required.

Tennessee.

ALTO. An electric light and ice plant will be installed at Alto by L. S. Atkins, of Spencer.

ARLINGTON. It is understood that a bond issue for a water works system is before the Tennessee Legislature for the town of Arlington.

BRISTOL. A bond issue has been authorized for a water works system for Bristol.

CHATTANOOGA. The McLean Lumber Co.'s saw mill at Chattanooga, Tenn., was destroyed by fire on March 22nd. The loss is estimated at $60,000 and practically all of the machinery including the power plant will have to be replaced.

DAYTON. A bond issue of $25,000 for the purpose of providing a water works system to Dayton is soon to be presented in the Tennessee legislature.

JACKSON. The proposition of the Jackson Railway & Light Co., to light the town has been rejected and the city will purchase a new plant throughout with a capacity of 340 arc lamps.

KNOXVILLE. It is understood that a franchise has been granted to the East Tennessee Power Co. to serve the community with light and power. This company is building a hydro-electric plant in Polk county.

LENOIR. According to reports the Lenoir Light & Power Co. has been incorporated with a capital stock of $10,000 by T. C. Foster, J. R. Browder, H. C. Foster, J. E. Foster and S. De Witt.

MEMPHIS. A resolution has been adopted by the commissioners of the city of Memphis asking the state legislature to authorize a bond issue sufficient to enable a municipal lighting plant to be constructed.

JACKSON. It is understood that T. H. Hartmus secretary of the municipal board desires prices on a 250 h. p. engine, generator and switch board for the municipal plant.

NASHVILLE. It is understood that plans are under way to extend the new lighting system in the down-town section. The lamp standards have been purchased from the Union Metal Co., of Canton, Ohio.

PULASKI. It is understood that a bond issue of $20,000 is a subject of a petition to the state legislature. The proceeds will be used for the construction of a modern electric light plant which will take the place of the present out-of-date and over loaded one.

Texas.

ALVIN. The Alvin Ice, Light & Power Co., has been incorporated with $15,000 capital stock. The incorporators are W. R. stockwell, S. O. Smith, and others.

DALLAS. It is understood that the board of trade at Hillsboro is promoting the construction of an interurban electric railway between Dallas and Hillsboro.

GRANDBURY. The Grandbury Water, Ice, Light & Power Co. desire prices on electrical equipment for their plant.

GLANO. Extensions are to be made to the municipal light system and improvements to the plant.

LULING. The Luling Electric Light & Power Co. has been granted a franchise to install, maintain and operate an electric light and power plant.

LONGVIEW. It is understood that the city is contemplating the erecting of electric light poles on the business streets and the installation of an up-to-date lighting system.

NEW BRAUNFELS. Plans are being prepared by W. K. Palmer Co., 717 Dwight Bldg., Kansas City, Mo., for the installation of a municipal hydro-electric plant.

SAN ANGELO. It is understood that Moore & Myers desire prices on sidewalks, lights and other types of equipment.

SHERMAN. It is understood that bids are desired by the superintendent of the water works at Sherman, Texas, for an internal combustion motor, gas producer, air compressor, electric generator, motor switchboard and power driven pumps.

WACO. It is understood that the business men's club of Waco through president H. H. Shear, are planning on the installation of an interurban electric railway between Waco and Cleburne.

WICHITA FALL. Has granted a charter to M. A. Marcus and T. E. Dobbins for the installation of an electric light and power plant.

Virginia.

IVANHOE. A dam 20 feet high to develop 3,300 H. P. and a power plant to generate electric energy to operate iron furnaces is the work now being accomplished by Carter Iron Co., Pittsburg, Pa.

NEWPORT NEWS. It is understood that the city will vote an issue of $150,000 in bonds for construction of an electric light plant.

RICHMOND. Until May 8th, sealed proposals will be received at the office of the supervising architect, treasury department at Washington, D. C., for the installation of conduit, wiring and lighting system, in connection with the construction of the United States post office, court house and custom house building at Richmond, Va. The supervising architect is James Knox Taylor.

PERSONALS.

CHARLES L. EDGAR, president and general manager of The Edison Electric Illuminating Company of Boston, and a party sailed from New York on the George Washington of the North German Lloyd Line on March 30 for an extended period of rest will be enjoyed in an automobile tour through Europe, Mr. Edgar having taken his car with him. About two weeks each will be spent in driving through England, France, Italy and Germany. With Mr. Edgar are Mrs. Edgar, their son, Mr. Leavitt L. Edgar, Miss Margaret Clough and Miss Laura F. Duclos, together with a maid and chauffeur. All will return in the early summer.

W. P. SOUTHARD formerly Electrical Superintendent of the Kansas Gas and Electric Company, Wichita, Kansas, has been appointed manager of Los Vegas Light & Power Co., Los Vegas, New Mexico. The Los Vegas Company is at present operating an electric railway which in the near future the company purposes to considerably extend. It also supplies electric light to the surrounding townships.

J. W. CUSHMAN, who for some time past has been special representative of the Fostoria Incandescent Lamp Company in North and South Carolina, has taken up a new position with the same company in Pennsylvania, where it is trusted that the climate will agree better with Mr. Cushman's health. Mr. E. V. Plane, the Fostoria representative in Georgia and Alabama, has taken Mr. Cushman's place in the Carolinas, while Mr. W. M. Tibbs, who for a number of years has been affiliated with various electrical interests in Knoxville, Tennessee, will continue Mr. Plane's work in the middle South.

ALLIS-CHALMERS COMPANY announces the appointment of E. T. Pardee, formerly manager of its Boston Office as manager of its power and electrical department. Mr. Pardee is well qualified for this position, having been actively connected with the selling of power and electrical apparatus during most of his business life.

Mr. Pardee began his business experience with the Western Union Telegraph Company at Syracuse, New York, with which company he was connected from 1885 to 1891. Following this he represented the Fort Wayne Electric Corporation at Omaha and San Francisco from 1891 to 1898, being advanced in the latter year to manager of the Boston Office, which position he held until 1901. In that year he entered the Boston office of the Bullock Electric Manufacturing Company as a salesman and remained with Allis-Chalmers Company in a similar capacity after it had acquired the Bullock Company. Mr. Pardee was made manager of the Boston Office of Allis-Chalmers Company in 1905 and in his work there has made a host of friends.

Mr. Pardee will be succeeded as manager of the Boston Office of Allis-Chalmers Company by T. J. Lynch, who for the past seven years, has been manager of the Toronto Office of Allis-Chalmers-Bullock, Limited. Prior to that he had been connected with the Construction Department of Allis-Chalmers Company. Mr. Lynch was born and spent his early life in Boston and is now returning to his home city.

INDUSTRIAL ITEMS.

THE AMERICAN CARBON & BATTERY CO. announce the removal of executive offices to suite 700-702 La Salle Bldg., St. Louis, Mo., on April 15, 1911. This action has been deemed necessary on account of a need for improved facilities for handling increasing business. The new street address will be 509 Olive street.

THE CUTLER-HAMMER CO. advise that the Chicago office has been moved to the Peoples Gas Bldg., 122 South Michigan Boulevard. This move took place April 15, 1911, and was due to a demand for more spacious quarters.

THE WESTERN ELECTRIC COMPANY has recently been advised that the two telephone exchanges which it has been installing in the city of Peking, China, were successfully cut into service on April 2nd. These exchanges are both of the common battery type and are equipped for 6,400 lines apiece. At present 3,000 subscribers' lines are connected to this telephone system, which is owned and operated by the Imperial Government.

The new telephone system covers the whole of both the Tartar and Chinese cities. Underground cable, 3 1-2 inches in diameter and containing 400 paper insulated wires, has been used. The telephone system will employ about thirty operators, all of whom will be Chinese girls. The foreign residents in Peking are particularly pleased with the arrangement of one section of each switchboard for their use. English speaking operators will be employed on these sections.

THE REYNOLDS ELECTRIC FLASHER CO., of 195 Fifth Ave., Chicago, announce the moving of their plant to the Electric Building, 617-631 West Jackson Boulevard. The new plant will double the working capacity of the old one and at the present running of the company, it is expected to expand very soon to its full capacity.

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CONTENTS.

Southern Central Station Activity.

Since the St. Louis N. E. L. A. convention developments have run high in the organization of the central station industry as is evidenced by the fact that the total N. E. L. A. membership has passed the 8000 mark, an increase of over 2500 during the past year. The interest in company and geographical sections is highest in the history of the association, and considerable credit must be given such organizations for the rapid progress made in extending association influence. The activities which reflect the central station conditions in the Southern states are decidedly gratifying and are keeping pace with the general industrial and commercial improvements in that section. Two geographical and several company sections are now established, all the outgrowth of a recognition of the mutual benefit to central stations and the public from co-operation in matters of common interest and the broadening of the scientific and practical knowledge of principles relating to light and power. Complete details as to the recent formation of two Southern state sections are given in detail elsewhere in this issue. Their working field includes over 200 stations and the result of concentrated efforts to be put forth is certain, however any predictory statements from present plans are altogether impossible due to the present limited vision and lack of comprehension of facts and factors which will effect so new and so large a field of activity.

The era of Southern central station development has only well begun. Past progress as presented in the January issue showed conclusively the present tendencies. Based on these developments and those now going on, the expansion in the Southern field as to number of stations being established is one and a half times the rate for the whole United States. The largest increase in number of central stations has been among those of the smaller sizes with the hydraulic type figuring prominently. When it is remembered that the streams of the Southern Appalachian alone are credited with an available water horsepower of over six millions and when it is further remembered that the whole of New England, with all of its careful utilization of horsepower has chained less than 1.500,000 horsepower, the importance of this great asset to Southern possessions comes to light.

The South is rapidly regaining the potential influence in the affairs of this country which was experienced prior to the civil war. Everywhere and in all lines of business this is noticeable. The expanding of the central station industry in the South and the increasing activity in such fields of operation cannot be taken otherwise than the outgrowth of greater industrial, social and financial relations, all of which tend toward a still greater development and a more stable foundation for the work of the future. With this good beginning in central station work, it can be well expected in the next few years with better organizations and stronger relations that important and resulting benefits will come to the industry and to those who are closely related to it, the public.

Steam and Hydro-Electric Generating Stations of Empire District Electric Co.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

BY H. M. BEAL, ASSOCIATE MEMBER A. I. E. E.

UP TO the time the Empire District Electric Company was organized in 1909 by Henry L. Doherty Company, of New York, the Consolidated Light, Power and Ice Company and the Joplin Light, Power and Water Company served Joplin, Webb City and Carterville, Mo., and Galena, Kansas, the Spring River Power Company serving a part of the adjacent mining territory, requiring in all about 150,000 horsepower to operate the various industries of the district. Since the organization of the Empire District Electric Company, the above named companies have been consolidated, and all classes of service is now furnished by the Empire District Electric Company. The total population of the cities and towns served is over 100,000, and there are over 100 miles of street and interurban railways besides manufacturers of mining machinery, structural steel, foundries, flour mills, limestone quarries, etc. The lead and zinc mines, which are the largest of their kind in the world, use a large part of this total power in their operation, as the average mining and ore concentrating plant uses from 150 to 250 horsepower.

At the time the Empire District Electric Company was organized, the then existing generating stations had a normal capacity of about 7,000 K.W., and as this was entirely inadequate to take care of the additional load expected from the new business campaign then inaugurated, contracts were at once let for the erection of a 15,000 K.W. steam turbine generating station at Riverton, Kan. This station was to be on the Frisco railroad and Spring River, which affords easy coal handling facilities and furnishes an abundant supply of water for the steam boilers and condensation. Ground was broken for the station November 4, 1909, and the first concrete work started December 15, the erection of steel work for buildings begun January 27, 1910, the boiler and stack erection February 26, and turbines and switchboard erection commenced March 28, 1910. The first unit was ready to start June 15, but owing to the shortage of coal occasioned by a coal strike the first unit was not put in service till August 11, 1910.

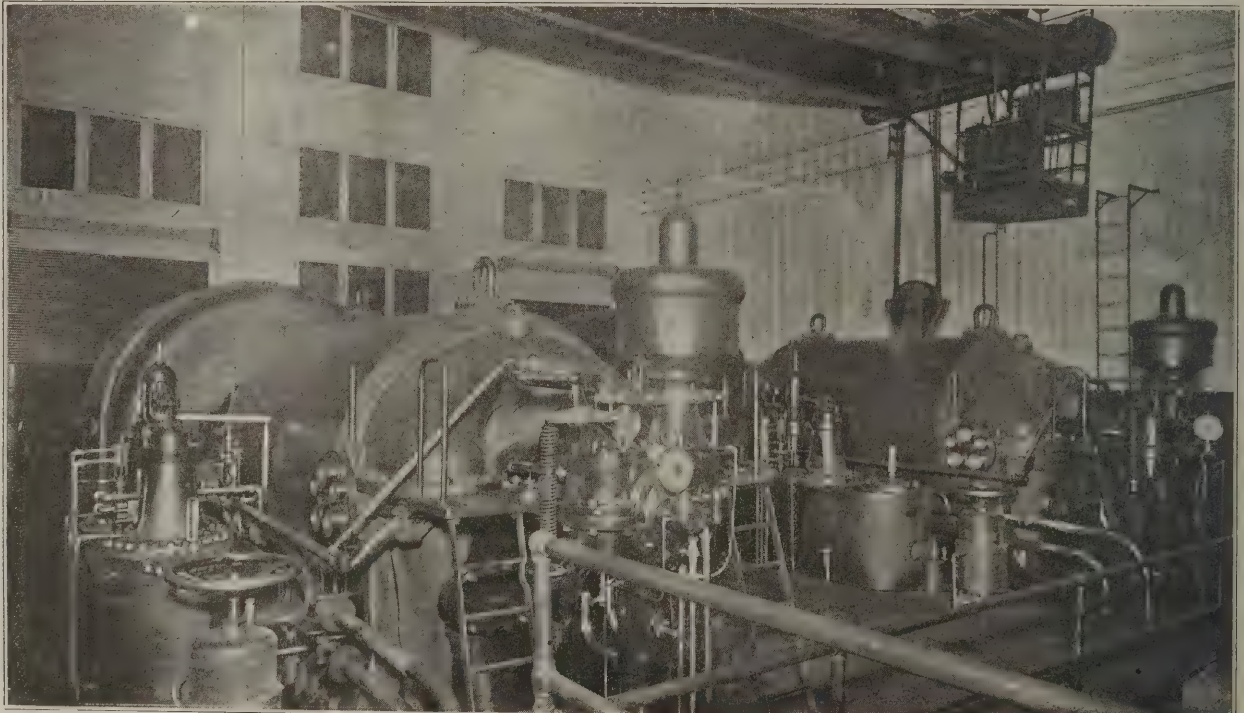


FIG. 1. TURBINE ROOM OF RIVERTON STEAM STATION.

STATION ARRANGEMENT AND OPERATION.

The arrangement and operation of the station is worthy of note and will be taken up separately. The coal is received from the railroad on a double switch which is graded so that the full cars travel down grade toward the incline leading to the storage structure and the empty cars away from it. A coal storage structure 150 feet long, 50 feet wide and 34 feet high has been built at the end of the boiler room, adjacent to and parallel with the railroad. This structure is fireproof, being built entirely of concrete and iron, and is arranged so that it may be flooded, entirely submerging the 8,000 tons of coal in a very few minutes and draining it as quickly. As the full cars reach the incline they are pulled up by a motor driven hoist and placed at any desired position over the coal storage on a steel trestle. The cars are either dumped or unloaded by a grab bucket hoist of 1½ tons capacity which travels on a monorail over the cars in the center or over the storage bin on either side of the cars and from there may be run over the coal bunkers in the boiler room. This hoist, therefore, performs the double duty of unloading the cars and filling the boiler room bunkers.

The boiler room is 160 feet long and 80 feet wide and contains 16,500 horsepower of Sterling water tube boilers, all of which are equipped with superheaters and Green chain grate stokers, fed from coal bunkers running lengthwise of the boiler room, over the aisle between the two

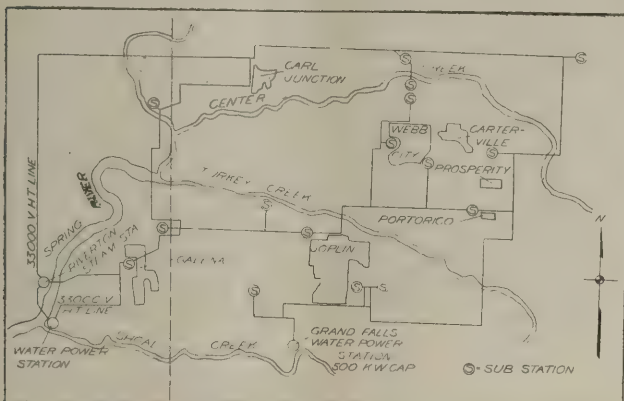


FIG. 2. MAP OF TRANSMISSION SYSTEM.

rows of boilers as shown in Fig. 4. The stokers are operated by steam engines placed in the basement.

The ashes fall from the chain grates and are carried by gravity to the front of the boiler, where they are sucked into an eight inch line of suction pipe leading to an overhead tank of forty tons capacity located outside the boiler room. A special Sturtevant exhauster direct connected to a fifty horsepower General Electric steam turbine running at 3,600 r. p. m. supplies the suction for the ash handling system. The storage tank is supplied with a sprinkler system for wetting the ashes and a gate in the bottom through which they may be loaded into cars or wagons.

Steam is carried at 225 pounds pressure and delivered to the main header through six-inch nozzles welded into the header. The steam header consists of a complete loop of 15-inch steel pipe extending around the boiler room, resting on rollers supported by iron brackets fastened to the walls. This pipe is made in extra lengths, all joints are of the Vanstone type with wrought steel flanges, bends being used in the place of elbows. Draught for the boilers is furnished by two Custodis radial brick stacks, each fourteen feet inside diameter and 250 feet high. Each stack is connected to eight boilers by overhead steel breechings.

FIG. 4. BOILER ROOM.

GENERATING EQUIPMENT.

The turbine room is 80 feet long by 50 feet wide and contains the two steam turbine units, auxiliaries, and the eight panel control switchboard. The auxiliaries are placed on a floor, level with the boiler room floor, the main floor being raised about 15 feet above and is at a level with the turbine bed plates. The switchboard is on a slightly raised gallery near the high-tension switch room.

The generating equipment consists of two Westinghouse double flow, horizontal turbine units. The generators are 3 phase, 25 cycle, 1500 r. p. m., 6600 volt machines with a normal rating of 6000 k.w. at 80 per cent.

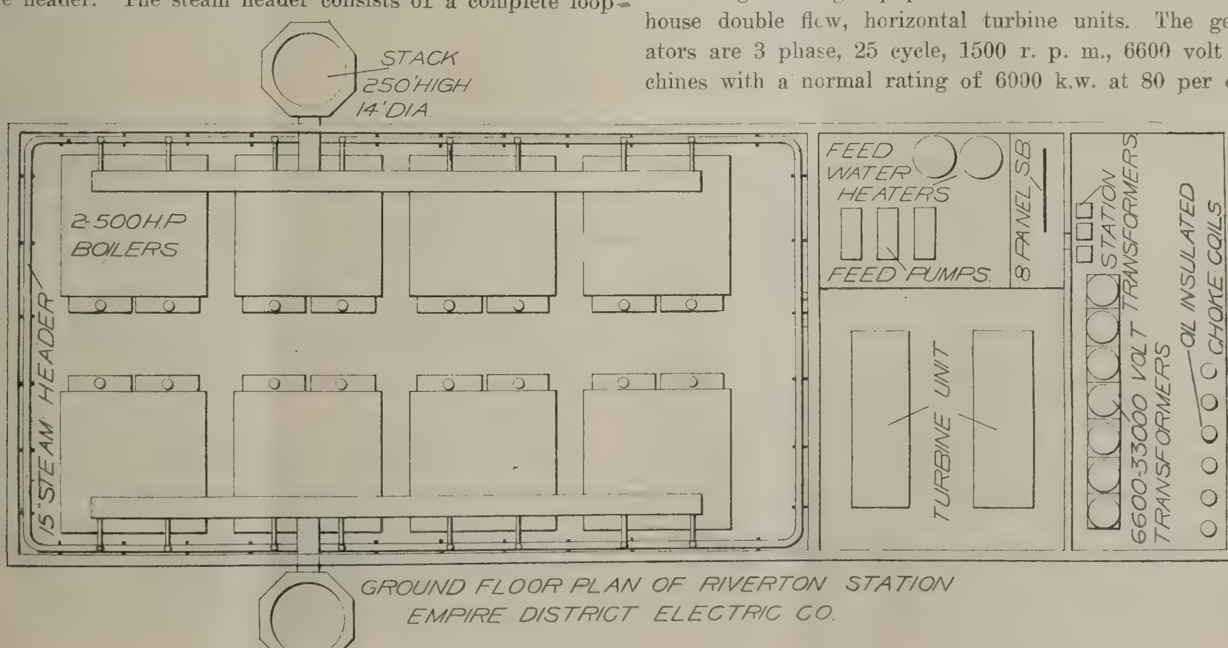


FIG. 3. LAYOUT OF APPARATUS, RIVERTON STEAM STATION.

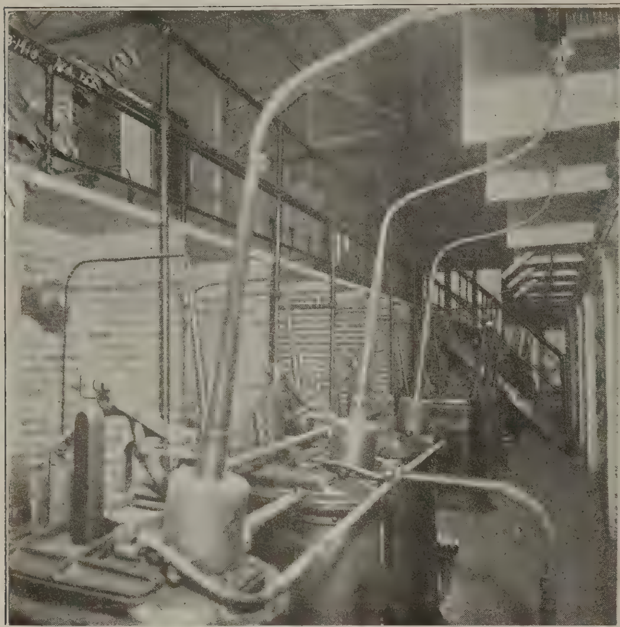


FIG. 5. HIGH TENSION SWITCH ROOM.

power factor. The exciter equipment consists of one 125 k.w. steam turbine driven unit and one motor generator unit of the same capacity. Each turbine is equipped with a Westinghouse Leblanc condenser mounted beneath the turbine and suspended beneath its bed plate. The circulating pump and special dry vacuum pump are mounted on the same shaft and are driven through a flexible coupling by a 150 horsepower high-speed Westinghouse steam engine. The water for condensing and boiler feed is taken

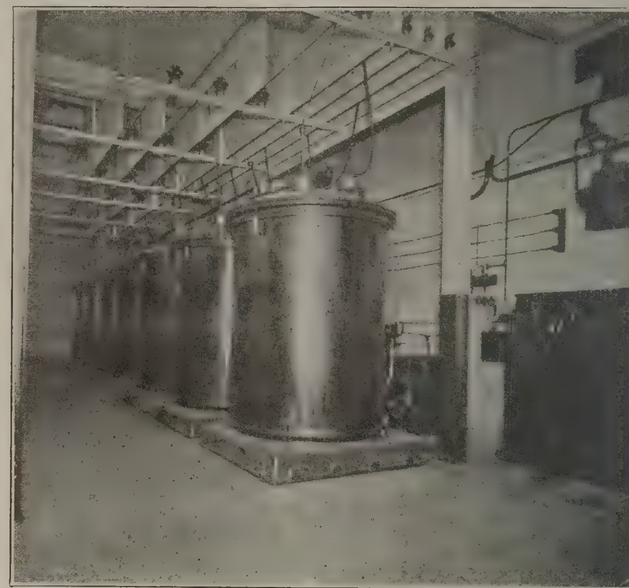


FIG. 7. TRANSFORMER ROOM.

from an intake tunnel extending into Spring River and is pumped by two engine driven, single stage centrifugal pumps, to a 30,000 gallon storage tank and two 5000 horsepower Cochrane open feed-water heaters and purifiers which are heated by the exhaust from the boiler feed pumps, stoker engines, ash fan turbine, pump and con-

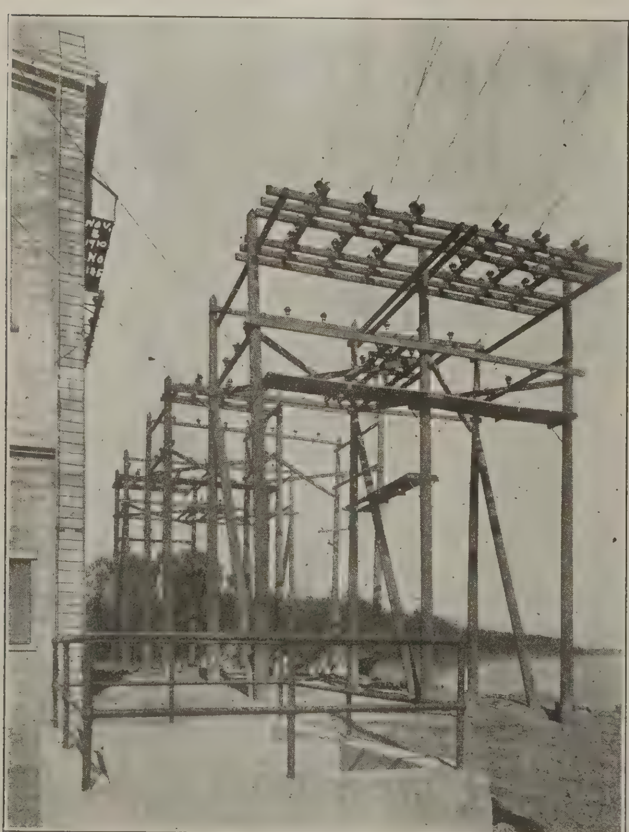


FIG. 6. DISTRIBUTING STRUCTURE FOR 33,000 VOLT LINES, REAR OF RIVERTON STATION.

FIG. 8. TOWER FOR 33,000 VOLT LINES AT CROSSING POINT OF SPRING RIVER.

denser engines. The boilers are fed by three Worthington duplex boiler feed pumps.

The transformer room is 80 feet long by 30 feet wide and contains two banks of 2000 k.w. water-cooled, oil insulated transformers and one spare transformer that can be connected to either bank. The transformers are delta connected for 6,600-33,000 volts. The high tension switch room is the same size and directly over the transformer room, beside the turbine room. All generator and 33,000 volt out-going line switches are of the remote control type, and located in the high tension switch room and are controlled from the switchboard in the turbine room. Each leg of the 33,000 volt switches is enclosed in a separate steel tank, immersed in oil.

Fig. 9. Hydro-Electric Plant and Dam at Lowell. Transformer House at Left, Riverton Station in Distance at Right.

The generator busses are mounted in separate compartments built of pressed brick and Vermont slate on a steel superstructure in the high tension switch room, and all 33,000 volt wires are protected by barriers of asbestos board. Each of the out-going lines is protected by electrolytic horn gap lightning arrestors and oil-immersed choke coils. The switchboard is eight panels, made of black marine-finished slate and is divided as follows: Two exciter panels, one house panel, two generator control panels and three high tension control panels.

HYDRO-ELECTRIC STATION AND TRANSMISSION FEATURES.

The water power station was constructed by the Spring River Power Company about four years ago and is situated on Spring River at Lowell, Kansas, about a mile below Riverton. This station is now operated in parallel with the steam station, although the available water supply is not sufficient to permit of constant operation at full capacity only a part of the time. As shown in Fig. 9 the station is built in the dam, both being of concrete construction. The equipment consists of two 1500 k.w. 3-phase 25-cycle generators direct connected to two turbines. The mains from the generator switchboard in the station pass through conduit to the transformer house on the bank where the voltage is raised to 33,000 volts.

TRANSMISSION LINES.

During the past eighteen months there has been constructed a 33,000 volt transmission line 64 miles in length encircling the district, starting from and ending at the Riverton station, each end feed independently. The older transmission line, erected by the Spring River Power Company and connecting with the water power plant at Lowell and the steam plant at Riverton, runs across the circle formed by the belt, connecting with it at both ends and at intermediate points, as shown in Fig. 2. The belt and other transmission lines make a total of 100 miles and are so sectionalized by high tension oil switches in the substations and knife switches on the four pole structures that trouble may be localized and only a short section of line cut out at a time for repairs.

The conductors are of number 0 hard drawn bare copper wire and are supported on 35-foot Idaho cedar poles with 8-inch tops spaced 150 feet apart. All cross-arms are

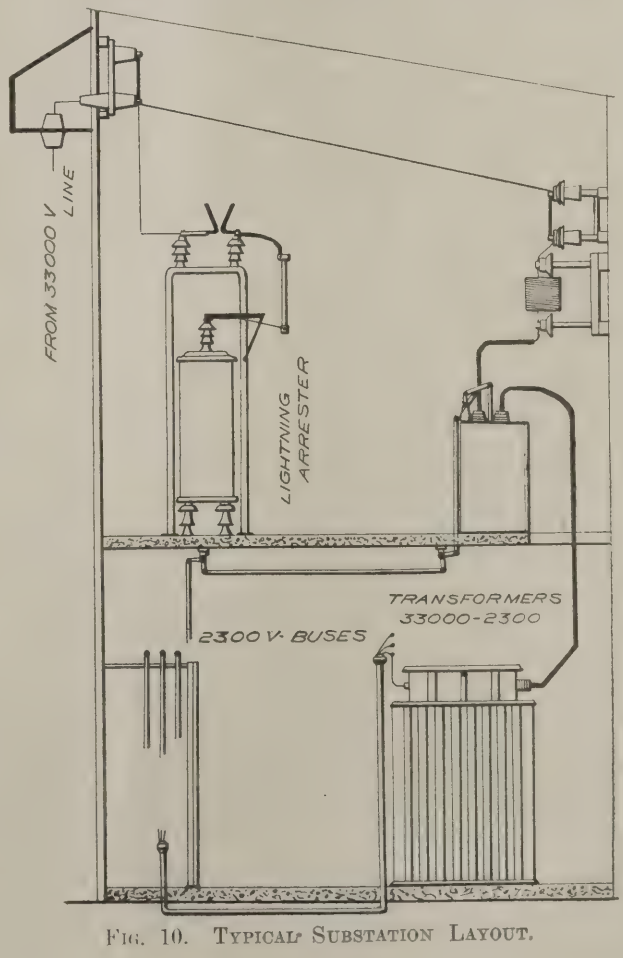


Fig. 10. Typical Substation Layout.

of Washington Fir, 5 feet x 4¼ x 3¼ inches. The top arm carries one transmission conductor and one galvanized iron ground wire for lightning protection and the other arm carries the other two transmission conductors. A second ground wire is supported on a bracket directly below the lower arm, and a telephone circuit is carried on brackets about six feet below the lower ground wire. Transmission wires are spaced not less than four feet and transposed every two miles. The telephone circuit is transposed every second pole. Both of the galvanized iron lines are grounded every second pole with independent grounds.

All poles are brush treated with a creosote mixture for one or two feet above and below the ground line, this being where poles are most effected in this district. Each pole is also surrounded with finely crushed stone for the double purpose of admitting air to the poles at the ground line, thereby helping to preserve them and serving as a protection against grass fires.

Electric service is distributed from the substations for power purposes at 2300 volts on separate pole lines from the 33,000 volt transmission lines. The poles for these lines are the same size as those used in the transmission lines, but the three wires are carried on one cross arm, which is 6 feet x 4¼ x 3¼ inches. Only one galvanized iron wire is used for lightning protection and is run next to the pole on the cross arm, grounded at every second pole the same as the transmission lines.

SUBSTATIONS.

The substations used for the distribution of power in the mining district, are portable structures built of steel and corrugated galvanized iron with concrete floors and of an average size of 17x22 feet and 29 feet high. The 33,000 volt lines enter through a projecting structure near the roof, built of slate supported by an iron frame. On entering, the lines connect to hook switches, then pass to a set of remote control hand operated oil switches, then through another set of hook switches and out, thus forming a loop and enabling the operator to sectionalize the line in case of trouble.

Fig. 11. Section of Belt Transmission Line Showing Pole Structure and Switching Tower.

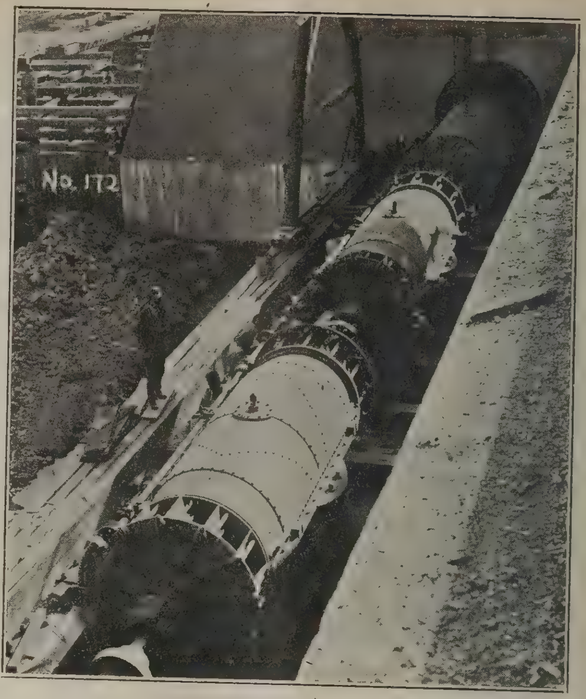


Fig. 12. Water Turbines at Lowell Station.

The wires leading to the transformers are tapped in ahead of the oil switches and connect to another set of hook switches and then to the choke coils and a second set of oil switches and then to the transformers. Wherever the substation is fed from a branch of the main transmission line, the main line oil switches are omitted.

Each sub-station is equipped with a set of electrolytic lightning arresters connected to the entrance hook switch. Each leg of the oil switches is enclosed in a separate tank and this is enclosed in a separate brick compartment built on the concrete floor and each switch is operated by a lever on the switchboard on the first floor. The high-tension oil switches and lightning arresters are installed on the second floor and the three 250 K.V.A. oil insulated, self cooled 33,000 to 2,300 volt transformers and switchboards on the first floor. The 2300 volt circuit from the transformers leads to the switchboard where it divides into two circuits, each circuit passing through an oil switch mounted on the switchboard to the two distribution circuits leaving the substation in opposite directions. All 2300 volt wiring inside the sub-station is enclosed in iron conduit and the out-going lines are protected from lightning by multigap lightning arresters. The current passing out over each 2,300 volt line is indicated on an ammeter and the current of both lines registered on a switchboard type, three phase integrating watt meter. A 2300 volt, bracket type volt meter is also mounted on the switchboard.

The aggressive new business campaign which was started when the Empire District Electric Company was organized has been very successful, having secured a large amount of new business and created much interest in purchased power which will make it comparatively easy to secure contracts in the future.

The esthetic requirements in any lighting problem are that the light and its carrier shall take their proper place in the architectural and decorative scheme of the room in which they are placed.

A Practical Discussion of Depreciation.

(*Contributed Exclusively to* Southern Electrician.)

BY FRANK F. FOWLE, CONSULTING ENGINEER.

THE recognition given to the subject of depreciation has greatly increased during the past decade, owing to a variety of influences. Theoretical reasoning and analysis have played no small part, but what is vitally important is the fact that the theories thus established are being widely accepted and applied. The commission plan of regulating rates under state or federal supervision is one of the most prominent developments which have brought this matter to the front. Adequate provision for depreciation by public service companies, in full accord with theory, has been compulsory in many instances, but it is very satisfactory to observe that compulsion has not invariably been the motive. The need of making a proper provision, from every standpoint, has been so widely discussed and so generally accepted that it is rare now to hear of any contrary opinions from authoritative sources. At the same time, practice has not fully caught up with theory and in some of its phases the subject is far from exhausted.

Without attempting to give an ironclad definition of depreciation, the term means in a general way the shrinkage of property values, as measured initially by cost, with advancing age. The fundamental cause of depreciation is the fact that there is a limit to the useful or economical life of property of nearly every kind. Land and natural resources form a notable exception to this rule and may, on the contrary, appreciate in value, as they frequently do. In this respect we may distinguish between natural and artificial property, meaning by the latter constructed works, plants or systems, of the kind everyone knows. The second group is the one which essentially suffers depreciation, despite all efforts or precautions to the contrary short of actual reconstruction or replacement. Increased efficiency of upkeep or maintenance may prolong the life, but can never prevent the ultimate arrival of the time when usefulness ceases, unless those terms are so broadly interpreted as to include reconstruction with current upkeep or repairs. That is, depreciation advances with age whether it is visible or not and outward signs alone form no safe or sure criterion as to condition.

While the broad question, as to whether or not depreciation needs to be provided for in a systematic manner, is generally accepted as settled, there is still a disposition to temporize or procrastinate when the period of reconstruction, in whole or part, is somewhat remote. Most expenses of operation are periodic and recur daily, weekly or monthly, while a few occur, perhaps, annually. The charges for reconstruction are in another class, however, because they recur only at long intervals, comparatively. But such charges are too heavy in the majority of cases to assess against the current operating expenses as they arise, and such a practice, even if it were generally feasible, would introduce a large element of uncertainty in the net income or profits. The consistent plan is to assess a proper pro rata of such charges against each year's operation, in a constant amount as nearly as possible. This produces much greater stability in the operation costs as a whole and makes it possible to analyze the cost with much accuracy, so as to fix rates for service or determine the net profits.

When depreciation is entirely neglected and no fund is accumulated to meet it by means of yearly assessments against revenues, several things are evident. When the time of reconstruction arrives, the necessary funds must be raised by new capital or loans, except so far as current revenues can be drawn upon; the new and additional obligations will result in greater earning capacity, and the burden will fall either upon the stockholders in the shape of diminished returns, or upon the public in the form of increased rates, neither of which is fair or equitable. The indefinite continuance of such a policy will obviously result in financial disaster to the owners. because the rates will finally become so burdensome as to suppress the business entirely, or through financial reorganizations the original investors will lose their holdings. In the second place, the gradual depreciation of a property can mean only a corresponding shrinkage of the plant assets, and hence the intrinsic value of the capital securities issued upon such property has been falling at the same time. If these securities have been sold, or exchanged for value received, on a basis approximating their original value or apparent earning power, it is evident that such transactions may have been, and probably were, inequitable and perhaps greatly so. In other words, the plant assets have been unprotected by a depreciation reserve and have been constantly shrinking with the progress of time. Thirdly, it is evident that the owners have misled themselves as to the real profits, or have knowingly taken as profits the funds which in reality should have gone to the depreciation reserve. Whenever the profits taken by the owners have included the funds which should have gone to reserve, the conclusion is inevitable that they have been paying dividends out of assets, or investment.

These arguments constitute, perhaps, a severe arraignment of neglect to recognize and properly provide for depreciation, but the evils which arise in consequence of that neglect seem to justify such a summary of the situation. It is possible, moreover, to elaborate upon still another phase of the matter. This relates to instances where rates for service have been too low, in reality, to pay expenses and meet depreciation, with a fair profit or return. Nevertheless a profit or dividend has been paid in many such cases upon the belief, in good faith, that it was earned; while in truth the dividend was paid out of depreciation reserve, partly or wholly.. The day of ultimate settlement and loss will finally arrive in every such case, and not only is it unfortunate for those immediately concerned, but it throws similar enterprises into a position where they are looked upon with distrust or suspicion.

A partial but inadequate provision for depreciation relieves these consequences only in degree, it can never do so fully. It is a step, of course, in the right direction and may even approach a satisfactory condition. But depreciation is fully established as a fact aand there need be no argument on that score; and not only does it exist, but it progress beyond the possibility of being arrested or compensated except through the systematic accumulation of a sufficient reserve fund.

Granted that these facts are established, it remains to determine how great a fund is needed in each instance and how to accumulate it most economicaly, with due regard for the protection of the investment. On the first point there is little difference of opinion except where judgment or experience plays some part. The fund needed at the time of reconstruction is not necessarily equal to the original cost, for various reasons. In the first place, there is frequently some salvage or scrap value which acts as an offset. But against this there is the cost of removing the old plant to make way for the new, and the extra expense, if any, of maintaining service meanwhile. When the first cost is adjusted by these respective credits aand debits, the actual depreciable value is known; if the prices of labor and materials are unchanged the depreciable value is the exact amount needed to finance the reconstruction. It frequently happens, however, that labor and materials have changed in price, and the recent tendency, as a whole, has been upward. When labor and materials have actually advanced, the excess cost of reconstruction, over what it would have been if prices had remained stationary, is chargeable to capital account because it represents a legitimate increase in the cost of plant. If the wornout or useless plant is replaced by new plant of larger capacity, that part of the cost which represents increased capacity is chargeable to capital account, of course, because it provides increased output and earning capacity.

When labor and materials have decreased in price, so that the reconstructed plant costs less than the original, the difference represents actual cash in hand, in the depreciation fund. The capital account should then be decreased by an equal amount, which could be effected by applying the cash left over to the purchase of outstanding stocks or bonds and placing the latter in the treasury. The same course would apply to the case in which the new plant has less capacity than the original. This presents the strict theory of the matter, but when the excess or the deficiency of the cost of the new plant is relatively very small the construction accounts, if it is necessary to charge them at all, can be adjusted through the surplus.

The exact manner in which a depreciation reserve should be accumulated is a matter over which there is some difference of opinion. In this respect there are now two general theories, and these will be discussed in some detail. Both theories rest, however, upon one fundamental assumption, that the sum of the present or depreciated value of the property, at any time, plus the simultaneous value of the depreciation reserve fund, should equal the original cost or investment. This assumption rests, in turn, upon the principle that the investment must be fully protected at all times; that is, the progressive shrinkage in the plant assets (or present value of plant) caused by depreciation, must be fully offset or compensated by an increasing cash reserve. The statement made above that the sum of present value plus present reserve should equal first cost is true, of course, in the broad sense. It might be modified slightly by consideration of scrap value, cost of removal and extra expenses incident to providing continuous service during reconstruction. This fairly establishes the fact that the manner in which the reserve accumulates must be regulated to correspond with or offset the advance of physical depreciation.

Probably the oldest theory in regard to the rate at which physical depreciation progresses is the so-called straight-line theory. Under this theory the advance is uniform at a fixed per cent per annum from beginning to end of life. For example, if the life were twenty years, the annual depreciation would be five per cent, and at the end of six years the present condition would be 70 per cent. The reserve fund, in this case, should accumulate at the rate of five per cent per annum and the total would follow a straight-line law of accumulation. It has frequently been assumed in referring to this theory, especially by those who reject it, that no interest is allowed on the accumulations in the fund and hence that the annual charge against revenues would be, in the above case for example, five per cent of the depreciable value of the property. This is not necessarily true and in fact is very improbable. After the first year the fund would draw interest if properly managed; it is hardly fair to assume interest on the fund under one theory and disregard it under some other theory. Returning to the straight-line method, it is quite evident that the gross amount of interest would increase year by year and that correspondingly the annual depreciation assessments against operating revenues would decrease. As a whole, this method rests upon assumptions as to the rate of advance of physical depreciation.

The second theory is the so-called sinking fund theory, which is based primarily upon considerations of a financial character. It is well understood that equal annual payments to a fund, placed at compound interest, will produce at the end of a term of years a larger total amount than the sum of the payments; and further, that the fund accumulates at an accelerating rate with respect to the passing years. Consequently the graph of the fund with respect to time is a curve, which has been termed the sinking fund curve. If the annual payments and the term of the fund are so adjusted as to provide a proper amount for rebuilding a certain plant when it ceases to be useful, it appears that this method might be a suitable one for meeting depreciation. But further consideration shows that the physical depreciation must, of necessity, be assumed to advance according to an inverted sinking fund curve, if this theory meets the test that present value plus present reserve equal original cost, substantially. This is equivalent to saying that a property depreciates slowly at first, then more rapidly as its age advances and finally very rapidly when it becomes old.

In some cases those who uphold the second theory assert that property does depreciate, in fact, in conformance with such a curve. That is, at an accelerating rate.

But only in theory, at most, has such a contention been sustained; and the connection between the sinking fund curve and the true rate of physical depreciation, if one exists, is not a relation but merely a coincidence. Others have held the view that there is no such thing, in fact, as physicial depreciation and that a property or plant is just as valuable the day before it is discarded as it was when new; at the same time they recognize that a reconstruction fund is a necessity and would provide it by means of the sinking fund before described.

These conflicting views and theories are here presented to stimulate study and discussion of the whole subject. Lack of space forbids an elaborate discussion of the respective merits and weaknesses of the several theories, but it seems quite clear that the burden of proof to show that the sinking fund curve represents true physical depreciation rests upon those who uphold that theory. And furthermore, it seems to be true that the fundamentally correct starting point, in any theory, is the determination of the law which states the rate of advance of physical depreciation.

A mathematical comparison of the straight-line and sinking fund methods, under like conditions, shows that their average annual assessments are nearly equal, there being a slight difference in favor of the first theory. But a comparison of these methods as applied in the determination of present values, when making physical valuations or appraisals, reveals considerable discrepancy. The difference increases as the useful life becomes greater. It is not possible to compromise this difference by using part of one method and part of the other, because such a course violates the base principle that present value plus present reserve must equal original cost. One method or the other must be coonsistently adhered to, if either is chosen.

An account of a discussion of these two methods by the writer, in another place, is referred to in the footnote* for the benefit of those who may wish to pursue the subject. The importance of the subject undoubtedly warrants its careful consideration, with the object of settling as far as possible the difference of opinion which now exists in regard to the rate of advance of true physical depreciation. It is not to be concluded from the preceding discussion, however, that all the possible methods of establishing a reserve fund have been touched upon. The number of methods, from the theoretical standpoint, is almost indefinite. Those discussed above are the ones most commonly considered and apply particularly to properties which are owned and operated by public service companies.

A difficulty concerning the proper dividing line between expenditures for current maintenance or upkeep and those for plant renewals arises quite frequently and is sometimes a rather complex one. In strict theory any replacement or renewal, however small, is chargeable to depreciation and should be paid for out of reserve. But in practice the strict theory is seldom if ever observed. The renewal of small parts, which wear out much sooner than the machinery of which they form a part, such as shaft bearings, packing, or valves, for example, is commonly charged to maintenance. Many other illustrations might be cited in a plant of almost any kind, but these serve very well for illustration. The common practice in this regard amounts, in fact, to charging some renewals to maintenance and some to depreciation. Of course such charges to maintenance constitute the renewals of a comparatively frequent and inexpensive character, but nevertheless the gross amount of such items may be considerable. There is substantially little gain in economy in putting such renewals in the class of depreciation, because the useful life of the parts is ordinarily so short that the interest on a corresponding reserve fund would be almost negligible.

At the same time it often happens that renewals creep into maintenance expense which do not properly belong there. It is substantially as important to draw a reasonably sharp line between maintenance and depreciation as it is between renewals and construction. Maintenance implies, in the narrow or strict sense, only that care of the plant which is necessary to keep it in operation, exclusive of any replacements of worn-out equipment or parts. In this class would be included such items as painting buildings and structures, clearing derangements or faults in lines and equipment, tightening connections, periodical tests and inspections, general overhauling and cleaning, etc. The replacement of any part or complete unit which fails prematurely is chargeable, in theory, partly to maintenance and partly to depreciation. That part of the renewal cost which is proportional to present value, or equal thereto, is chargeable to maintenance, while the remainder, which corresponds to the value extinguished through depreciation, is chargeable to depreciation. The last distinction is not always observed, although a correct one theoretically.

It becomes of greatest importance, of course, when the failure concerns a substantial portion of the plant. As an example of this which is not infrequent, the failure of a pole line in a sleet storm will be quite familiar. If the line as a whole has depreciated 30 per cent, an equal proportion of the net cost of rebuilding is properly chargeable to depreciation. In such a case the wire lines are frequently serviceable again, at least to some extent; and under such circumstances the cost of repairing the wires themselves is wholly a maintenance expense, except when new wire must be employed.

But in practically all matters where depreciation is concerned it is necessary to have a consistent theory concerning the actual rate of physical depreciation from year to year during the assumed useful life. It is not a question which can safely be solved from considerations of accounting, because it involves engineering matters in which judgment, experience and theory all play a part. That part of the subject which concerns the rate of physical depreciation is especially commended to those who are interested, as one of the important questions which needs to be thoroughly studied and discussed with the object of settling those differences of opinion which now exist. It cannot be that both methods are equitable and correct under the same conditions, although it is within the limits of possibility that both are wrong in some degree. The older theory, in the writer's estimation, is much the sounder of the two. But whatever the ultimate outcome, it is essentially important to establish the economically correct method as soon as possible.

*"Depreciation In its Relation to Appraisals," Electrical World, Oct. 6, 1910, page 796.

In Birmingham, England, the handling of street-car passengers during the "rush hours" is assisted by having the lines radiate in all directions from the manufacturing and business portions of the city. Standing in a street car is specifically prohibited, due to a desire for the comfort of the passengers and to the fact that the lines are narrow gauge, the tracks being only 3½ feet wide, although when the weather is bad and sometimes during the rush hours a few standing passengers are permitted. A few straps hang from the top of the car only for the purpose of assisting passengers entering and leaving.

The ordinances of the city give the police authority to regulate the loading and unloading of passengers, consequently there is no rushing and crowding in getting on cars.

Hydro-Electric Development on the Colorado River in Texas

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

ONE of the most important hydro-electric developments in the Southwest from an engineering and commercial standpoint, is the work now under way and projected by the Colorado River Power Company at Marble Falls and other points on the Colorado River. The developments form an installation of about 20,000 horsepower and hold an important position in regard to electrical distribution in this section. Work on the undertakings was started in 1909, by the construction of a reinforced concrete dam at Marble Falls, one of the best natural dam sites on the river. Here three natural falls of a total height of 53 feet were submerged by the construction of a dam, making available a head of 70 feet. There are available on this river two other dam sites within a distance of 12 miles, the lower one at Smithwick Falls and the upper one at Cummins Dam, with available heads of 50 and 40 feet respectively. About 60 miles above the Cummins dam on the San Saba River a third dam to be known as the San Saba is planned which will be 80 feet high, close a narrow gorge and give sufficient storage to operate a plant similar to that at Marble Falls. The main purpose of this dam, however, is to create a flood storage. According to present plans the Cummins and Smithwick plants will operate in parallel with the Marble Falls station. The locations of the various sites are clearly shown on the accompanying map.

Government data on the flow of the Colorado River are available for a period of fifteen years, from 1896 to 1910 inclusive, and show a flow ranging from an average minimum of about 250 second feet to a maximum of 123,000 second feet with periods of drought and flood about equally divided. The enormous variation of flow is to be overcome by the construction of a flood storage already mentioned on the San Saba River, a large tributary stream flowing into the Colorado above the three developments, where at a reasonable cost a storage of approximately 116,000 acre feet can be obtained. With this enormous storage available, it is estimated that a constant minimum flow of 740 second feet will be obtained at Marble Falls.

ELECTRICAL OUTPUT AND DISTRIBUTION.

The estimated primary power output of the three developments, based on the flow data of the past fifteen years, is 56,325,000 electrical horsepower hours, in addition to which there would have been available secondary power ranging from a minimum of 28,000,000 electrical horsepower hours in 1910 to a maximum of 42,000,000 electrical horsepower hours in 1900, averaging for the fifteen years, 35,000,000 electrical horsepower hours per year. The power produced by these combined developments will be transmitted to the large cities and towns of central Texas, Austin, Temple, Waco, San Antonio, and other cities as shown on the map in Fig. 4. The company expects to sell the larger proportion of its power at wholesale to large consumers, a part of it having already been contracted for. On account of the high cost of fuel in this district, a market for the secondary power will be readily found with consumers now having steam power plants of sufficient capacity to supply their present needs. During the periods of low water a reciprocal agreement can be made with the steam power plant owners whereby water power will

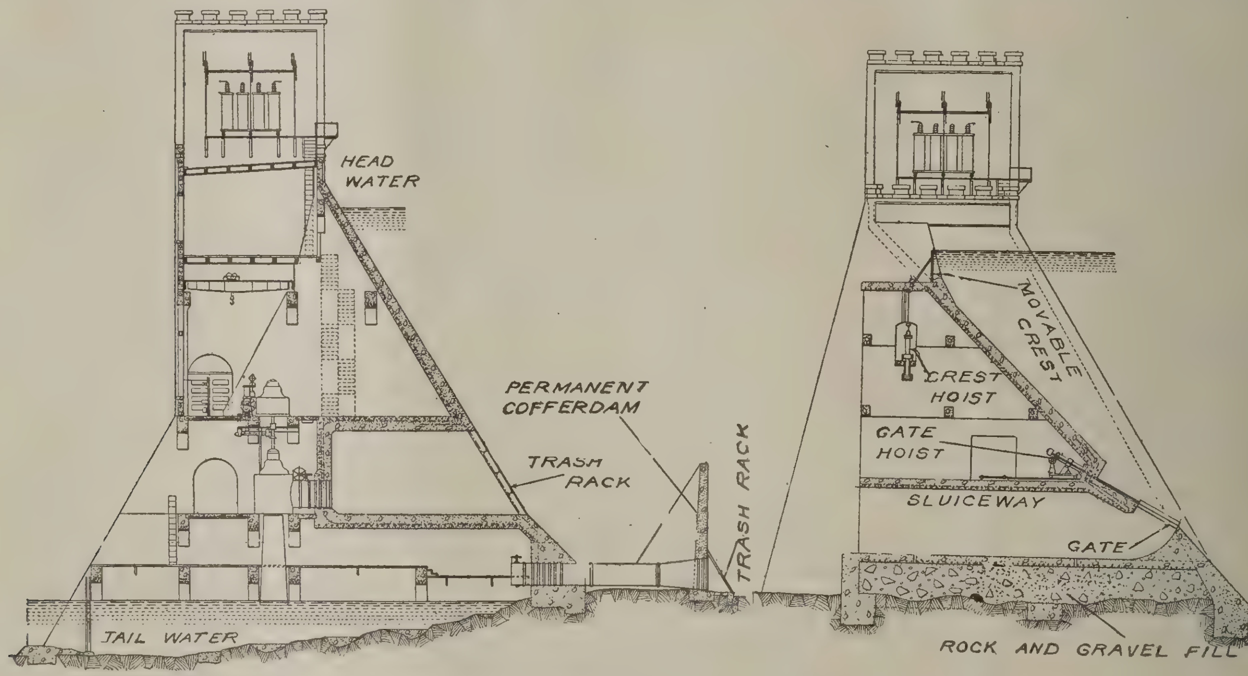


FIG. 1. SECTIONS OF POWER PLANT AND DAM AT MARBLE FALLS.

be used for their peaks and all surplus steam power available will be absorbed when required by the water power company, thus giving the steam plants a very desirable daily load factor when in operation. The company plans to retail its power at Marble Falls and the smaller towns along the transmission line. A feature of the market is the fact that power for irrigation pumping and for operating cotton gins will be required during the season coinciding with that of the maximum flow of the river, thus giving a profitable outlet for secondary power. The transmission system as shown in Fig. 4 extends from Marble Falls southeast 50 miles to Round Rock, a point near Austin, where it branches, extending northeast to Waco 80 miles and southwest to San Antonio 100 miles, a transmission distance from Marble Falls of 160 miles.

MARBLE FALLS DEVELOPMENT.

A description of the development now under construction at Marble Falls is given herein, and is quite typical of the proposed additional developments. The Marble Falls dam in cross-section is shown in Fig. 1. The site upon which this dam is constructed seems to have been prepared by nature especially for the purpose. The main channel of the river bed upon this point is about 500 feet in width and contains an abrupt fall of 15 feet. At the right bank just below the falls is a basin about 150 feet wide, forming a natural pool for receiving the discharge from the water wheel draft tubes. At a height of 15 feet above the water of this pool the solid rock bottom extends from the edge of the basin entirely across the river channel, a distance of 400 feet to the left bank, thus making an admirable foundation for constructing the sluice gate section of the dam. The saving in construction cost on account of the solid rock bottom being at an elevation of 15 feet above tail water, is apparent. Of still greater importance, however, is the fact that the flood waters in discharging from the sluice gates are received on the down stream side of the dam on this natural apron of solid rock, which gradually descends to the tail water level. When the sluice gates are closed, the entire down stream of this section of the structure lies high and dry, thus facilitating the inspection and maintenance of same.

the top of the dam by heavy hinges, which hinges and joints between sections are made practically water tight by means of strips of heavy rubber belting. The 10-foot movable crest sections can be raised or lowered one at a time by means of a portable hydraulic cylinder during floods.

The entire dam, both sluice gate and power house sections, consists of reinforced concrete buttresses which support the reinforced concrete bulkhead as shown in Fig. 1. The buttress of the sluice gate section are spaced 10 feet between centers and in the powerhouse section, 14 feet 6 inches between centers, except near the end of the sluice gate section, where it was originally planned to omit sluice gates. There will be provided 35 sluice gates, each 7½x8

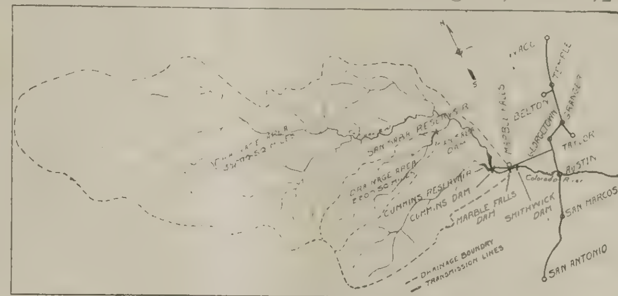


FIG. 3. MAP OF DRAINAGE AREA, WITH LOCATION OF DEVELOPMENTS.

feet, located as shown in Fig. 1. These gates and frames are made of structural steel, the frames being composed of 15-inch channels suitably reinforced with 6-inch channels so as to prevent deflection and also to prevent seepage between the concrete and the steel. The gates are built up of 9-inch channels and I beams reinforced with tie rods and concrete and covered with a ⅜-inch steel plate. Gates are operated one at a time by a portable hydraulic cylinder connected to the gates by stems or draw rods extending through stuffing boxes as shown in Fig. 1. The cylinder will be supplied with water pressure by a motor driven pump located on the truck carrying the cylinder.

During floods it is planned to first put the sluice gates into operation and then, if necessary, any part or all of the movable crest can be lowered, or if desired, the sur-

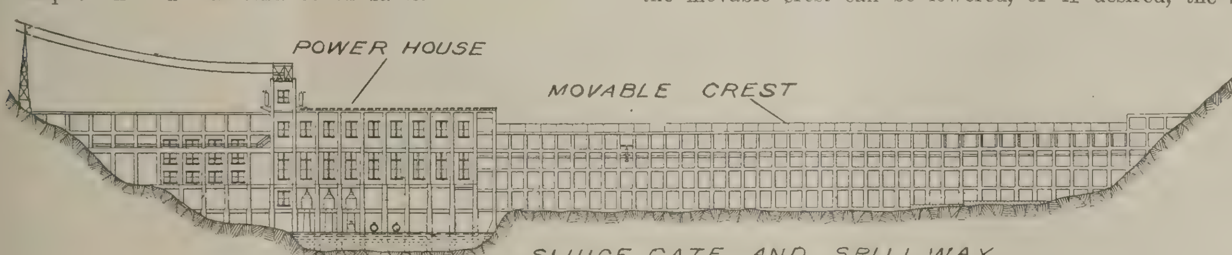


FIG. 2. THE MARBLE FALLS DAM AND POWER HOUSE, DOWN STREAM SIDE.

The entire river channel and banks are composed of a very hard limestone formation. The left bank rising almost perpendicular while the right bank has a slope approximating 45 degrees. The maximum length at the top of structure is 748 feet. The normal head created by the dam is 70 feet. The elevation of the highest point of the masonry on the sluice gate or spillway section is 65 feet, above which a 5-foot mechanically operated flashboard extends across the crest of this section a distance of 400 feet. This flashboard or movable crest is constructed in 10-foot sections, the frames being made of structural steel covered with 3-inch lumber and secured at

face of the pond may be allowed to rise and the surplus water flow over the top of the movable crest. The maximum flood flow recorded on this river at this point is nearly 200,000 second feet. This flow over an ordinary dam crest 350 feet in length would reach a height of about 20 feet over the crest. The capacity of each of the 7½x8 foot flood gates with a head under which they are required to operate is about 5,000 cubic feet per second for each gate, or 175,000 second feet for the 35 gates. Therefore it will be seen that a comparatively small volume of water will ever flow over the top of the dam.

One of the most unique features employed in the con-

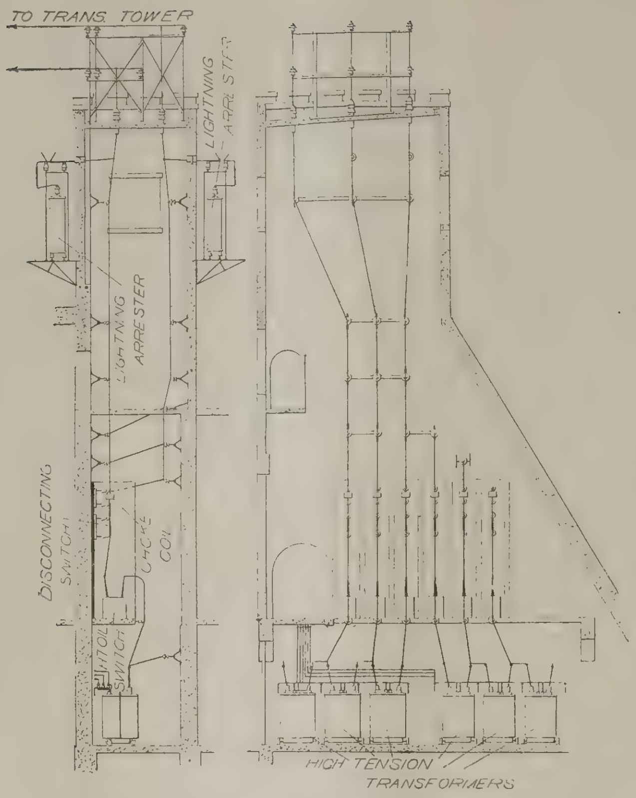


FIG. 4. ELECTRICAL LAYOUT OF EQUIPMENT.

struction of this property is what the engineers who originated the idea are pleased to term the "dry dock" system. This system consists of a permanent concrete coffer dam constructed along the crest of the natural fall just for the purpose of diverting the flow of the river through the sluice gates during construction, or later when making an inspection or repairs of the power plant section of the dam. Three steel tubes extend through this permanent concrete coffer dam toward the power house section, thence through the concrete bulkhead, and terminate in the discharge pits at an elevation slightly above tail water. These three tubes are each provided with cast iron valves of the swivel gate type, thus making it possible after drawing the water down in the pond, to divert the entire ordinary flow of the river through these tubes, and lowering the water in the pond to such an extent that the sluice gate section of the dam lies entirely above water. By providing a small drain or waste pipe, the space between the permanent coffer dam and the power house can also be drained into the tail race, thus making the upstream side of the power house bulkhead and foundations entirely out of the water. Tail gates are also provided for each section of the power plant so that the water may be pumped from any compartment, thus making it possible to repair or inspect foundations at this point of the structure. With this point accomplished, it will be seen that every part of this dam is accessible for inspection or repair without increasing the usual large expense for coffer damming and the consequent long period of shut-down in case repairs are found necessary. If this feature could have been applied to the numerous dams which have met with destruction, millions of dollars worth of property would have been saved.

POWER HOUSE AND EQUIPMENT.

The power house section of the dam will be built to a height well above any possible high water. The maximum height from the foundations of this section to the top of the wire tower being 115 feet. The design of the powerhouse section differs from that ordinarily adapted in hollow concrete dams, in that the bulkhead of the powerhouse section is so designed that the machinery in the powerhouse does not set directly below the bulkhead, as will be seen in Fig. 1, thus avoiding any possibility of leakage or moisture affecting the electrical apparatus. This design also makes it possible to equip the plant with a suitable traveling crane, and furthermore avoids any possibility of damage to the foundations of the power plant by reason of the water discharging over the structure and into the tail race. The design adapted in this case also favors the installation of the high tension transformers and other apparatus in the power plant.

The power house consists of nine compartments, three of which will be occupied by the three 550 horsepower Victor vertical turbines direct connected to the 350 kilowatt Westinghouse generators now being installed. Each unit is equipped with a Lombard oil type governor. Five additional compartments will provide for future units of 2200 horsepower each. One compartment will contain the high tension transformers and switching apparatus as shown in Fig. 3. The generators installed are wound to operate at 2,300 volts, 3 phase, 60 cycles, while for the long distance transmission the voltage will be stepped up to 66,000 volts. The present plans are to use wood pole construction and eventually to install duplicate lines from the Smithwick Falls plant to Round Rock, the junction of the two main transmission line branches. Details for the sub-station design and equipment have not yet been completed.

The prime mover in the organizing of this company is C. H. Alexander, of Dallas, Texas, president of the Colorado River Power Company. The engineers in charge of the plans and construction are the W. H. Zimmerman Company, of Chicago.

Electrical Business in West Indies.

Contracts for electric lighting have been entered into by the colonial government and by the municipalities of Basse Terre and Pointe a Pitre severally with a merchant in the first named city. The municipal contracts were made four or five years ago and contain a penalty of $1 for each day's delay after notification that service is demanded, but this notice has never been given, and there are thus no arrears to be paid. The contract with the colony was approved on September 1, 1910. The merchant has no means for carrying out his agreement, and proposed to pay for construction out of earnings, but he is now willing to cede his contract to a constructing company until such company shall be completely reimbursed. Ample water power is to be had at Basse Terre, but other power would have to be used at Pointe a Pitre. The total cost of plants and lines has been estimated at $55,000 to $60,000.—Consular Report.

The selection of a lighting fixture for any space should be such that the fixture, the light, and its shade will perform what is required of it *practically,* and at the same time meet all the *esthetic* requirements of its environment, whether placed in a foundry, or a mill, or a store, or palace, or a bank, a library or the home.

Alternating Current Engineering.

(*Contributed Exclusively to* Southern Electrician.)

BY WILLIAM R. BOWKER.

IN THIS article the writer will take up the subject of transmission of power, continuing the discussion of rotary converters from the May issue. The following polyphase connections of a combined three-phase power transmission system supplying energy to three-phase transformers, in combination with rotary converters differently connected, are variously used in practice. The choice in method of connecting is determined by the requirements to be fulfilled. All the diagrams illustrate the transformer primaries supplied with three-phase power excepting Fig. 32, which outlines a two-phase transmission circuit being utilized by a rotary converter connected two-phase.

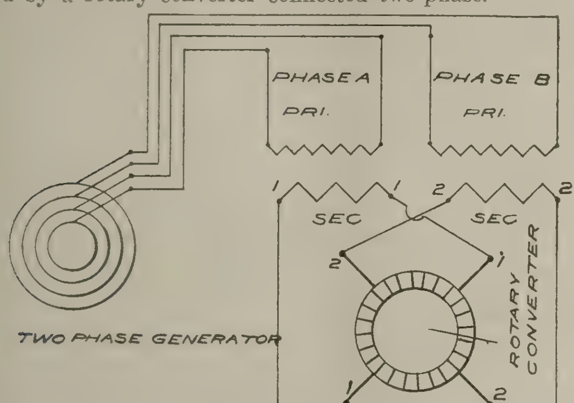


Fig. 32. Rotary Converter and Transformer, Polyphase Connections, Two-Phase Diametrical.

In these circuit diagrams no reference is made to the direct current side of the converter, only the alternating current circuits being shown. In the accompanying diagrams Figs. 32, 33, 34 and 35 show two and three-phase connections and Figs. 36, 37, 38 and 39 show six-phase connections.

In Figs. 32 and 36, it will be seen that the two terminals of each secondary transformer circuit is connected to the converter armature winding at an angular displacement of 180 degrees, being called diametrical connections. This is practical when the rotary converter has an even number of rings. When the step down secondaries are connected diametrically, in which there is one transformer for two rings, two for four rings and three for six rings, the secondary voltage across the terminals of each winding is of equal value, irrespective of how many rings are used on the rotary converter.

By connecting the transformer secondaries diametrically to the converter rings, it affords a more simple connection than those outlined in Figs. 37, 38 and 39, for the reason that this method admits of a step-down transformer being utilized with only one secondary coil. Thus necessitating only two secondary leads or outlets from each transformer, whereas it requires two secondary circuits or separate windings and four terminals from each transformer, when the methods of connecting as outlined in Figs. 37, 38 and 39 are utilized. Fig. 32 shows two step-down transformers supplied with two-phase current delivering to a rotary converter. Fig. 33 shows three step-down transformers receiving and delivering three-phase current to the brushes

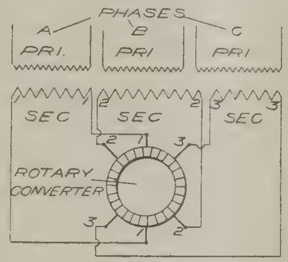


FIG 36

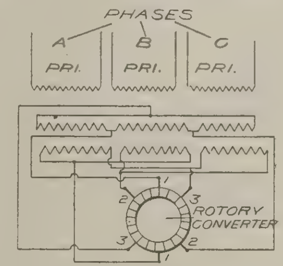


FIG 37

Fig. 36. Rotary Converter and Transformers With Six-Phase Diametrical Connection. Fig. 37. Same With Six-Phase Double Delta Connection.

and collecting rings of a rotary converter connected in delta and Fig. 35 the same, but the secondaries star connected to the collector rings. Fig. 34 shows two-phase currents delivered to the transformer primaries T (Tee) connected, and three-phase to the three ring converter.

In practice it is an advantage to connect the transformer in delta to the converter, for in case of damage or breakdown to any one of the transformers, the system is still operative with the remaining two, while the other is being repaired or replaced, thus giving practically continuous service.

The T (Tee) connections as shown in Figs. 34 and 39

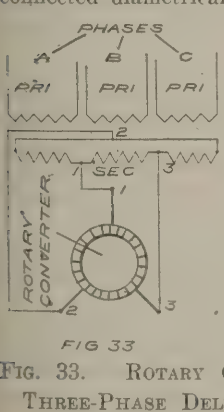


FIG 33

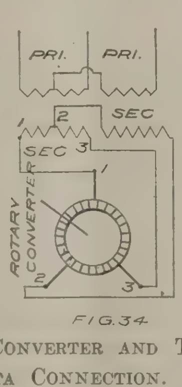


FIG.34

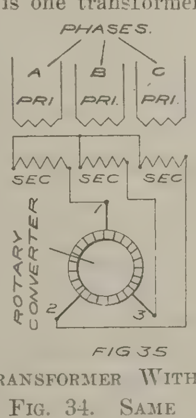


FIG 35

Fig. 33. Rotary Converter and Transformer With Three-Phase Delta Connection. Fig. 34. Same With Three-Phase T Connection. Fig. 35. Same With Three-Phase Star Connection.

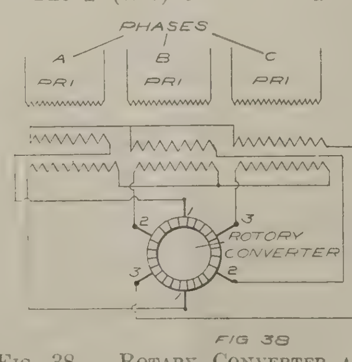


FIG 38

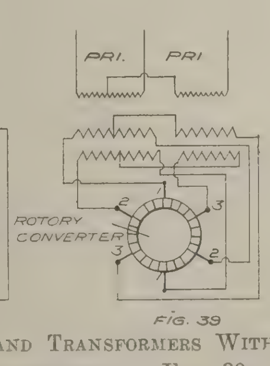


FIG. 39

Fig. 38. Rotary Converter and Transformers With Six-Phase Double Star Connections. Fig. 39. Same With Six-Phase Double T Connections.

require only two transformers and this method of circuit layout can be practically utilized to change from two or three-phase, to three-phase, and from two or three-phase, to six-phase, as shown in Figs. 34 and 39 respectively. Fig. 40 illustrates a three-phase transformer receiving high voltage three-phase current, the primaries of which are delta connected to the transmission lines, the step-down secondaries being delta connected and delivering three-phase current to a rotary converter, which in turn delivers 550-600 volt direct current to a street railway traction circuit. The outline diagram clearly shows the connections.

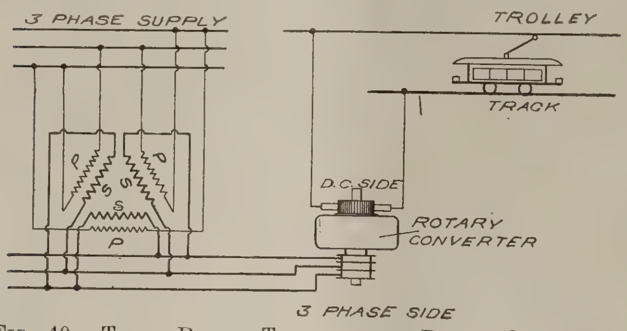


FIG. 40. THREE-PHASE TRANSFORMER DELTA CONNECTED SUPPLYING THREE-PHASE CURRENT TO ROTARY CONVERTER, D. C. SIDE CONNECTED FOR STREET RAILWAY SERVICE.

The commercial advantages resulting from this combination in practice are that the electrical energy may be generated at a considerable distance away from the street railway system and transmitted as high-tension three-phase energy by small sized copper lines, thus saving considerable capital outlay. It can then be transformed to low voltage three-phase alternating currents through the intermediary of a transformer, which in turn is electrically connected by short stout copper feeders connected to a switchboard with controlling and operating appliances, to the rotary converter. The converter finally transforms the three-phase currents into direct currents of suitable amperage and voltage, its armature being wound with a double circuit to bring about this transformation. The direct current is then utilized as energy for the street railway system. Fig. 41 is an outline showing transformer connections in various combinations, and the voltages resulting therefrom.

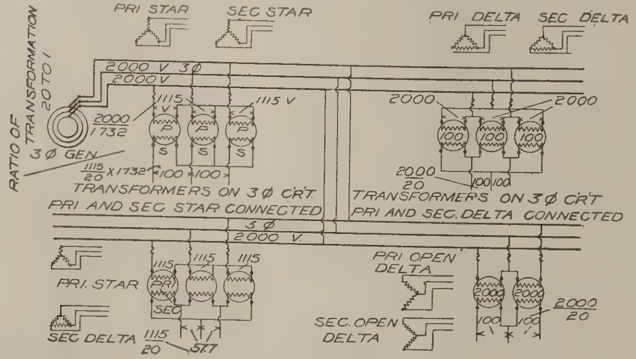


FIG. 41. SHOWING TRANSFORMER CONNECTIONS IN VARIOUS COMBINATIONS FOR VARIED VOLTAGES.

For series arc lighting, constant current transformers are utilized, and they can be designed so that in practice a more constant current can be maintained than can a constant voltage by constant pressure transformers. Transformers are designed and operated which can be adjusted to maintain a constant current of different values within certain practical limits. Fig. 42 illustrates the principle of construction of a constant current transformer, the automatic adjustment of which depends upon the principle of magnetic repulsion between the magnetic fields mutually existing between a fixed and movable coil. When energized by a current flowing through them, the strength of the magnetic repulsion for a given relative position of the two coils is proportional to the current in amperes flowing through the coils.

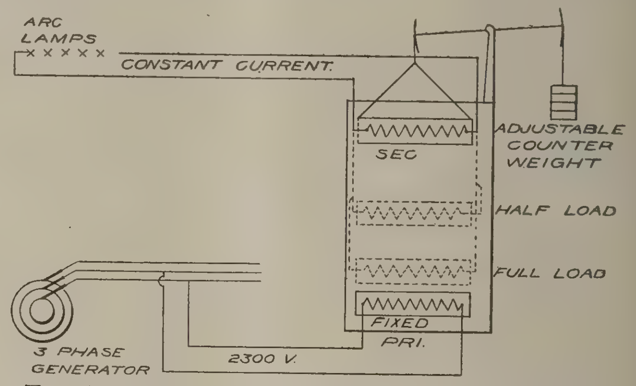


FIG. 42. PRINCIPLE OF CONSTRUCTION OF CONSTANT CURRENT TRANSFORMER.

In Fig. 42 the primary coil of the transformer is fixed, and the secondary coil movable, the weight of the movable coil being partially counterbalanced by a weight or weights suspended from a rocker arm lever, the resulting combined action of the mutual magnetic repulsion and counterbalancing weight keeping the current constant. The combination is so designed that the counterbalancing weight plus the effect of the magnetic repulsion, exactly balances the weight of the secondary coil for a given constant current value.

This transformer is so constructed that at normal full load, the primary or fixed and secondary or movable coils, lie close together, notwithstanding the magnetic repulsion between them. When one or more lamps are out of circuit, the current through the secondary increases, and likewise through the primary circuit, due to mutual induction between the primary and secondary circuits, thus increasing the strength and effect of the magnetic repulsion between the coils. This results in an automatic separation of distance between them, reducing the current to normal, because there is less mutual induction between the two circuits over a greater distance than when close together, thus less current induced in the secondary. At minimum load, the coils are separated a maximum distance owing to the greater effect of mutual repulsion.

The power factor efficiency of the constant current transformer and arc lamp system is about 85 per cent. at full load, due to the reactance of alternating current arc lamps, while for less loads the power factor and combined general efficiency of the system decreases more and more at decreasing load values. For that reason in practice it is not desirable to operate at loads much below the full load capacity. Provision is made for variable loads by interchanging the connections of the primary and secondary transformer circuits, so that adjustment of load conditions is attained, and by cutting out part of the transformer windings they can operate at 60, 70, 80, 90 or 100 per cent. full load. Thus allowing an operation of the particu-

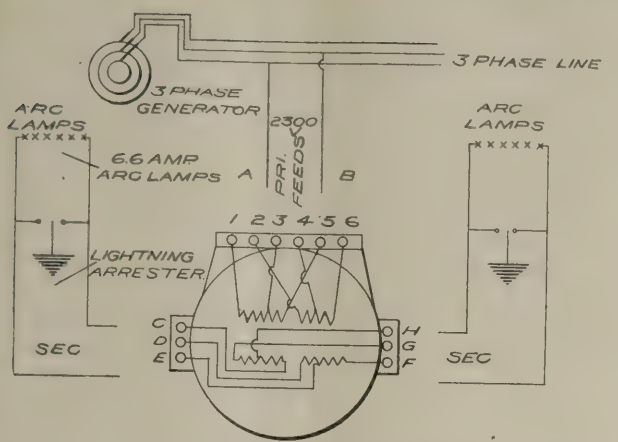


FIG. 43. CONSTANT CURRENT TRANSFORMER WITH VARIABLE CONNECTED LOAD.

lar primary and secondary windings connected in circuit at practically full load, although the total load on the transformer may be only 60 per cent. of its rated full load capacity, therefore keeping the power factor and general efficiency as high as possible. For instance in Fig. 43, by connecting primary A to 1, B to 6, 2 to 5, and leaving 3 and 4 open, the secondary lamp circuit being connected between C and E, and F H, it gives a primary and secondary circuit arrangement for 60 per cent. of normal full load capacity. Still at the same time it is utilizing that circuit represented by those connections at full capacity, and thus keeping the power factor high by cutting out a certain proportion of the primary and secondary windings which would otherwise not be operated to full working capacity. In practice this is desirable and very convenient, for it admits of the utilization of say a 50 kilowatt capacity transformer to carry 30 kilowatt load, by adopting the interchange of circuit connections for various loads. Thus the transformer is operated at full load capacity, as connected, with the resulting high power factor and general efficiency of the system.

We can thus vary the load circuit for different percentages of full load capacity by the interchange of suitable connections as outlined in Fig. 43, and keep the current at a constant value by the automatic action due to the magnetic repulsion between relatively movable coils, combined with a counterbalancing weight as outlined in Fig. 42.

For various loads the circuit connections are tabulated below:

For 60 per cent. load, connect primary A to 1; B to 6; 2 and 5. Leave 3 and 4 open and connect secondary lamps (arcs) between C and E, F and H.

For 70 per cent. load, connect primary A to 1; B to 6; and connect 2 and 5. Leave 3 and 4 open and connect secondary lamps between C and E; F and G.

For 80 per cent. load, connect primary A to 1; B to 6; connect 2 and 5. Leave 3 and 4 open and connect secondary lamps between C and D; F and G.

For 90 per cent. load, connect primary A to 3; B to 6; connect 2 and 5. Leave 1 and 4 open and connect secondary lamps between C and D; F and G.

For 100 per cent. load, connect primary A to 3; B to 6; and connect 4 and 5. Leave 1 and 2 open and connect secondary lamps between C and D; F and G.

Principles of Illuminating Engineering.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

BY A. G. RAKESTRAW.

IN the preceding section of this article published in the May issue, the subject of color has been considered from a scientific standpoint referring to white light as the standard. When, however, it is desired to definitely fix a color standard for light, we find that it is not such an easy matter, since white is not a simple color but is composed of vibrations of an infinite number of different wave lengths. It is common to speak of white as being the color of daylight or sunlight, but we find that daylight itself is subject to considerable color variations. There is a great difference between the quality of the rays from the noonday sun, the yellow or orange tints of sunset, or the cold blue of a northern sky, in comparison with which direct sunlight appears a golden yellow. For our purpose, however, we will define white light as that radiated from the sun at the zenith.

With this as a standard, we may approximately express the colors of artificial illuminants as follows: A number of these terms are taken from the Standard Handbook for Electrical Engineers.

ILLUMINANT.	COLOR.
High sun (at zenith)	White.
Low sun (near horizon)	Yellow to orange-red.
Skylight	Strong bluish white.
Mercury arc	Bluish green.
Welsbach gas mantle	Greenish white.
Short carbon arc (open)	White.
Long carbon arc (enclosed)	Bluish white to violet.
Moore tube with CO_2	White.
Moore tube with Nitrogen,	Yellow.
Acetylene flame	Very nearly white.
Flaming arc	Intense yellow, pink, or white, according to carbons used.
Nernst glower	White to yellowish white.
Tungsten filament	Nearly white.
Tantalum filament	Slightly yellowish.
Metalized filament	Slightly yellowish.
Carbon filament, normal voltage	Yellowish white.
Gas flame	Pale orange yellow.
Kerosene lamp	Pale orange yellow.
Candle	Orange yellow.

Another and a more accurate way of comparing light sources with sunlight and with each other, is to express the quality of the radiation in terms of primary color sensations, which as we have seen are three in number, red, green and violet. This is in no sense an analysis of the light into its constituent wave lengths, for as we have pointed out before, the eye cannot analyze the light further than to record the value of the color sensations, which may or may not bear any definite relation to the wave lengths producing them. For instance, orange monochromatic light produces certain impressions on the retina, while orange light composed of a mixture of red and yellow, although differing entirely in wave length, would produce exactly the same impressions.

However, the analysis of various lights by this method furnishes us with valuable and interesting information. As an example we may compare the sensations produced by sunlight, sky light, the open arc and a gas flame. Taking the red sensation as equal to 100 in each case, we get relative values for the others as follows:

	SUNLIGHT.	SKYLIGHT.	OPEN ARC.	GAS FLAME.
Red	100	100	100	100
Green	193	256	203	95
Violet	228	760	250	27

These figures show clearly the marked variations existing among the sources given. Note the great excess of skylight in the green and violet, and the equally marked deficiency of gas flame in these same sensations. Also note how nearly the light from the open arc approaches to sunlight. Figures showing similar results could be furnished in greater detail, but for our present purpose, the above will be sufficient to illustrate the point.

The fact that light sources vary in the proportion of the wave lengths, affects the appearance of colored objects when observed by different lights. Not only are the colors modified by the tint of the light by which they are viewed, as we might expect, but the relative appearance is changed, and two pieces of goods which match perfectly by one source of light may look entirely different by another. The exact reason for these changes is not always apparent. Many dyes which predominate in one color have also a considerable reflecting power of some other color. For instance, some green goods reflect a considerable quantity of red, which in white light is completely hidden by the green. If, however, this piece of goods be viewed by a light which is strong in red and weak in green, it will present a very different appearance, having a strong reddish tinge. Therefore two pieces of green cloth, one having this occluded red, and the other not, may look alike by daylight and yet appear dissimilar by the light of an incandescent lamp. The effect which the light from the more common lights has on simple colors may be expressed as follows:

The carbon filament, and to a lesser extent, the tungsten and the nernst lamp, render green a yellowish green; blue, a dark purple; yellow, an orange; white, a cream or ivory; and lavender, a pink. The welsbach mantle makes red very dark and changes yellow to greenish yellow, and white to greenish white. The arc lamp renders red, blue and yellow all too light, while the intensified arc lamp, and the Moore tube using carbon dioxide gas, renders all objects in their natural colors.

VALUE OF COLOR.

The value of color as a factor in illumination will next be discussed. That the effect of color is important no one will deny, but that its importance has been exaggerated will be admitted by many. The question has been made the subject of considerable discussion in recent technical literature and several different opinions have been presented as to the exact tints best suited for human vision. The writer will therefore in taking up this matter discuss the value of color, considered from at least three aspects: (1) Efficiency of production. (2) Efficiency of utilization or the selection of the hue at which the eye can work to best advantage. (3) Esthetic considerations, taste, or sensibility. The first of these, however, has been treated upon at length in the previous section of this article.

From the standpoint of efficiency it is of advantage to push the temperature to as high a point as possible and thus to approximate a pure white light, or even by taking advantage of selectivity or luminescence to increase the efficiency to a higher value than would be possible with a black body. While the question of efficiency is always important, it is not always the determining factor in the selection of the light source. Next we may inquire what tint of light is best suited to the eye. We know that the eye can adapt itself comfortably to wide variations of color. For example, daylight varies within a few hours from a golden yellow to a cold blue without discomfort or difficulty in performing the most delicate and intricate of operations. Also with artificial light, if the intensity is sufficient, we can see perfectly by the light of the candle, oil lamp, incandescent lamp or tungsten. In fact for most purposes of life, we can see about as well with one as with the other of our ordinary illuminants.

It may be of interest to look for a moment at the historical side of this subject. We note first, that up to quite recent years that all operations requiring accurate vision were performed during the hours of daylight, and what artificial light, if used at all, was simply to illuminate the interior of buildings sufficiently to get around in. It is just within the last half century that the extension of nearly all industrial operations over the hours of darkness has created a demand for artificial illumination practically equal to daylight. Next we note that up to very recent times all of the artificial light sources, such as the candle, oil lamp, gas flames, etc., had approximately the same tint, from pale yellow to orange or amber. It is significant that simultaneously with the demand for so much work at night, that the incandescent lamp should have been developed and improved. With the introduction of the metal filament lamps, we have not only greatly increased the efficiency, but have improved the quality of the light to meet the demand under more exacting conditions. This is an illustration of the familiar saying that necessity is the mother of invention, or that the power comes with the need.

Since the eye has been developed, at least as far as artificial sources is concerned, for some thousands of years by yellow light, some authorities have recommended this as the proper tint to be used. Most writers, however, favor a light as nearly white as can be obtained. It is the writer's opinion, however, that the color of light should be selected with reference to the purpose for which it is to be used. Since the region of greatest sensibility lies in the yellowish green of the spectrum, as the need for accurate vision increases, the color of the light should approach white. For instance, for social intercourse, the yellowish and amber tints are mellow and pleasant. For reading, sewing, and the like, a stronger and whiter light is desirable, while for accurate work such as drafting and engraving, we should have pure white of even light of greenish tints. It is significant that as the intensity required increases, the quality best suited for the work approaches that of sunlight.

Furthermore, the eye is benefitted by a change in both intensity and color from time to time, following the example of natural light. This demand has found expression in a table lamp recently put upon the market, in which a tungsten lamp is enclosed within a Holophane reflector and provided with a shade. In the base of the lamp is a resistance with an adjustable contact, by means of which the lamp may be varied in candle power and tone, so as to obtain any hue from a deep orange to a dazzling white. The restful effect experienced when the reader lays down the book and softens the light by switching in some resistance, proves that whiteness in itself is not always the determining feature in selecting a source of light.

For certain operations involving the matching of colors, white light is absolutely necessary. For this purpose the Moore tube with carbon dioxide gas seems to be satisfactory, as it is possible to carry on operations under its light that were formerly only possible by daylight. The open arc is also white in color, but has a somewhat limited field of application. Acetylene also is practically white but is subject to the limitations of other open flames.

Apart from the lamps which follow the black body law of radiation, we have some which are luminous or selective, producing colors quite different from any we have been considering, and seem to be peculiarly fitted for certain classes of work. A well known example of this is the mercury vapor lamp, the bluish green light of which is much used in drafting rooms and particularly effective in the perception of fine details, being furthermore restful and pleasant to the eye. It is used also to a large extent in steel mills, foundries, and other similar places, as the light is said to possess remarkable penetrating power through the smoke and dust which obscures the atmosphere in these places. Strangely enough we find that the entirely different quality of light, that from the flaming arcs appears to be also of great penetrating power, and is also much used in large shops where the air is often filled with smoke and dust. It is also claimed that this quality of light is stimulating and of value in increasing the production of the workmen who operate under it.

Besides considerations of efficiency in the production and utilization of light, we are confronted with the question of taste and sensibility. These, as a rule, do not lie within the province of the engineer, but of the architect and decorator, but since the illuminating engineer will meet these problems, it will be well to give them some consideration. That color does play an important part in our lives as far as it has an influence on temperament and sensibilities is now generally recognized. Each tint has its effect, almost insensible in some cases, but none the less definite. We may briefly consider some of these tints. Not only is the net result produced by the color of the light source, but also by the prevailing tint of the reflecting surfaces or transmitting media, such as wall paper, shades, etc., and since 50 per cent. of the total light falling upon the plane of vision may be reflected light, we see that these may play a very important part in producing the final color.

White or some very light tint appears to be best suited for the active duties of life, while amber and orange tones, in low intensities, are cheering and well suited for social gatherings. Bright yellow has a marked stimulating effect. It is always cheerful, pleasant and unoffensive. For equal amounts of illumination, far more energy is expended in the red than in the blue end of the spectrum, or the proportion of heat radiation to effective light radiation is greater in the red. This scientific fact is instinctively recognized by the eye and expressed in common language when we say that a red or pink light or surface is "warm" while a blue one is cold. That is, we unconsciously perceive the presence of greater heat rediation from the one than from the other. A small quantity of bright red among the decorations of a room is cheering, but an excess of red is irritating and in extreme cases may even be dangerous. In general, any considerable use of red shades or paper should be avoided. Blue, except in very light or very dark tints, is cold and depressing, and should be used sparingly. Green is quiet and restful and affords relief to the eye when under strain. Thus the use of green translucent shades on reading lamps.

Greenish light is not as favorable to the appearance of human features as lights of reddish or pink tones. It is related of an ancient dame, that when acting as hostess at social functions, each guest at dinner was illuminated by a light, the shade of which, was prearranged to throw light of a certain hue upon the face. Those who were in favor with the hostess were flattered by warm red lights which brought out the rosy tints of the complexion, while the rivals and other persons not in favor were seated under green lights which put them at a disadvantage.

The modification of color produced by shades, wall paper, etc., has been touched upon. These should be selected with some reference to the source of light. It should be remembered that they can never add to the amount of light of any given color, but only absorb certain wave lengths, and thus change the resultant tint. For example, if it is desired to correct the orange tones of an open flame, a greenish or bluish tinted paper will absorb the excess of red and make the resultant color more nearly white, while a red or pink paper or shade will accent the tint. Again, if a gas mantle be used giving a greenish tint, green paper if used will absorb red rays, leaving a light stronger proportionally in green than the source, while a red or orange paper will help to correct the color.

Wave lengths outside of the visible spectrum, do not strictly speaking, come under the subject of illumination, as these rays are invisible. The extreme violet and ultra-violet rays are chiefly of interest on account of their chemical activity, and the destructive effect that they have upon the tissues of the eye. Furthermore, while the eye is extremely sensitive as regards protecting itself against a harmful excess of radiation at the red end of the spectrum, it is not able to do this for the violet and ultra-violet rays. Therefore care must be taken in the use of lights which are rich in these rays. The mercury vapor light is an example of such a light source. It has no red rays, and therefore the retina fails to adequately protect the eye against too strong a light of this kind and care must be taken in installing such lights that they are not placed directly in the line of vision. The mercury vapor light also abounds in ultra-violet rays, but fortunately lead glass is opaque to these rays and the eye is therefore protected. The fused quartz tube of the quartz lamp, in which the mercury arc is used at a higher temperature, is transparent to the ultra-violet rays, and it is therefore always enclosed in an outer globe of glass.

For some purposes, photography in particular, the actinic value or chemical activity of the light rays is of primary importance. Some light rays are much more effective in producing results on the sensitized plates and papers than others, and furthermore this effect is not at all porportional to the visual intensity. The red and orange rays are weak or lacking altogether in actinic power, while the effectiveness increases as we pass to the other end of the spectrum until we get rapid action in the blue and violet and even into the ultra-violet. This explains why red always takes black and blue white in a photograph, and also why the evening light of sunset is worthless for photographic purposes, although apparently quite bright to the eye. The chemically active short light waves have been refracted and lost. It is also quite possible to take a photograph of an object in a room in which no visible ray of light enters. Again we find the mercury arc lamp of special interest. By its rays pictures may be taken practically as well as by daylight, as its rays are of great chemical activity. The arc lamp is also used a good deal for blue printing and similar work as it is rich in actinic rays.

In concluding, it is necessary that light be steady, as rapid variations of intensity are not only annoying but hard on the eyes. Variation in intensity is produced by various causes. In the incandescent lamp, it is produced by variation in the supply voltage. The carbon filament lamp is quite sensitive to such variations, an increase or decrease in voltage of only two per cent. causing fluctuations in candle power of over 10 per cent. This fact makes it imperative that good regulation be maintained on lighting circuits. The tungsten lamp is not so sensitive in this respect as the carbon filament, but due to the smaller cross section of the filament it responds more rapidly to any change. Note that on turning on a group of lights including both kinds, that the tungsten lamps light up immediately while it takes a short but perceptible time for the carbon filament lamps to attain incandescence. Note also that with several sizes of tungsten lamps on one circuit, the smaller ones will light quickly, while the larger sizes such as the 250 and 500-watt lamps will come up as slow as a carbon lamp, due to the larger filament.

Since on alternating current circuits, there is a reversal of the current each cycle, it follows that there will be a flickering of the light of any lamps operated on alternating current. At the frequencies in common use, such as 60 and 133 cycles, this variation is too rapid to be perceived by the eye, and the light appears perfectly steady. However on circuits of 25 and 15 cycles frequency, it begins to be noticeable. Lamps of the open flame type are much affected by currents of air, unsteadiness from this cause having been more or less successfully overcome by the use of chimneys. In arc lamps the unsteadiness is caused by imperfection in the feeding devices, which permit the length of arc to vary too much and sometimes allow the light to go out and light up rapidly which is very unpleasant. Uneven distribution is also caused by the shifting of the crater. Unless these objections are overcome it makes the arc lamp unsuitable for reading or writing.

Determining Alternating Flux Waves with the Harmonic Instrument.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN)

BY F. B. DAVENPORT, B. S. IN E. E., ADJUNCT PROFESSOR ELECTRICAL ENGINEERING, GEORGIA SCHOOL OF TECHNOLOGY.

THE instrument described in what follows has been given the name Harmonic Instrument by its designer, Mr. Montford Morrison, of Atlanta, Ga. This name was selected on account of the fact that its purpose is to determinate data for the plotting of the harmonically varying quantities of alternating currents. From the earliest investigation of alternating currents, the study of wave form has commanded a great deal of attention and we find the names of Joubert, who probably made the first determination of pressure waves in about 1880, Ryan, Mershon, Bedell, Blondel, and many others associated with methods for the determinnation of alternating waves of one kind or another. The vast majority of the work has been done in connection with the determination of the pressure waves of machines and circuits and in cases where the flux variation was required, it was determined by derivation from pressure curves. This derivation is comparatively simple, but involves a certain amount of tedious determination of areas and graphical constructions. In later years electrical engineers have been given the oscillograph, which has been an excellent aid to the study of current and pressure waves and other rapidly occurring phenomena of the electric circuit. A method has been suggested by Blondel whereby the oscillograph might be used to determine the flux variation.

The Harmonic Instrument is primarily intended for the study of flux waves aand the theory underlying it will be an aid to a closer conception of the method used. An instrument has been described in a bulletin of the Bureau of Standards, May 1908, for the study of such waves, but of a very limited field. The Harmonic Instrument is but of a very limited field. The Harmonic Instrument is not limited to number of poles nor to the harmonic order of the wave. The following discussion will therefore treat only the operation of the later instrumet.

Some of the equations which follow are taken from the paper by Messrs. Loyd and Fisher in the above bulletin:

The fundamental expression for the electro-motive-force (e) generated by conductors cutting lines of magnetic force is:

$$e = - N\, d\Phi/dt \ldots\ldots\ldots\ldots (1)$$

where N is the number of conductors in series and $d\Phi/dt$ represents the rate at which the conductors cut the lines. Solving this expresion for Φ we get:

$$\Phi = - I/N \int e dt \ldots\ldots\ldots\ldots (2)$$

If the voltage generated is commutated at the instant t, when the flux has the value Φ_t and commutation again occurs in T/2 seconds, where T is the period of wave (= 1/f, where f is the frequency), the limits of the integral above, become T/2 + t and t and the change in flux from the instant t (when the flux is Φ_t) to the instant T/2 + t (when flux is $\Phi_{\frac{T}{2}+t}$) is $\Phi_{\frac{T}{2}+t} - \Phi_t$ and the equation becomes:

$$\Phi_{\frac{T}{2}+t} - \Phi_t = - I/N \int_t^{\frac{T}{2}+t} e dt \ldots\ldots\ldots\ldots (3)$$

If the wave contains only odd harmonics or in other words has positive and negative lobes exactly similar, the relation is true that $\Phi_{\frac{T}{2}+t} = - \Phi_t$ and this value of $\Phi_{\frac{T}{2}+t}$ substituted in equation (3) gives:

$$- 2\, \Phi_t = - I/N \int_t^{\frac{T}{2}+t} e dt \ldots\ldots\ldots\ldots (4)$$

The expression $\int_t^{\frac{T}{2}+t} e dt$ represents the area of the voltage wave between the times t and T/2 + t. The mean ordinate of this curve, which is the average voltage generated during the T/2 seconds is;

$$V = \frac{\int_t^{\frac{T}{2}+t} e dt}{T/2} = \frac{2}{T} \int_t^{\frac{T}{2}+t} e dt \ldots\ldots\ldots\ldots (5)$$

As the wave under discussion is commutated by means of a two-part commutator, its average value would be read on a voltmeter of the permaent magnet type. Solving equation (5) for the integral, gives:

$$\int_t^{\frac{T}{2}+t} e dt = VT/2 \ldots\ldots\ldots\ldots (6)$$

This value of the integral substituted in the expression for $- 2\, \Phi_t$ equation (4) gives:

$$- 2\, \Phi_t = - I/N \times VT/2$$

which when solved for Φ_t becomes:

$$\Phi_t = VT/4N \ldots\ldots\ldots\ldots (7)$$

From the last expression it is seen that the flux at the instant of commutation is directly proportional to the average voltage of the commutated wave. If the upper limit of the integral expression is made aT/2 + t in place of T/2 + t, where a is any odd number, it does not affect the final solution of the equation but means that a number of complete cycles (a — 1)/2 have been introduced between the times of commutation. In other words if commutation is effected at any time after the instant t, when the ordinate of the wave is equal but of opposite sign to the ordinate at the instant t, the method still holds theoretically. Practically, if a is made too large, that is if the wave from a many poled machine is being observed, the error due to the break in the commutator is increased until it has a rather bad effect on the curve obtained.

From equation (7) it may be seen that if an arrangement is made whereby the electro-motive-force wave may be commutated at different points and a permanent magnet type of voltmeter is used to read the average values of these commuted voltages, we can plot from these readings the flux curve. The simplest arrangement of this kind consists of a two-part commutator having four brushes rubbing on it and separated from each other by 90 degrees. These brushes are so arranged that they may be all moved by small steps through at least 180 electrical degrees and at all times maintain their separation from each other by 180 electrical degrees. Taking brushes opposite each other in pairs, one pair is connected to the coil surrounding the flux whose curve is to be determined and the other pair is connected to an ordinary voltmeter of the permanent magnet type. One end of the commutator shaft is fitted with a coupling or other arragement so that the commutator may be driven by the machine which furnishes current for the coil. A voltmeter reading is taken, the brushes are shifted through a small angle, say six degrees of the wave being observed, and the voltmeter reading again taken. This procedure is repeated through at least one-half cycle. The meter readings when plotted as ordinates against the total angles turned through at each reading as abscissae, gives the required flux curve.

The instrument having a one two-part commutator and four brushes is limited in its usefulness because it cannot be used to determine waves from machines having any number of poles. It may be used only on machines having 4 poles. By using rings in connection with the commutator the scope of the instrument is broadened, it being posible to take curves from machines having 2 or 2 + 4N poles in addition. N being any whole number not too large. If N is taken too large the error due to break in commutator becomes excessive.

A cross section of the instrument, without brushes and cross section lines for sake of clearness, is shown in Fig. 2. Brushes are attached to the large gears meshing with worms turned by the wheels shown along the top bar, this bar being fastened to the two other gears which are also geared so as to be turned by means of the small wheel at the bottom. This little wheel is arranged with a scale so that the angles turned through by the brushes may be known. The brushes are placed on the large gears and made independent of each other in order that they may be used on other work and also in order to at all times maintain their correct spacing.

The flux curves are determined as previously indicated, that is, by attaching the opposite pair of brushes of the instrument to the coil of the secondary surrounding the flux to be determined and connecting a direct current voltmeter to the other pair of brushes and taking the voltmeter readings for the different positions of the brushes. To obtain a voltage curve, a comparatively high resistance is connected in series with an air-core transformer. The secondary of the transformer is connected to the Harmonic Instrument. This method is based upon the fact that the current that produces the flux in the air-core transformer varies approximately with the voltage, as the largest part of the impedance of the air-core transformer primary circuit is made up of resistance.

A current curve is obtained by connecting the primary of the air-core transformer in series with the current consuming device, or load, and connecting its secondary to the Harmonic Instrument. The flux curve of the air-core transformer will be similar in shape to the current in the primary. It will be seen from what has just preceded that the curve obtained in each case is in reality the flux curve. The problem in the case of voltage and current is to create a flux having a shape similar to the voltage or current.

On account of the fact that the Harmonic Instrument has been primarily designed to study the effects of hysteresis and to determine core loss, it may be of interest before discussing the curves shown, to review some of the characteristics of flux and voltage waves and to note the effect of different shaped waves on the iron losses of transformers and induction motors. One interesting feature is the fact that whatever the shape of the curve may be, the zero value of the flux or magnetization wave will be found under the center of gravity of the voltage wave. A rectangular pressure wave results from a triangular magnetization curve while a triangular pressure has associated with it a parabolic flux curve. A flat topped pressure curve would be produced by a peaked flux curve having nearly straight sides.

If transformers are operated on peaked waves, the wave of magnetization in the core will be flat and as the iron losses vary with the maximum induction, these losses will of course be less with the peaked voltage wave. It has been shown that the Steinmetz formulas for iron losses do not hold true when the pressure wave is other than a sine, but that the form factor of the wave must be introduced. In case the magnetization curve has only one maximum per lobe, that it has no dimples, it is possible to determine its form factor with the Harmonic Instrument. Any instrument which gives the effective voltages of the alternating voltage wave can be used to measure the effective voltage, and the maximum reading of the direct current meter connected to the Harmonic Instrument will give the average of the wave. The ratio of effective to average gives the form factor.

The flux in the core of an experimental transformer supplied by a machine having a ring wound, smooth core armature, is shown in Fig. 3. After plotting out this curve, its close resemblance to a sine curve was noted and a theoretical sinusoid was superimposed. The two curves practically coincide, as shown by the circle points. Another interesting item in regard to this particular curve was the closeness of the check of the maximum flux as determined from equation (7) and by the expression involving flux, frequency, number of turns, and voltage, used in transformer design, the agreement being within two per cent.

In Fig. 4 is shown the form of the flux in the core of a series transformer. When it is remembered that the voltage is proportional to the rate of change of flux, it can be easily seen why the open circuit voltage of current or series transformers rises to abnormally high values. This curve was taken practically on open circuit, the Harmonic Instrument with the voltmeter being the only load on the secondary.

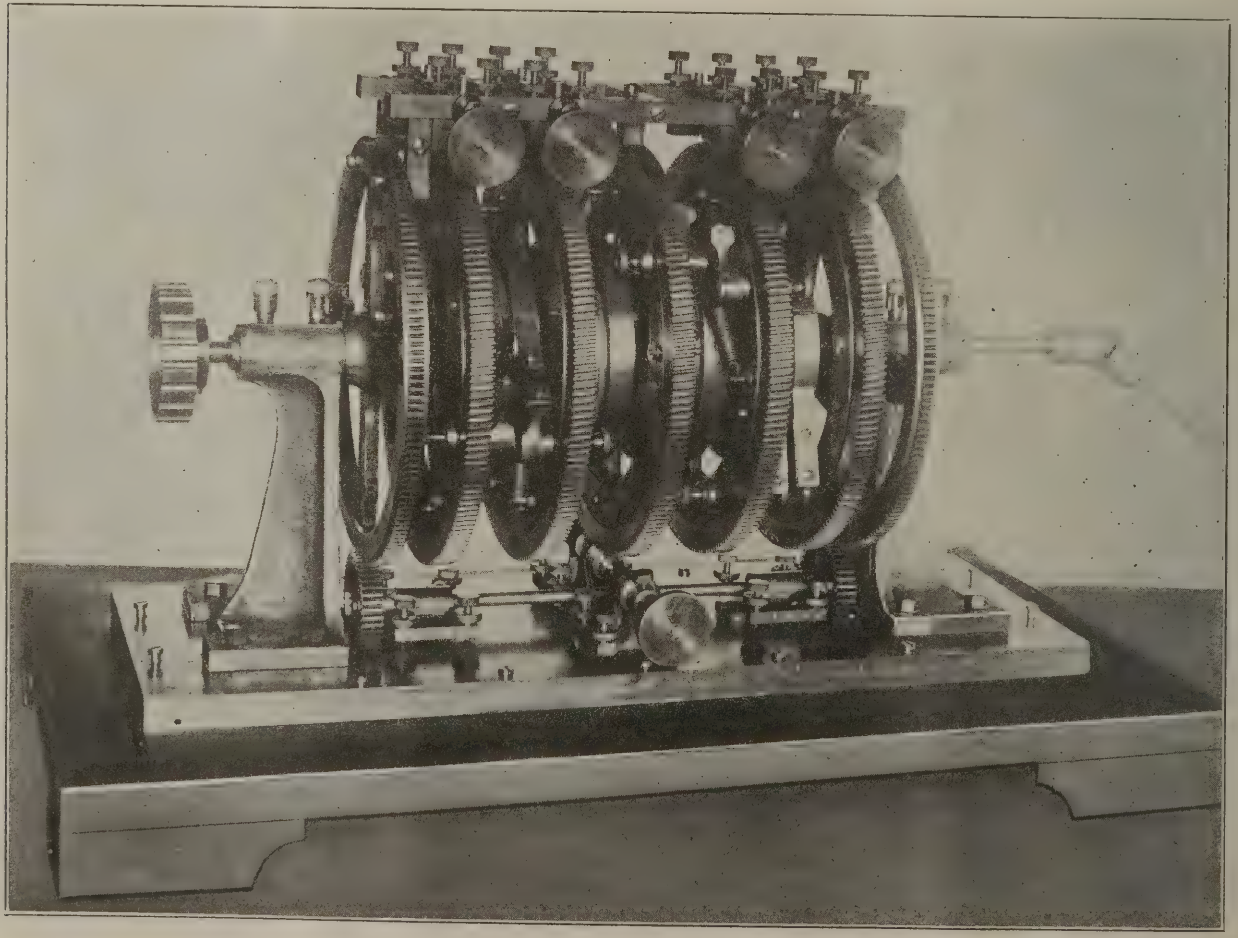


Fig. 2. The Harmonic Instrument.

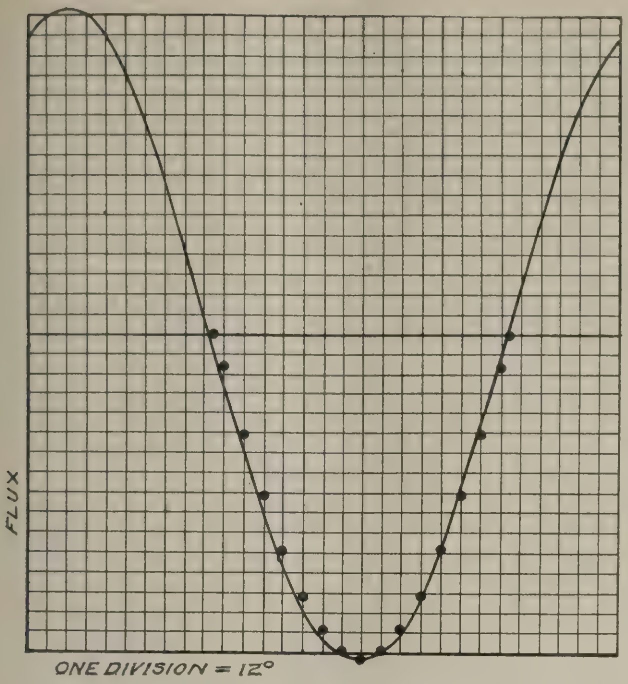


Fig. 3. Flux Curve for Core of an Experimental Transformer.

The curves shown in Fig. 5 are the flux and voltage from a small bipolar generator which has been equipped with rings. The flux curve was taken and the position of the instrument brushes at starting was marked. When the pressure curve was taken the brushes were set in the same position for a start. The curves show that the voltage and flux are nearly 90 degrees out of phase. The curves shown herewith were taken from a model instrument built at the plant of the A. A. Wood & Sons Co., Atlanta, and on exhibition at the Georgia School of Technology.

Going back to the equation

$$\Phi = - I/N \int edt \text{ — — — (Equation 2)}$$

which shows that the flux is the integral of the e.m.f.,

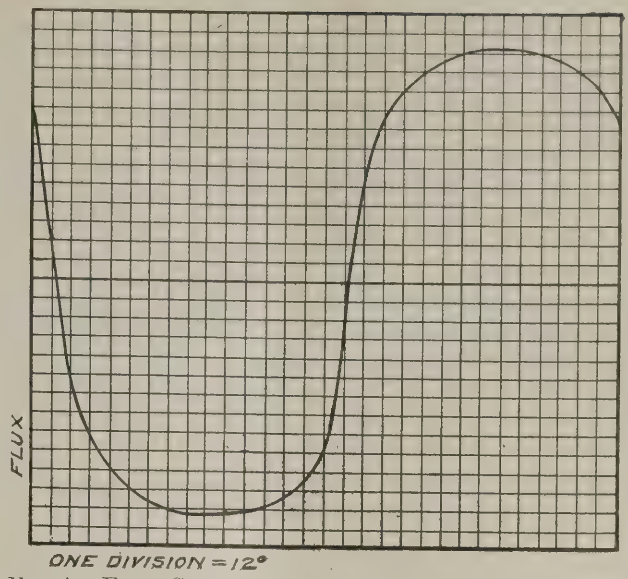


Fig. 4. Flux Curve for Core of a Series Transformer.

consider first when only uneven harmonics are present. By inspection of the preceding equations, the flux at any point is equal, graphically, to the algebraic average of the e.m.f. during the following half-period. But the flux is the integral of the e.m.f., therefore the algebraic average of the flux during t and t + T/2 limits, is equal to the integral of the e.m.f. at t. Now t is a variable, then the flux is a curve representing the successive steps of integration of the emf for the half period following.

When even harmonics are present. We shall confine our mathematical discussions to the more simple working principles of the calculus, since the application of Fouries' series would prove nothing and be like using a wooden teesquare to test a glass straight edge. However, to avoid the use of a great many graphs, it would be well to employ some of the sine series equations.

In the general equation,

$$y = 2 [\sin x - (\sin 2x)/2 + (\sin 3x)/3 - \ldots] \quad (8)$$

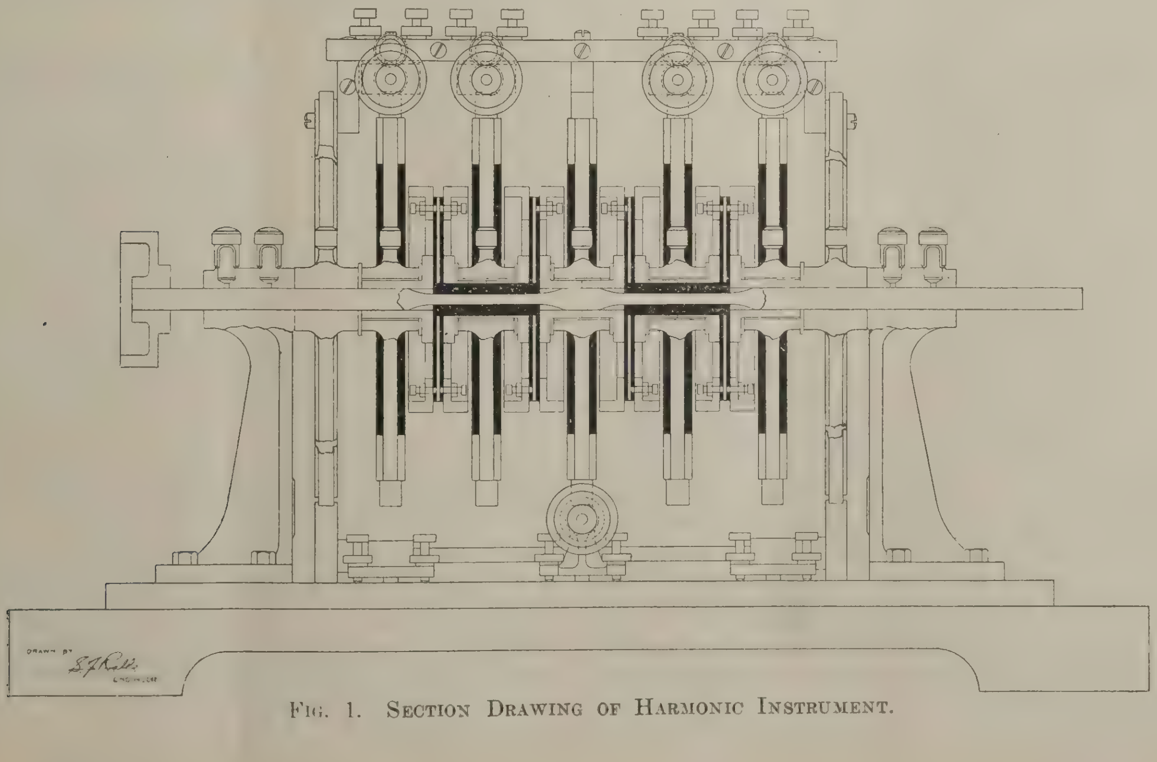


Fig. 1. Section Drawing of Harmonic Instrument.

Plot the bracketed terms and we get one of the familiar even harmonic curves, which is symmetrical about its origin. Fancy this plotted for three *pi*. But, regardless of shape of the negative lobe, that is between the *pi* and two *pi* limits. Plot the positive lobe, or that portion of the curve which lies between the zero and *pi* limits, with negative values between the two *pi* and three *pi* limits, or in other words, substitute a wave geometrically similar to the positive lobe, for the time occupied by the third lobe. Substitute a second harmonic between the *pi* and two *pi* limits. Now we have a curve which from zero to one hundred and eighty degrees contains even harmonics, from one hundred and eighty to three hundred and sixty degrees has two complete and equal lobes, from three hundred and sixty to five hundred and forty a lobe equal and similar, ragarding time also, to the first lobe but of negative position.

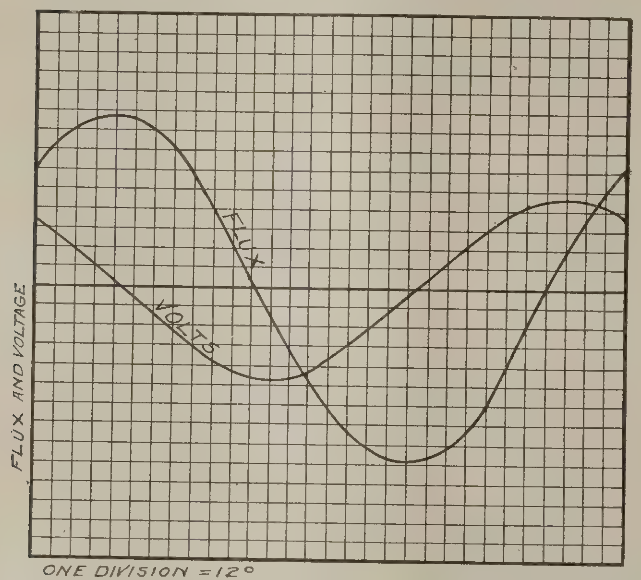


Fig. 5. Flux and Voltage Curves for a Small Bipolar Generator.

It is evident on inspection that if the above described curve be integrated for algebraic average for a T period and a curve containing only positive and negative lobes similar to the first *pi* period of the before described curve, be integrated for the same purpose, for a T/2 period, the result will be the same.

Now with the original curve, shift the work one hundred and eighty degrees and proceed as before or in short treat the negative lobe as the positive was treated. The flux that would produce the first lobe has been found, also that which would produce the second. Plot them in position. It is obvious that the flux curve is continuous.

This shows that a wave of any shape, or of any characteristics may be applied to the Harmonic Instrument. The second harmonic was introduced to obtain a steady voltmeter reading. The above re-arranged curve represents the work of the instrument therefore, for even harmonic curves. This is the only instrument of the algebraic average type covering harmonies of any order.

The following is a brief sketch of the life of the inventor or designer of the Harmonic Instrument as he chooses to call himself: Montford Morrison was born in the early eighties at Bainbridge, Ga. He commenced school in a private institution and later entered the common schools, spent a short time in a military academy, and from there again in common schools. Finally finishing here he began the actual work of acquiring knowledge under the well known Winfield P. Woolf of Atlanta, and to whom he declares, is due the credit for everything he knows. Beside the general line of study, his major course was mathematics and physics and his minor chemistry. He also pursued thorough courses in German, French and Italian and speaks all three languages. Mr. Morrison's mathematics include such works as Betti's Teorica delle Froze Newtoniane, Heine's Kugelfunctionen, Picard's Traite d' Analyse, etc. He claims mathematics and foreign languages as a means of acquiring it, the pilot of his work. He is the designer of several calculating instruments which bring many mathematical equations to a simple mechanical operation. Also has devised a very accurate method of graphic integration. His designs as he prefers to call them, reach into the hundreds. The simplest being a flat metal plate for calculation, and the most complicated an accounting machine of twenty-eight thousand pieces.

Montford Morrison, Designer of the Harmonic Instrument.

Among the large number of patents to his credit are the following: A rotary and a reciprocating valve to be used on steam engines direct connected to generators for high speed work; a redesign of the Goodson Igniter for automobile use; an accounting machine containing approximately 28,000 parts and of such a nature as to register cash, make change automatically and record accounts; a telephone transmitter with multiplier for determining frequency and character of vibrations graphically; automobile wheel construction for heavy trucks with puncture proof pneumatic tube; an automatic block signal system for electric railroads requiring one wire for operation and the trolley wire; an automatic telegraph transmitter for calling and holding stations; an improved end thrust roller bearing for boring mill work; a 20-8 foot boring mill of special design for working stone; a lock nut for locomotive nuts; a special type of drawing instrument with parallel adjustments; an instrument for dividing polar diagrams to locate the equivalent circle position of irregular curves, designed at the suggestion of Prof. Wood, Georgia School of Technology, Atlanta, Ga.; and the Harmonic Instrument described above, together with many others.

While the original aim of the designer was to work along electrical lines and to this end his training was directed, yet due to the demand of mechanical design at the beginning of his practical career, a considerable number is to his credit. During the past ten years his activities have been wholly directed toward research work leading up to the creation of special electrical designs. He has twice been offered the position of professorship in physics and languages.

At the present time he is retained by Messrs. Prior, Howard and Sprague of New York City, and is directing his attention toward the development of an oscillograph which will cut out errors of refraction, nearly all those of reflection and eliminate the loss of time at the end of the period of oscillating mirrors of the Blondel type.

Nature of Early Electrical Supply Business in the South.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

BY G. WILFRED PEARCE, C.E., E.E.

THE electrical supply business in the South is 500 per cent. per annum more than the total annual sales made twenty years ago. Almost four-fifths of the increase is on account of electric fixtures, the one great factor in the increase being the displacement of kerosene fixtures. From 1884 to 1892, the writer represented in the territory from Baltimore to the borders of Mexico the largest lighting fixture making corporation in the country, and for most of that time he represented the Edison General Electric Co., in a large part of the territory. In 1879, and until the end of 1886, the South was a fertile field for the promotion of arc lighting companies. Many of these were financed by adepts in the arts of pyrimiding securities upon uneconomical types of arc machines, and few of the promoters belonged in the Southern States. The majority of them were Eastern and Western men who had floated out-of-date and suspended machine shops in the East and West as manufactories of arc machines and supplies for that line of lighting.

From 1879 until 1883, speculation went mad in arc lighting, and it raged nowhere more violently than in the South. In those days boom towns were springing up at scores of places in the Southern territory, and about the first thing which the town did was to float an arc lighting company, and set the lights agoing without regard to public demands. In those days towns and cities paid arc light companies 75 cents to $1 per night each, for what were rated as 1200 candle power arcs, however, few of these exceeded 600 candle power each. Most of the arc machines served to energize 40 to 50 arcs. Educated electricians were few and most of the men who installed and operated plants were rule-of-thumb mechanics who had come out of the general machine shops of the country. In the South, most of the good men who ran the early electric light plants came from the saw mill machinery making and repairing shops.

A number of Southern cities, against the advice of sound electricians, persisted in adopting the mast system of lighting that had been introduced into Detroit, Cleveland and some other Western cities by the early makers of arc lamps. An idea of schemes then current may be illustrated by one advanced by an early lighting concern in Nashville, Tenn. This company promised to flood the city with light by burning a battery of 1200 candle power arcs on top of the Capitol. A number of conservative citizens retained the writer to pass upon the practicability of that plan and a conference of a number of well informed Nashville dealers in gas lighting fixtures was called. The conference condemned the proposed scheme, and for this we were ridiculed in certain newspapers that advocated the opinions of the arc light boomers. The project went through, however, and was a dire failure. The Capitol was then lighted by means of artistic gas fixtures that had been designed by the original architect of the structure and were of English make.

After the failure of the arcs at the top of the cupola idea, the arc light boomers in Nashville brought forward a plan to take out the fine art gas fixtures and install crude arcs. They succeeded in placing arcs in the Senate Chamber that buzzed terribly, which led to a project for installing incandescent lights.

Until 1893 about 75 per cent of the gas, combination and electric lighting fixtures retailed in the South, were bought from plumbers. Stocks were very small, and up to that time C. Y. Davidson & Co., of Baltimore; Brooks & Co., Washington; John Bowers, Richmond; Hunnicutt & Bellingrath, Atlanta; J. W. R. Browne, Memphis; Manion & Co., New Orleans, and Morris & Co., Houston, were the only concerns in the South that carried large stocks and made a special feature of selling and erecting lighting fixtures. In the early days of incandescent lighting the companies did not do much with fixtures—very low priced brackets, pendants and drop cord lights excepted.

From 1884 until 1896, the South built many superb hotels, and all were fitted with fine art fixtures; for instance there were the Ponce de Leon and Alcazar at St. Augustine, the De Soto at Savannah, the Jefferson at Richmond, the Caldwell at Birmingham, aand many others. In the same time the Capitol at Austin, Tex., the second largest public building in the world, and the Capitol at Atlanta, and many beautiful private mansions, clubs, colleges and academies were built after designs by Southern architects. Those were the years of the resurrection of the Southland, the years when she demonstrated her long slumbering power, and set into motion those great developments that have made her the wonder of the world.

In those years, while the Southern agricultural, manufacturing, transportation and mineral industries were greatly stimulated, the claims of art in public and private buildings were not forgotten. Thus there came into being a wholly original and beautiful Southern art in public and domestic and ecclesiastical buildings and in all that relates to the interior furnishings, decorations and lighting fixtures of structures. One Southern architect, Freret, of New Orleans, as supervising architect of the Treasury during President Cleveland's first term, imparted to Federal buildings the true art feeling of the South, and Sidney Root, trained in his native city, Atlanta, did great things for architecture in the West. As to the fine art lighting fixtures in the South, such architects as Major Dimmock of Richmond, Thomas Morgan of Atlanta, and Clayton of Galveston, created designs that to this day are the every embodiment of true art in chandeliers, brackets and newels.

There is another debt which the electrical engineering profession owes to Southern architects, and that is the treatment of switch boards as to marble and metal fittings and as to the designing of wall switches in connection with lighting fixtures. In the early days of the incandescent lighting industry there was not a man in the business who had received an education in decorative art. Consequently, the switchboards, panel fittings and wall switches were stridently vulgar in shape. I remember a day spent at the Etowah marble quarries in Georgia twenty years ago, when my friend Mr. Thomas Morgan, Architect, at Atlanta, looking at a switchboard design for which the marble was being made ready for a large building in Chicago, said, "If I were asked to design a switchboard for that undertaking, I would put art into the design." Thereupon he made a sketch. I sent it to the Edison agent in Chicago, who adopted the design for a number of after undertakings, and ere long all switchboard makers were using that design which put the sculptural effect into the marble slabs and gave a fine art in metals expression to the handles and bars. Edgar Hunnicutt of Atlanta, was the first in the field of electric fixture lighting who suggested and had carried out a decorative art effect in wall switches. He also originated the then novel designs for fixtures that were first used in the Capitol at Atlanta, and which since that time, 1891, have become standardized as models for public building fixtures.

The electric wiring and general electrical contracting business began to assert itself in the South at about 1890. In Atlanta up to this date and in fact up to 1905, all wiring both for motors and houses was done by the Georgia Electric Light Co., then a central station company. The first firms to establish for the purpose of doing electric wiring was the Cole & Gentry Company and the Gate City Electric Co., of Atlanta, the engineer to whom credit is due for his early accomplishments in setting the business on a firm foundation being Capt. J. B. Hollis. In 1891 the Carter & Gillespie Company was formed, entered the business in Atlanta, and carried on for a number of years one of the largest contracting and electrical businesses in the South. The next important movement was made soon after the Cotton States and International Exposition in 1895 when the Georgia Electric Light Company sold out its contracting business o Oscar Turner. For a number of years Mr. Turner carried on a successful business in Atlanta and surrounding territory, finally determining to expand into more extensive lines. In 1909 he went to Birmingham, Alabama, and founded the Southern Wesco Supply Co., of which firm he is president. This company is doing an extensive electrical supply business which has substantiated the opinion of its founder, namely, that the South would respond if an electric supply house were started and conducted by Southern business men, competing with other electrical jobbing houses as to quality and price. The company is composed entirely of Southern men and their salesmen work exclusively in the States of North and South Carolina, Florida, Georgia, Alabama, Mississippi, Tennessee aand a portion of Kentucky.

The following names will be familiar to those conversant with the early electrical business in the South, and especially in Atlanta. W. E. Carter, of the Carter & Gillespie Co., now manufacturers' agents in Atlanta; George Wade, inventor and manufacturer of electrical heating apparatus, of the firm of G. H. Wade Electric Co., Atlanta; Edgar Hunnicutt, of the Hunnicutt & Bellingrath, now with the J. E. Hunnicutt & Co., electrical fixture dealers; J. W. Little, one of the first electrical engineers in Atlanta, now with the Russell-Nichols Electrical Company, of Atlanta, a company doing an extensive Southern general electrical contracting business; and Henry Reynolds, now with the Southwestern Underwriters at Birmingham. In Birmingham there are at the present time ten firms carrying on a successful fixtures and electrical supply business, and in other cities of the South, a similar number, in Atlanta twelve, in New Orleans eight, and in Memphis ten.

In the Southwest, every line of business is represented in a wholesale way, yet there is probably no particular line that has developed as rapidly as the electrical supply business. The oldest electrical supply house in the city of Dallas is the Hobson Electric Co. This company began business at Waco in about 1900, with a capital of $2,000. In 1903 the company bought the business and stock of the Texas Telephone Supply Company and moved to Dallas, where they established permanent headquarters, at the same time opened a branch house at Houston. In 1907 they took over the business of the Independent Supply Co., and one year later the North Electric Co. was added to the business and the company capitalized at $200,000. At that time they were the only concern handling electrical supplies in the Southwest. From a business of $160,000 in 1907 this concern did a business in 1910 of a million and a half and was compelled to erect a large business house last year at a cost of several hundred thousand dollars.

Within the past two years, or from 1908, five of the largest electrical companies in the United States have entered the Dallas market in an active way. While these concerns have done a large amount of business in this territory for years, it was not until 1908 that any of them had a branch house in this section.

In addition to the six houses there are many smaller concerns and agencies that make Dallas headquarters for this section of the Southwest, and it is estimated that the business done by these electrical supply houses from Dallas during 1910 exceeded $7,000,000, while it is stated that all of them together did not do a business of $2,000,00 in 1907.

Starting as we have seen in the corner of a plumber's shop, the electrical contracting business has sprung into a flourishing one supporting numerous flourishing companies. The increase in Southern commercial progress and the establishment of various industries in which electrical apparatus is conspicuous, bids fair to make the South a field for further developments in the electrical business.

Work of National Electric Light Association During the Past Year.

An ACTIVE Association including over 8,000 members and each one of these members exerting an individual influence to broaden the Association's scope is imaginable, yet not often realized. However, such is the actual state of affairs in connection with the National Electric Light Association. A convention of this body can well be imagined as a serious problem, as indeed it has become, for at least one-half of the membership must be accommodated and provisions made for liberal discussions of the various central station problems growing out of the diversity of interest represented. New York City is one of the most desirable places for holding the N. E. L. A. convention and the results accomplished at this meeting through the serious discussions of leading topics will be eagerly watched for by those of the members so situated or connected with the industry that it is impossible to attend.

The extensiveness of the present convention gathering is in a sense indicative of the magnitude of the industry. How much larger it is possible for the convention to become is further indicated, however, by the fact that there are now over 5,700 central stations in this country of which on an average five representatives are entitled to membership. When therefore the total number of central station men eligible for active membership are taken into account, it will be seen that the Association, thrifty and growing as it is, has still plenty of room for further expansion. Recent developments and the outgrowths of the schemes for increasing the area of contact, while at first of doubtful value, has worked out most admirably and with particular success to those participating. The smaller company has proved the chief beneficiary of Association work and it has been clearly proven that the Association needs them as factors in the exertion of its influence.

The past year has witessed a wider development of the company section than ever before, especially in the establishment of new and strong ones. The older sections have also continued to show increasing interest, so that the record of the section idea is clearly one of the beneficial contact with Association activity. This rapid development of the section organization and the characteristic growth of those already formed are not only, however, indications of principles well founded and immediate good accomplished by the Association, but a manifestation of a co-operative spirit and an earnest desire for the speedy solution of the problems confronting every central station, namely elimination of public prejudice and the establishing of cordial relations as a public servant.

The general opinion of the work accomplished seems to be centered on the extension of the Association's benefits and influence. This has been gathered from communications received, among which are the following, including one from the retiring president and from the secretary, which read thus:

"The features that have been characteristic of Association growth during the past year have without a question been the State and Company sections. Especially the latter have contributed most largely to the really sensational increase in membership, which has continued during the past year on an even larger scale than during the year preceeding. A net gain of twenty-five hundred active members for last year was believed to have established a record which could hardly be beaten and yet it now seems probable that that splendid record will be exceeded by the time of our annual convention, when the membership will probably reach eight thousand.

"While the value of Association effort from the standpoint of company units has been clearly recognized from the inception of the organization, twenty-five years ago, it is only within the past two or three years that there has been a proper realization of the practical and direct benefits of membership to the individual employe especially in companies that are large enough to have company sections. These members, in addition to receiving the information which comes directly from the Association, are

W. W. Freeman, 1910-1911 President of N. E. L. A

enabled to hold monthly conventions at home where, through interchange of ideas and experiences, they can keep themselves abreast with the development of their business and with the art. The posibilities of further expansion in this direction are practically unlimited and the true prophet as to the status of the Association ten years hence would appear very visionary now, notwithstanding the really remarkable growth of the past few years."

W. W. Freeman,
President N. E. L. A.

The following comments from Mr. Martin bring out further, interesting and striking accomplishments of the past year:

"The National Electric Light Association has had a strenuous and it might with justice be said, a wonderful year, the latter adjective applying more particularly to its increase in growth. At the St. Louis Convention, May, 1910, the total membership was 5520 and at the present moment of writing, May 16, it is 8150, with every prospect of reaching at least 8500 at the time of the convention. In round figures there is a gain of 2630 for the year and the probability that it may reach very nearly 3000. The gain during the past eighteen months has been 5000, which is an altogether unprecedented record in the history of engineering bodies either here or abroad.

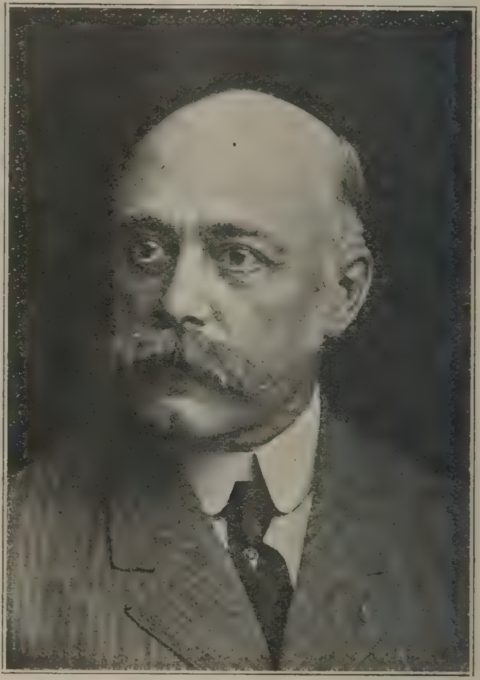
"Taking the nineteen South Atlantic and South Central States, including Missouri and New Mexico, it would appear that during the year the Association has gained in that region 17 Class A members, 213 Class B, 4 Class D and 3 Class E, making a total of 237 members. This is quite a creditable gain, but it is believed that with the new State sections and as the work of the Association becomes better known, 1912 may fairly be expected to show an increase far in excess of even these excellent figures. The features of membership growth during the year, include the affiliation of the two Southern State sections in the shape of the Electrical Associations of Georgia and Mississippi. Nebraska has also fallen into line and more significant than all, the sister Canadian Electrical Association has voted unanimously to recommend joining hands with the National body.

"There has also been a notable extension of company section work and vigorous, strong, new sections have sprung into existence at Pittsburg, Pa., Scranton, Pa., Joplin, Mo., and Hamilton, Ontario. Another new section is that of the New York companies, embracing eleven of the companies in and around New York City, exclusive of Brooklyn. Although started only a few months ago, this section has already reached a total of nearly 1300 members and expects to be some 1500 strong at the time of the annual convention.

"During the year the Association has issued its Standard Classification of Accounts in book form and is now putting through the press a useful compilation called the Revision of the Question Box, giving the pith of the first four or five years of that useful part of the Bulletin. A new and extended edition of the Handbook has also been issued and this has run into two or three extra editions. This year the Overhead Line Construction Committee is bringing out its final report and judging from the inquiries on the subject it looks as though several thousand copies of this will be required to meet the demands from all branches of the electrical industry using such construction. During the spring, the Power Transmission section held a conference on State and National Governmental control of water powers. This was highly successful and the report will be distributed at the annual convention. Secretary Fisher, the new head of the Department of the Interior, accompanied by Director Smith of the United States Geological Survey, was the guest of the Association at that time, and made a most favorable impression by his attitude and remarks. It is hoped and believed that through such work a happy solution may be reached of the present difficulties and problems which now restrict the utilization of these wasted resources.

"The Association has taken up during the year the question of Resuscitation from shock and the application of improved methods. In co-operation with other leading electrical societies and medical bodies and with the co-operation of the Government Bureaus, it is now organizing a commission whose report will be extremely useful and valuable in the saving of life.

"One of the most significant pieces of work accomplished during the year is that of the Public Policy committee which has worked out a most elaborate and practical scheme of welfare work for the employees of the whole central station industry, as represented by the thousand companies in membership embracing 90 per cent. or more of the industry. This report offers suggestions, recommendations and plans for accident and sick insurance, savings funds, death benefits, profit sharing for employees, annuities for continuous and meritorious service, and investment funds. This is the most comprehensive effort of the kind ever made in America or by one industry; and the report will be read at a meeting of the Association at the New Theatre on May 31st, when an address will be made by Secretary Nagel of the United States Department of Commerce and Labor.



T. C. MARTIN, SECRETARY OF N. E. L. A.

"The Bulletin of the Association has been of increasing usefulness to the members throughout the year and the Question Box in some issues has run from 60 to 90 pages. The Bulletin thus serves increasingly for the ready solution of many of the difficulties encountered by the members, particularly those connected with the smaller operating companies."

T. C. MARTIN,
Secretary N. E. L. A.

As to the developments and activities typical of N. E. L. A. work in the State and geographical sections, the results accomplished by the Pennsylvania Electric Association may be cited. This organization covers only the State of Pennsylvania and has a definite hold on central station affairs within its limits. The following comments are taken from a letter received from the president, Mr. A. R. Granger:

"The membership of the Pennsylvania Electric Association embraces all of the larger electric companies in the State and about 50 per cent. of the smaller companies, and at this time there is a well organized campaign in progress by the membership committee for systematically canvassing the State with the hope of securing all companies as members. The Association can point with pride to its third annual convention, held in September last, at Glen Summit Springs, Pa., at which there was an attendance of 250 delegates and guests. The work accomplished at that time has been of great benefit to all the members. The papers presented and the discussions of same have been compiled and put in a neatly bound volume of nearly 300 pages, and distributed to all members. The coming convention, to be held probably at Conneaut Lake, Pa., in September, will cover a wider range than heretofore, owing to the appointment of additional committees, and also on account of an expected increase in attendance. There is every prospect of having between 400 and 500 delegates and guests present.

"The executive officers of the Association have, during the past few months, devoted themselves to the task of keeping all the electric companies in the State, both member companies and others, informed as to the trend of legislative matters brought before the Pennsylvania Legislature, and the outlook for a successful year is very promising, from the standpoint both of increasing membership and also of the broadening influence of the coming convention."

A. R. GRANGER,
Pres. Penn. Electric Association.

Where to place the credit for the initiative in pushing the Association's work of the past year to so successful a close is a difficult matter, so enthusiastically and so earnestly have the large number of men representing the executive end of the Association pursued the duties entrusted to them. However so conspicuous have been the results of the efforts of the Association's secretary, we feel sure we are voicing the sentiment of the industry in general by saying that to him is due the spirit of progressiveness and confidence in presenting proposed plans. This after all has been one of the main factors to which the realization of the various developments already reviewed may be credited. In Mr. T. C. Martin the Association not only has an able executive member, but one who having been associated with central station work since its infancy knows intimately the conditions in the industry. To him year after year others have looked for opinions on the past and a prophecy of the future, and yet it is so even with the press of official duties. In view of the growing extensiveness of the demands upon his office, the Association and industry in general are fortunate in having one with a capability to cope with them so satisfactorily.

Notes on N. E. L. A. Convention at New York.

At the time this issue goes to press, the thirty-fourth convention of the National Electric Light Association is less than two weeks hence. Although with the increased attendance year by year the arrangements for this great annual convention has become a most serious proposition, announcements are made that the carefully laid plans are being rapidly executed. All meetings will be held in the United Engineering Societies Building, beginning Monday, May 29, and ending Friday, June 2.

Reduced fares have been authorized to New York City for the occasion by the following passenger associations: Trunk Line, New England, Central, Eastern Canadian, South Eastern, and Transcontinental. The general rule for all these associations will be one and three-fifths of single trip first-class fare, with the return trip ticket issued on certificate plan and a charge of 25 cents for each certificate vized. The tickets will be on sale May 16 to 29 and the final return limit stated in most cases as June 6. For the convenience of those intending to attend the convention it is stated that full one-way first-class fare tickets can be purchased to New York on the certificate plan at numerous railway stations not earlier than May 25, from Southeastern points May 26 and not later than May 31. The purchaser should obtain a certificate when buying the ticket and these certificates should be deposited with Mr. Hodskinson, master of transportation of the association upon reaching the headquarters of the association in the Engineering Societies Building, New York City.

The following is the program for the convention, which is subject to modification but will probably be closely lived up to. The program provides for two sessions daily during four days with in all over sixteen sessions, there being several parallel sessions. There are twenty-four papers in the program and nearly forty committee reports. In all there are some seventy items in the order of business and it will take the full time of the convention to dispose of them. The papers and reports are associated with the names of a great many leaders in the industry and should interest all in central station work.

GENERAL SESSIONS.

On Tuesday at the first general session, the address of President Freeman, the report of the committee on membership, Mr. H. H. Scott, chairman; the report of the committee on progress, Mr. T. C. Martin, chairman, and a paper entitled "Master and Men," by Mr. Paul Lupke, will be given. On Wednesday afternoon at the second general session, Mr. L. A. Ferguson will present a paper on "Electrical Exhibitions"; a paper entitled "Company and Company Section Bulletins," will be read by Mr. E. A. Edkins. The following reports will be presented: "The Insurance Expert," by Mr. W. H. Blood, Jr.; "The Bulletin Question Box," by Mr. M. S. Seelman, Jr.; "The Library Committee," by Mr. Arthur Williams; "The Solicitors' Handbook," by Mr. Arthur Williams; report of secretary by Mr. T. C. Martin, and the treasurer's report by Mr. George H. Harries. Topical discussion on work of company sections will also be held. On Friday afternoon, the third general session, the committee on rate research, Mr. John F. Gilchrist as chairman, will report. Mr. T. C. Martin will present report of committee on memorials, and Mr. Frank W. Frueauff report of committee on section organization. Papers will be presented as follows: "Valuation of Properties as Related to Rates," by Mr. W. F. Wells; "Reasons for Variations in Rates Under Varying Conditions of Operation," by Mr. N. T. Wilcox; "The Standardization of Electrical Selling," by Mr. Douglass Burnett, and "Economies in Operation Possible Through Time Study," by Mr. L. B. Webster. This will be the concluding session of the convention, the nominating committee will submit its report, and the election of officers will take place.

TECHNICAL SESSIONS.

On Wednesday morning at the first technical session reports by chairmen of the committees will be given as follows: Mr. Farley Osgood, overhead-line construction committee; Mr. W. K. Vanderpoel, preservation of poles committee; Mr. W. L. Abbott, underground construction committee, and Mr. G. A. Sawin, meter committee. On Thursday afternoon at the second technical session Mr. R. B. Williamson will read a paper entitled "The Ventilation of Turbo-Generators"; Mr. H. O. Troy a paper on "The Progress and Development in Self-Cooled Transformers." Reports will also be presented as follows: The committee on prime movers, by Mr. I. E. Moultrop; the lamp committee, by Mr. W. F. Wells, and the committee on electrical apparatus, by Mr. L. L. Elden. On Friday morning, at the third technical session, Mr. W. H. Blood, Jr., will present report of committee on the grounding of secondaries. Papers will be given as follows: Mr. P. M. Lincoln, "Grounding Low-Tension Circuits"; Mr. W. A. Layman, "Recent Important Improvements in Single-Phase Motors," and Mr. F. D. Newbury, "Relation of Motor Load to Station Equipment."

ACCOUNTING SESSIONS.

On Wednesday morning at the first accounting session Mr. John L. Bailey will give report of accounting committee. Papers will be presented by the following: Mr. John T. Brady, "Tracing Storeroom Material"; Mr. T. W. Buxton, "The Purchasing Department," and Mr. Alex. Holme, "The Advantage of a Job-Cost System." On Wednesday afternoon, at the second accounting session, three papers will be presented as follows: "Handling Customers' Orders," by R. F. Bonsall; "The Collection of Bills," by Mr. E. J. Bowers, and "Electric-Vehicle Accounts as Applied to a Department of a Central Station Plant," by Mr. Herman Spoehrer. On Thursday morning at the third accounting session, a paper will be read by Mr. Franklin Heydecke on "General Office Accounting"; one by Mr. H. M. Edwards on "Depreciation," and one by Mr. William Schmidt, Jr., on "The Extent to Which a Tabulating Machine Can Be Used in Accounting Work."

COMMERCIAL SESSIONS.

On Wednesday morning at the first commercial session committees will submit reports as follows: "Electricity in Rural Districts," Mr. J. G. Learned; "Power," Mr. E. W. Lloyd; "Electric Vehicles," Mr. J. T. Hutchings. On Thursday morning the second commercial session will be held and devoted to an executive session of members. On Thursday afternoon the third commercial session will be held. Mr. Clare N. Stannard will present report of the committee on residence business and Mr. M. S. Sloan the report of the committee on industrial lighting. Report of committee on improved wiring and equipment standards will be given by Mr. M. C. Rypincki. Mr. F. H. Gale will give report of committee on electric heating, refrigeration and kindred appliance sales. On Friday morning at the fourth commercial session Mr. C. W. Lee will present report on electrical and central station advertising; Mr. H. J. Gille the report on competitive illuminants, and Mr. T. I. Jones the report on the functions of a sales department.

TRANSMISSION SESSIONS.

The first session of the transmission section will be held Thursday morning, opened by the report of Mr. H. L. Doherty on the April conference of the N. E. L. A. on the governmental control of water powers; Mr. B. E. Morrow will read report on protection from lightning, and Mr. Fred Darlington will give a paper on "The Utilization of Central Stations for Supplying Electricity to Operate Railroads." On Friday morning at the second session of the transmission section Mr. H. A. Wagner will give a paper on "A New Method of Reducing the Investment in Central Station Boiler Plants," and Mr. George H. Walbridge will read one on "Determining Cost of Production in Steam Properties Under Varying Conditions." Operating transmission systems will be the topic for discussion.

Chicago Convention of A. I. E. E.

The annual convention of the American Institute of Electrical Engineers, will be held in Chicago on June 26 to 30, inclusive. The convention will meet in the new Hotel Sherman, the most recently completed of Chicago's group of modern hotels. The sessions will be held in the handsome Louis XVI. room, which will seat 700 people and can be connected with adjoining apartments to seat 1,500 if desired. While the list of papers to be presented at the convention is not complete, the following partial list of papers that will probably be presented shows the diversity of subjects to be considered. "Economical Design of Direct Current Magnets," by R. Wikander; "Catenary Span Calculations," by W. L. R. Robertson; "Currents in Inductors of Induction Motors," by H. Weichsel; "Multiplex Telephony and Telegraphy by Means of Electric Waves Guided by Wires," by Major G. O. Squier; "Electrolysis in Reinforced Concrete," by C. E. Magnusson; "Induction Motor Design," by T. Hoock; "The High Efficiency Suspension Insulators," by A. O. Austin; "The Electric Strength of Air," by J. B. Whitehead; "Electrification Analyzed, and Its Application to Trunk Line Roads," by W. S. Murray; "Telegraph Transmission," by F. F. Fowle; "The Cost of Transformer Losses," by R. W. Atkinson and C. E. Stone; "The Costs of Railway Electrification," by B. F. Wood; "Induction Motor for Single-Phase Traction," by E. F. W. Alexanderson; "Magnetic Properties of Iron at 200,000 Cycles," by E. F. W. Alexanderson; "Electric Storage Batteries," by Bruce Ford; "The Characteristics of Isolated Plants," by P. R. Moses; "Elevator Control," by T. E. Barnum.

It has been many years since the convention met in that city, although the electrical attractions of Chicago and vicinity are exceptional in interest and variety. Among these points of interest may be mentioned the Ryerson Physical Laboratory of the University of Chicago, where the atomic theory of electricity has been demonstrated by most interesting experiments; the electric furnaces in the steel mills at South Chicago; the enormous electric plant at the Gary, Ind., steel works, driven by gas engines; the great central stations of Chicago, famous for their size and modern design; the hydro-electric development of the Chicago Drainage Canal; "Underground Chicago," with its network of electrically operated freight tunnels; the latest large automatic telephone system; several of the largest manually operated telephone exchanges in the world; street railway and other substations of unusual interest; possibly the largest street railway shops in the world, with electric drive throughout, and many other notable electrical applications.

A committee of fourteen local members of the Institute has been appointed to make arrangements for the convention. Mr. Louis A. Ferguson, 120 West Adams street, Chicago, is the chairman of this committee

Southern N. E. L. A. News.

Organization and Progress of Georgia Section.

Some two years ago articles were adopted by the National Electric Light Association providing for the organization of geographical and company sections affiliated with the Association. In the short time intervening the geographical section idea has become the connecting link between the work of the company section and the purpose of the parent body. Central station conditions vary according to location so that what the company section has come to mean to the individual station, the geographical section brings to every station in its territory. No better plan could have been devised for securing unity of action and aim, for each new section gives the association a broader viewpoint tending to truly effect a well controlled organization of the electrical interests in this country.

John S. Bleecker,
President Georgia Section N. E. L. A.

The first action taken to extend N. E. L. A. work into Southern territory was the formation of the Georgia State Section, October 20, 1910. The section started at that time with a membership of 11 class A and 25 class B members. At present, although there has been little time for a membership campaign, on account of organization matters taking up considerable time, the membership is well toward 50 and prospects of doubling this number in the next few months are good.

The officers of the section are as follows: President, J. S. Bleecker, of Columbus Railroad Co., Columbus; vice-president, W. R. Collier of Georgia Railway and Electric Co., Atlanta; secretary and treasurer, H. M. Corse of Columbus Railroad Co., Columbus; executive committee, J. J. Cagney, of Central Georgia Power Co., Macon; Burdett Loomis, Jr., of Ware County Light and Power Co., Waycross; and R. P. Mayo of Augusta Railway and Electric Co., Augusta.

The executive committee of the Georgia Section held its first meeting at Augusta, Ga., April 6, 1911, to discuss ways and means of promoting the common interests of the members aand to establish cordial relations with the public, kindred associations and with manufacturers of electrical supplies. The results of this meeting form an important part of the section's activities thus far and the proceedings are therefore given in some detail. The following appointments and recommendations for appointment were made by the president, J. S. Bleecker of the Columbus Railroad Co. As chairman of membership committee, W. R. Collier of the Georgia Railway and Electric Co., Atlanta. That a circulating correspondence committee be appointed so that members desiring to ask information from other members should send their questions to the chairman of such circulating correspondence committee in sufficient number of copies for each member and the chairman of the committee. The chairman to send out the questions to te various members, requesting them to send their answers to the chairman, made out in duplicate, the chairman to send one copy of the answers to the questions to the member asking the questions and retaining the other copy in his files. The chairman to state in sending out questions that a complete file of answers may be obtained by writing to the member asking the questions. H. M. Corse of the Columbus Railroad Company, Columbus, was made chairman of the circulating correspondence committee. A membership and finance committee was appointed in the place of the existing membership committee with W. R. Collier as chairman, who passes on all matters relating to the expenses of the Section before moneys are distributed by the treasurer. Committees on convention arrangements, convention papers and public policy, were selected with chairmen as follows: P. S. Arkwright, president of the Georgia Railway and Electric Co., chairman of public policy committee; R. P. Mayo of the Augusta Railway and Electric Co., chairman of the committee on convention papers, and C. B. Young chairman of committee on convention arrangements.

An invitation was extended to the executive committee by President Bleecker to hold the annual convention of the Georgia Section in Columbus, which invitation was accepted. The date for this convention was set at about the last week in September, subject to change by the committee on convention arrangements, the convention to last about two days. At this meeting Southern Electrician was appointed the official organ of the Georgia Section and the secretary instructed to furnish the editorial offices with the proceedings of all meetings for a report and publication.

Aims, Plans and Prospects of Georgia Section.

In view of the fact that the work and aim of the section may be new to a large number of readers, we publish in some detail, through the courtesy of the president, Mr. Bleecker, a report on the subject submitted by him:

"It gives me pleasure to advise that the Georgia Section of the National Electric Light Association has for its principles and reason for existence, the same broad and conclusive arguments of mutual benefit to central stations and their customers that have been for so many years the foundation of the success of the National Electric Light Association. As stated in article 2 of the constitution, the object of the Association is to foster and promote common interests of its members, advance scientific and practical knowledge in electric light and power matters and to establish cordial and beneficial relations with the public.

"The action on the part of the National Association a year or so ago in amending its constitution so as to make possible the organization of geographic sections was entirely in keeping with the progressive thought of those in whose hands the management of the National Association has been placed, and the exceedingly gratifying result in increased membership of the Association and in the formation of State and geographic branches proves most conclusively the correctness of these farsighted plans. The Georgia Section is one of other geographic sections and necessarily gets its initiative from the National Association, but its particular field is Georgia. Its enthusiastic membership is made up of central stations and their employees doing business in this State as well as the employees of electrical manufacturing and other closely related activities who may be living and working within its borders.

"At the organization meeting in Atlanta on October 20th and 21st, 1910, it became evident that such a body as the Georgia section was needed to bring together those interested in electrical matters, who could in no other way successfully exchange experiences and benefit each from the other's work. While there were not a large number in attendance at that meeting, those who were present were most enthusiastic and the business of organizing, drawing up constitution, electing officers and appointing committees was expeditiously and efficiently done.

"The first and foremost plan of the Association, as expressed at that meeting, was to secure new members, recognizing that until such time as practically all the central stations in this State were represented in our membership, the greatest advantage could not be derived by any one of them. This determination to increase the membership has brought forth very gratifying results, the active membership reported at the meeting of the Executive Committee in Augusta on April 6th being over one hundred per cent. greater than those actually represented at the organization meeting in October. There is no reason why this record should not be repeated during the second six months of the first year of our existence. The next most important object or really the most important object, but possibly only after the membership is large, is the interchange of views and experiences by correspondents and by convention. Even with the small membership of the first six months much in the way of exchange of experiences was accomplished through the office of the Secretary, who handled numerous questions and answers, resulting in great benefit to the companies particularly concerned.

"The meeting of the Executive Committee, which was held in Augusta on April 6th, brought out the fact that the beneficial results of questions asked and answered during the first six months had merely whetted the appetite of the members for more, and a special committee to handle this part of the work was appointed who would be governed by the general plan laid down by the executive committee for carrying it on. The selection of the SOUTHERN ELECTRICIAN as the official organ of this Section was a decided step in advance, giving to the officers and executive committee an opportunity to easily place before all of the members those matters on which they might be most interested. Some of the matters already considered and discussed as well as those which will be taken up, may be described briefly as follows: Sign lighting, mill power, stream flow, municipal ownership, decorative street lighting, meter accuracy, court decisions, development of water powers on public lands, underground distribution, street lighting rates, reasonable return on investment, power station economies, electric vehicles, direct reading wattmeters and many others.

"The meeting of the National Association May 29th to June 6th should greatly stimulate the activity of the various geographic sections, and great hope is expressed by the members of the Georgia Section that at the convention to be held in Columbus the last week in September, the first year of the existence of this organization will go ito history as a successful beginning of a prosperous career."

Yours very truly,

JOHN S. BLEECKER,
President Georgia Section N. E. L. A.

Convention of Mississippi Electric Association, State Section of N. E. L. A.

At a meeting of the executive committee of the Mississippi Electric Association, held in Meridian, Miss., January 19, 1911, Gulfport, Miss., was selected as the next place of meeting for the annual Convention, and June 20 to 22, selected as the dates. Plans are now nearing completion for an important convention meeting and all indications point toward a large attendance. At the January meeting of the executive committee referred to, the Association by the unanimous vote of all the member companies requested affiliation with the National Electric Light Association as a State section. This action was considered at the March executive meeting of the N. E. L. A. and approved, thus securing representation in the South by two strong and growing State organizations.

The following papers have been prepared and will be presented at the different sessions: "Engines of 750 K.W. and Under." "Steam Turbines, 750 K.W. and Under." "Non-Condensing and Condensing, and Low Pressure Turbines in Connection with Engines of 500 H.P. and Less." "Electrically Heated Appliances." "Engineering Department of National Electric Lamp Association." "Relation of Our Employees to the Company and to the Public." "The Necessity for a Commercial Department." The committee on National Electric Code requirements will also report.

In the words of the Association's secretary, A. H. Jones, "The Association is decidedly alive and doing much good." It is therefore urged that all members make early arrangements for the Gulfport meeting and also other central station men in Mississippi who plan to connect with the organization.

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.

WATTMETER READINGS CHANGE, WHY?

Editor Southern Electrician:

(218) In our plant we have two 2300 volt, 60-cycle, 3-phase generators. When the fields are increased or decreased the two wattmeter readings change, one increases and the other decreases, yet the total power is the same. Kindly explain this action, giving reasons for it. We are operating induction motors, and two 200 K. V. A. synchronous motors. Would this load have anything to do with the actions referred to? H. A. S.

TUBE ILLUMINANT VS. INCANDESCENT.

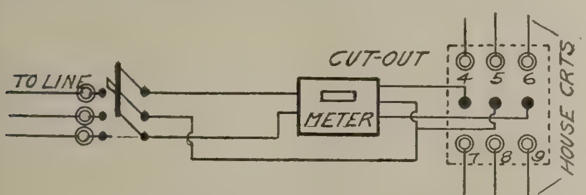
Editor Southern Electrician:

(219) Kindly publish the arguments of comparison of light distribution by the tube illuminant nd incandescent of same candle power, such as the Linolite, mercury vapor lamp, Moore tube aand tungsten and carbon incandescents. H. A. T.

WHY DID FUSE BLOW?

Editor Southern Electrician:

(220) I would like to see an explanation of the accompanying diagram which shows connections for house lighting on a 3-wire A. C. system using 110 volt lamps. Explain why two wires on the line side enter the meter and three leave it. Also give schematic drawing of circuits in meter to accompany explanation. The meter is a Thomson high torque, 3 wire, 220 volt, A. C. Explain the



Three-wire House Circuits.

use of the particular cut-out shown. How many circuits can be taken from it? Indicate the general arrangement by marking on diagram a few lamps. Fuse marked No. 2 blows continually when an electric iron is used on circuit 8 and 9. The iron is rated 110 volts at 3.3 amperes and the fuses are 10 amps. Please explain why line fuse goes. C. A. B.

EXPLANATION OF HOUSE WIRING.

Editor Southern Electrician:

(221) Kindly request from your readers an explanation of the 3-wire A. C. distribution system such that 110 volt lamps can be used connected across any two wires. Furnish diagram for such a system, showing line entering house, switch and meter connections, also fuses and wires leaving fuse block to lamps. A. H. B.

COOPER-HEWITT LAMP.

Editor Southern Electrician:

(222) Kindly explain the production of light by the Cooper-Hewitt lamp and why it is necessary to tilt the tube in starting it. C. C. P.

3-PHASE POWER BY TWO WATTMETERS.

Editor Southern Electrician:

(223) Kindly advise if it can be assumed that 100 per cent power factor exists on a three-phase circuit when the two wattmeters used give the same reading. Does the nature of the load have anything to do with making the readings equal? C. L. M.

DIAGRAM OF MOTOR CONNECTIONS.

Editor Southern Electrician:

(224) Kindly publish the following questions in the question department of Southern Electrician: How shall I proceed to connect a 19 horsepower 220 volt shunt motor and also a compound wound direct current 220 volts motor to a system? Give sketch of connections, fuses, starting box and fuses. In connecting to line, how can I tell which is the positive or negative lead without the aid of instruments? How can I find the positive and negative pole pieces, and how must the brushes be set in relation to them? Give also a sketch of a ground detector. L. A.

SOLDERING FLUX.

Editor Southern Electrician:

(225) Kindly request readers of Southern Electrician to submit a receipt for making a flux for soldering cable to carbon brushes which he has found successful. L. A. C.

Charging Storage Battery, Ans. Ques. 188.

Editor Southern Electrician:

In answer to question No. 188, I wish to give the following: There should be no trouble charging the battery mentioned with a compound wound generator, providing the generator voltage is high enough to overcome the voltage of the battery, but in the instance given this is not the case, as is shown by the following:

We will say that each cell has 1.5 volts at discharge, then the combined voltage of the 60 cells at discharge would be $60\times1.5=90$ volts. As the generator gives a voltage of 110, this would give a working voltage amounting to 110 volts less 90 volts=20 volts at discharge. Then at full charge, which is 2.5 volts per cell, the battery would have a voltage equal to $60\times2.5=150$ volts, or 40 volts above generator voltage, but this could not happen when the 60 cells are being charged from a 110 volt circuit, because when the battery was charged up to 110 volts, the current would cease to flow in either direction. In order to charge the 60 cells from a 110 volt circuit it would become necessary to charge, say 30 cells of the battery, which would give the generator a working voltage of $110-(30\times2.5)=35$ volts above the voltage of the batteries when they are fully charged, and $110-(30\times1.5)=65$ volts at discharge.

H. R. Williams.

Charging Storage Battery, Ans. Ques. 188.

Editor Southern Electrician:

In answer to question No. 188 republished in April from the January issue, W. T. R. may possibly find the following information of some value in the solution of his storage battery problem. The e. m. f. allowance for charging each lead storage cell must be about 2.7 volts, so that with 60 cells in series there would be required 2.7×60=162 volts charging E. M. F.

The 110 volt machine would therefore have to be operated at a voltage nearly 50 per cent in excess of its rating in order to change the number of cells in series, and it is hardly probable that the machine could do this unless it were specially designed for the purpose. If the requirement were merely to charge the battery without regard to any operating conditions, we might connect it up with 30 cells each and charge each set separately or connect them in parallel as shown in the sketch, Fig. 1. The amperage of the two sets connected in parallel in this way woould be twice the amperage of a single cell, and must not exceed the ampere capacity of the machine. A rheostat R should be connected in series with the battery as shown, in order to provide a means of adjusting the current to the required amount. This rheostat, it should not be forgotten, must be of a capacity to carry the current continuously, as a portion, at least, of it will be constantly subject to undue heating.

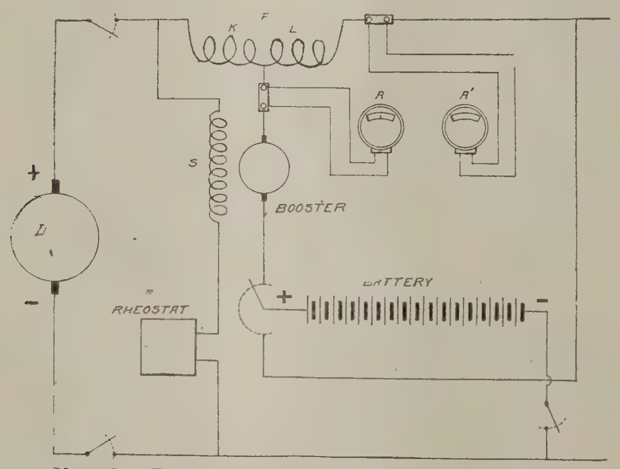


FIG. 2. DIAGRAM FOR BATTERY AND BOOSTER.

The arrangement of the battery I have here shown cannot, of course, apply where it is to be used at the same time, with the dynamos supplying current to the line and is, in operating vernacular, kept "floating on the line." That is, it is kept constantly connected with the circuit and assists the dynamo during the high or "peak" loads and is charged during the light load periods. To work the battery in this way, it will be necessary to operate a "booster" in connection with it. This "booster" is a small dynamo driven at a constant speed and connected in series with the storage battery across the circuit mains. During light load periods the "booster" voltage opposes that of the battery and assists the main dynamo to charge the latter. When the load exceeds the capacity of the dynamos the "booster" e. m. f. reverses and aids the battery to discharge into the line.

In Fig. 2 is shown the general scheme of connections for the device. The explanation is as follows: The series field F of the booster dynamo is in two sections, K and L, see Fig. 2, and wound so as to oppose the shunt field S. Section K carries the current from the main dynamos D, which maintains practically a constant current. The line current circulates in section L and varies with the load on the line, thus varying the series field strength in accordance with the load.

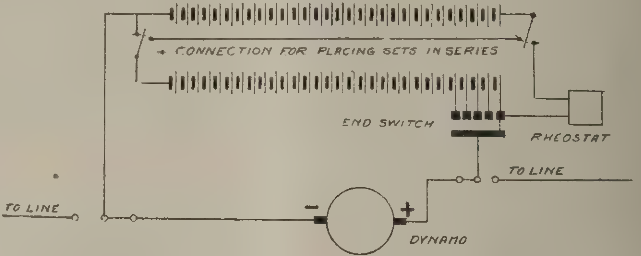


FIG. 1. DIAGRAM FOR CHARGING BATTERY.

When the load is greater than the capacity of the main dynamo, the strength of the series field exceeds that of shunt field, and thus gives the booster e. m. f. such a direction that it adds to the battery e. m. f., helping the latter to discharge to the line. When the line current is less than the capacity of the dynamo, the shunt field overpowers the series field, reversing the booster e. m. f. so that the latter is added now to the dynamos e. m. f. and helps to charge the battery. A and A′ are ammeters connected in the battery lead and line respectively. As shown, A indicates in either direction and shows whether current is flowing from or to the battery. The shunt and series fields of the booster are so proportioned that when the line ammeter A′ indicates a current just equal to the dynamo capacity, the pointer of ammeter A will be at zero, thus showing that the battery is neither receiving nor delivering current.

VICTOR C. VANCE.

Charging Storage Battery, Ans. Ques. 188.

Editor Southern Electrician:

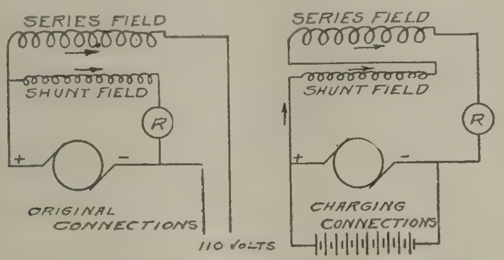
Referring to question No. 188, I do not believe it would be advisable to make changes in the field windings of W. T. R.'s 110 volt generator. Increasing the ampere turns on the field to give the required e. m. f., of about 170 volts with 60 cells in a series, at the ammature terminals would strain the insulation and in all probability cause a burnout. If W. T. R. will split his battery into 30 cells each and charge the two sets in parallel, I believe he will find it to work satisfactorily. This will require a maximum e. m. f. of about 90 volts.

A. H. MITCHELL.

Charging Storage Battery, Ans. Ques. 188.

Editor Southern Electrician:

In reply to question 188 of the April issue, I wish to say, that the voltage of a 60-cell storage battery when fully charged would be 60×2.5=150 volts, and on discharge the voltage should not read less than 1.7 volts per cell, or 102 volts for the battery. In charging a storage battery the supplied voltage must be just enough higher than the latter voltage to force normal current through it. So with a 110-volt generator, running at normal speed, it would be impossible to charge a 60-cell battery which would possibly require 170 volts on a finishing charge. If the generator is to be used only for charging the battery, and its mechanical construction is such that it will stand a 40 per cent increase in speed, it could be used. An extra shunt field rheostat should be inserted in the shunt field circuit, so as to limit the current in it to approximately the same value as when operating as a 110 volt machine. Unless this is done the field coils would carry more than rated current and thus get too hot. The series field winding should be disconnected from the armature circuit and connected in series with the shunt field,



Circuits for Charging Storage Battery.

being careful to see that it helps to build up and not weaken the shunt field winding. The following diagram may be of assistance in changing to series field. A. L. Utz.

Induction Generator Discussion, Ans. Question No. 185.

Editor Southern Electrician:

I note a discussion of question 185 in the May issue by Mr. Zuch in which he says that my statements concerning power factor are erroneous, and then without explaining just what he disapproves of, proceeds to discuss a phase of the subject that I did not mention and having little bearing on those features that I did discuss. Mr. Zuch is quite right when he says that the internal power factor of an induction generator is the same as that of the lines to which it is connected when in operation. Nothing in my article that would warrant anyone in supposing that I thought otherwise. I think, however, that the way Mr. Zuch expresses himself at this point is not quite clear. He says that the induction generator operating on an induction circuit would tend to adjust itself, etc. This is poorly expressed since the induction generator, which requires that its current be leading, can never adjust itself to a system in which the current is lagging, that is, an inductive circuit. That is to say it would not generate at all if the circuit were only inductive.

Of course an induction generator may operate on a system of which the load is largely inductive if there be a synchronous machine of sufficient capacity on the system. In this case the power factor at the induction generator is not lagging but leading, since the synchronous machine over compensates the lagging current of the external load, by the amount of leading current given by the induction generator, which leading current is balanced by a similar amount of lagging current from the synchronous machine. Thus we see that the power factor at any machine is the resultant of the power factors of the rest of the system, both motors and generators. If we have an induction generator it supplies leading current which is the same in effect as consuming lagging current, therefore it has the same effect whether used as a motor or generator. The synchronous machine if sufficiently excited gives lagging current as generator or consumes leading current as motor, both actions being the same in effect and just the opposite to the induction machine.

Mr. Zuch in his discussion repeats my second statement and therefore I can only conclude that he disagrees with the first one in which I said that the induction generator does not raise the power factor. Also his remark concerning its tendency to adjust itself would indicate the same erroneous conception. As a matter of fact the induction generator will adjust itself when connected to the system, but it will do so by taking lagging current from the synchronous machines, or what is the same thing, it will give leading current to them. Thus it will have precisely the same effect that an induction motor would, that is, it will lower the power factor still further. Of course since the powerfactor is the cosine of te angle of phase difference between the current and voltage it will be at its maximum of unity when the vector sum of the lagging and leading currents is zero. Therefore if either one be greater than the other, the power factor will be less than unity and could be raised by increasing the smaller component. Since in the great majority of cases the lagging current of the system is the greater, it is decidedly wrong to suppose that the power factor could be improved by increasing the lagging current by the use of an induction machine. Also there is no reason why there should ever be occasion to use an induction machine to balance the leading current of the synchronous machines since they can be made to operate at any power factor either lagging or leading by varying the field excitation. In the original question, it is very plainly asked if the induction generator will raise the power factor, the same as a synchronous motor. My answer is emphatically no, it will lower it still further.

If the power factor of the circuit external to the induction generator be constant and leading and lower than that required by the generator, that is, the leading current be greater, the generator will excite and its voltage will rise until the increase of exciting admittance, due to saturation of the magnetic circuit, causes its power factor to fall to equality with the external circuit. This condition, however, does not exist in the case under discussion, for the external power factor is not fixed either in value or in direction. It will depend entirely upon the generator itself. If the generator be an induction machine and therefore only capable of giving leading current the power factor will be leading and of the value required by the generator at that particular load. If, however, it be a synchronous machine the power factor will be either lagging or leading or unity according to the adjustment of the field excitation.

This must not be construed to mean that a generator can determine the power factor of the load, but rather that its share of the leading or lagging current may be adjusted by means of the field rheostat. I would refer the reader at this point to my answer to question 198 in the April issue, particularly the last part of the third paragraph on page 163. It will be understood that the power factor (the lagging current) is determined by the load and if it is not furnished by the generator under discussion it must necessarily be furnished by some other synchronous machine of the system, either motor or generator. Suppose we have three synchronous generators in parallel with an induction generator on a load consisting of induction motors, lights, etc., with a synchronous motor or two. The power factor of the load without the synchronous motors will be lagging, but by their use we can raise it to unity so that the synchronous machines need only supply the lagging current of the induction generator, or if it is large enough we can make it supply that also so that the power factor at the synchronous generators will be unity. However even in this case if their fields are not equally adjusted there will be wattless cross currents between them, that is, their individual power factors will not be unity. We might consider that the one with the weaker field excitation were similar to the induction machines which have none at all, and then we will more readily understand why it takes lagging current. As a matter of fact power factor is simply a question of magnetising current anyway. We have a certain line voltage which all the machines must generate (neglecting IZ drop) both motors and generators. If they have not sufficient field excitation to do so they will take magnetising (lagging) current from those that have more than they need. Obviously the induction machines will take the most since they have no direct current fields at all, although synchronous machines can be readily adjusted to do so.

Referring to the ability of an induction generator to adjust itself to the external power factor I should say that it does not do so even in the case when the power factor is leading, but rather it adjusts the external power factor to suit its own internal power factor, which internal power factor varies somewhat with the generator load. Mr. Zuch has this just backwards, for he says that the induction generator would adjust itself until the power factor required by the external circuit coincides with the internal power factor of the induction generator. He evidently thinks that the external circuit has a certain fixed power factor and the induction generator has a variable one that can be adjusted to suit it. This is not so, for the induction generator has a certain fixed power factor for a given load and voltage and it is the external power factor which must vary to suit it. Mr. Zuch's misconception is evidently due to his failure to consider the part that the synchronous machine plays in the matter. He very naturally concludes since the power factor of the external load has a certain fixed value, independent of the generators, that the generators must do the adjusting. That is quite right (neglecting for the present the synchronous motors) but it is the synchronous generators that vary their power factor and not the induction generators. If we should remove a large induction generator, the power factor of the synchronous machine would change, but if we removed the synchronous machine the power factor of the induction generator would not change, its lagging current would be taken care of by the other synchronous machine.

As I stated before the power factor at the induction generator is not that of the external load, but is resultant of the load power factor with that of the synchronous generator, is variable to suit the induction generator, and is leading, otherwise the induction generator would not generate. Mr. Zuch's statement would indicate that he is uncertain as to whether it is the power factor of the induction generator or of the external circuit that varies with the voltage. As a matter of fact the power factor of any induction machine varies very little with the voltage except in the unusual and undesirable case when it is working near magnetic saturation. Also since the external load consists of induction motors and other apparatus of constant (approximately) power factor it will not vary with the voltage. It is the synchronous machines, either motors or generators, whose power factor varies and thereby adjust the resultant power factor to that required by the induction generator.

In order to make this more easily understood we will consider the case of a synchronous motor operating from an induction generator without any other apparatus in the system. If the generator should not have sufficient leading current its voltage will be low since the leading current (leading generator current) is what magnetises it. Also if the applied voltage (line voltage) at the motor is low it will cause it to take leading current, the result being that the two machines will strike a balance at that point at which the generator voltage is lower than the motor voltage by just the amount that is necessary to cause the required leading current.

In conclusion, under the conditions that are implied in the original questions, such as usually are found, the power factors of the external load and of all induction machines, both motors and generators, are practically constant for slight variations in load and voltage, and all variations in power factor caused by connecting in induction machines are taken care of by the synchronous machines, either motors or generators, said change of power factor being an increase of lagging current whether the induction machine be a motor or generator. The power factor at any given machine is the resultant of the rest of the system and is determined by the relative adjustment of the field excitation of the various machines. Such machines as are deficient in excitation, as under excited synchronous machines or induction machines, will consume lagging (magnetising) current while the rest will either operate at unity power factor or will consume leading current. The reader is here reminded that consuming lagging current as motor is the same as supplying leading current as a generator, and consuming leading current as motor is the same as supplying lagging current as generator. From the foregoing we will see that the induction generator does not under any circumstances raise the power factor that is made low by induction motors.

T. G. SEIDELL.

Distribution Systems, Ans. Ques. No. 202.

Editor Southern Electrician:

In reply to question 202 appearing in your March issue, I offer the following: In England it is generally considered advisable to adopt the following transmission and distributing systems in districts and for loads of the stated nature: Districts 2 miles in diameter with load uniform and population dense—440 volts D. C.; districts 1 mile in diameter with load uniform and population dense, 3 wire 440 volts D. C.; districts 1½ miles in diameter with heavy load within central mile, 3 wire 440 volts D. C.; districts 1½ miles in diameter, sparsely populated—single phase A. C.—(in the case of scattered villages, transform down in the houses or in substations at the center of villages; districts 3 miles in diameter, high tension D. C. or A. C. transformed to low tension D. C. before distribution; districts over 3 miles in diameter, extra high tension A. C. transmission, step-down transformers or converters at load end of line.

In the present case the choice seems to lie between three phase A. C. and three wire D. C. If the motor load now forms, or is likely in future to form, the greatest part of the total load, single or two phase A. C. at once becomes undesirable and unless a great extension of the demand is anticipated, D. C. assumes many advantages over three phase supply, especially for such short distances as the present. Supposing three phase supply to be adopted, it would be advisable to transmit power overhead to a static transformer substation located centrally in the load area. With three phase supply throughout the latter, there need be no moving machinery in the substation which may therefore be locked up except during switching period. If desired, switching could be controlled from the power station through pilot wires. This would hardly be necessary in the present case. The nature of the machines driven or the personal inclination of the owners might preclude three phase motors being installed and in that case it would certainly be advisable to lay down a 3 wire D. C. transmission from the central station. The distance of transmission is here so short that it is by no means certain that D. C. supply would not be preferable in any case. The higher efficiency of transmission of the high tension alternating current scheme and the saving in line copper are heavily discounted by the capital cost of the substation and static transformers required and by the well known advantages of D. C. for general electrical supply. A three wire D. C. line could presumably be supplied by the existing rotaries.

In any case three phase current is preferable to single or two phase supply where motor loads have to be operated. 400 to 500 volts, D. C. or A. C., is a convenient pressure at which to supply large motors, while 100-200 volts is suitable for lighting circuits, the higher pressure having the advantage that small motors can be economicaly supplied thereat. In the present instance, no consumer appears to warrant high tension supply in bulk. There would be no difficulty in running the lighting load from A. C. mains unless the frequency were exceptionally low. The lower the frequency, down to say 25-30 cycles, the better from the point of view of large motor supply but the worse from the lighting standpoint. Arcs are considerable less efficient and generally satisfactory on A. C. than on D. C. supply, but filament lamps, including even metal lamps of recent types, show practically equal efficiency and longevity on both.

In the writer's opinion, three wire D. C. supply with 400 to 500 volts between outers, would best meet the needs of the present case. From the consumer's point of view, D. C. supply would certainly be preferable and this would be almost as cheap, if not cheaper, than a 220 volt A. C. transmission and the entailed additional high tension equipment. A precise determination of the relative efficiencies of the several systems available may be readily effected when the magnitude and distribution of the various loads are known. Thence a final decision may be made by considering the capital cost and operating conveniences of the alternative scheme. From England by CEC. TOONE.

Remarks on Answer Question No. 205.

Editor Southern Electrician:

In looking over the questions and answers of SOUTHERN ELECTRICIAN, issue of May, 1911, on page 213 appears an answer to question number 205. It is the writer's belief that the statement made about metering a 3 phase induction motor load with a single phase wattmeter and using a multiplier of 3 is not sufficiently accurate for practical purposes, as the accuracy of the wattmeter is affected more or less by the power factor of the circuit. The writer would be pleased to have Mr. Bates verify his statement as made in the above referred to answer. L. McCOY.

P. F. of Motor Load, Remarks on Question No. 205.

Editor Southern Electrician:

In regard to Mr. W. A. Bates' answer to Question 205, in which he states that the power factor of an induction motor circuit is usually the same in the different phases and that a single phase wattmeter inserted in one phase will indicate one-third of the power supplied, I was surprised that anyone pretending to have a knowledge of polyphase currents could make such a statement. For instance, if single phase wattmeters be connected in two phases and their potential leads be connected to the third phase, as is done in taking wattmeter readings with single phase meters on polyphase circuits, a condition will exist whereby the two meters will read nearly the same so long as the load is balanced and the power factor remains at 100 per cent. As the power factor drops, one meter reading will drop much more rapidly than the others until the power factor reaches 50 per cent., when the one meter reading will reach 0, going to negative as the power factor goes below 50 per cent. The power supplied at all times is the algebraic sum of the readings of the two meters. As the power factor of an induction motor load is always below unity and decreases as the load decreases but not in proportion to the load, it is only posible to get an approximate reading with a single phase wattmeter. This is done as follows. Number your phases 1, 2 and 3. Connect the wattmeter in No. 1 with potential from 1-2 and read. Maintain the same condition of load, etc., and connect the meter in No. 3 with potential from 2-3 and read. Now if your power factor is above 50 per cent. the power will be the sum of the two readings, while if below 50 per cent. it will be the difference between the two.

SINGLE-PHASE ON THREE-PHASE SYSTEM, ANS. QUESTION NO. 206.

I would state that it is considered better practice to use one phase only in cases of the sort mentioned, as 70 per cent. of the rated capacity of the alternator is available. If the load is divided, a Scott connected transformer would supply a two-phase circuit very satisfactorily. Any sort of a balance coil will unbalance the alternator and at the same time cause a lower power factor than would otherwise be the case.

RAISING P. F. BY SYNCHRONOUS MOTOR, ANS. QUESTION NO. 214.

It is found most satisfactory in using synchronous motors as rotary condensers, to install them of such capacity that they will deliver about 70 per cent. of their rated capacity in power, the other 30 per cent. being leading wattless current. Except where the motor is of special design, it is not practical to over-excite the field more than would be the case under above conditions.

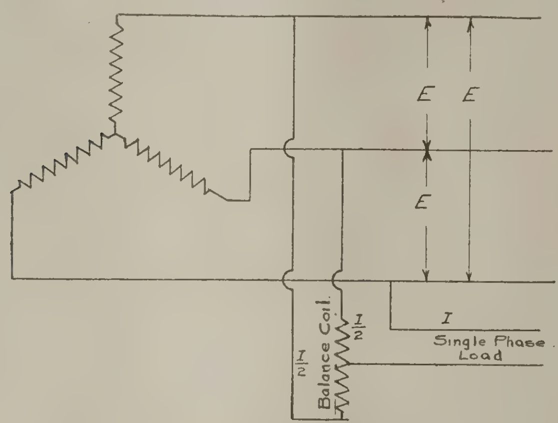
C. L. Hayward.

Single-Phase Load on 3-Phase System, Ans. Question No. 206.

Editor Southern Electrician:

In regard to the inquiry of A. F. L. in question 206 of the April issue, I will state that the use of the balance coil to get single phase connection on a three-phase system is satisfactory in those cases where a voltage greater or less than line voltage is desired. The balance coil serves to force the current to divide equally thus making two wires of the three-phase system a return for the third wire. The connections for a voltage less than line voltage is shown in the accompanying diagram.

If full voltage is required for single phase connections equally good results are obtained by placing the load across any one of the phases and in this way making the balance coil unnecessary. Unbalanced conditions should always be guarded against in order to obtain efficient operation of the 3-phase system. It is claimed that a three-phase generator will deliver only 75 per cent. of its rated capacity in single phase current between any two conductors, with the same heating as when delivering three-phase load. The potential difference of phases when running as single phases are usually required, however regulators in this feeder may be used to take care of these differences which



SINGLE-PHASE CONNECTION TO 3-PHASE MACHINE.

in a well layed out system will be small. Three phase motors operated on the system and synchronous apparatus also takes care of these differences and tend to bring about balanced conditions. The principle reason for installing a three-phase generator for single-phase operation is on account of the fact that it is cheaper than the single-phase machine. With proper arrangement of circuits and by use of regulators good results as to regulation can be obtained.

H. F. BOYLE.

Fuses for Induction Motors, Ans. Ques. 209.

Editor Southern Electrician:

I have been interested in your Questions and Answers Department for some time, as I have problems continually coming up that I do not understand. I am always glad to help others and as I have charge of over 2000 H.P. of induction motors, I believe the following will help H. A. P. out in trouble mentioned in the April issue: H. A. P. does not state the actual operating conditions of his 50 H.P. motor, however the fuse capacity all depends on the following: Means of starting—starting with no load—full load—or overload. Large induction motors are usually started with compensator, auto starters or internal resistance. The first devices are usually composed of reactance coils which reduce the line voltage and thus also reduce the large current flow on the sudden starting.

Small motors up to about 10 H.P. can be started with plain knife switches. For larger sizes the usual practice is to start the motor with starting apparatus in circuit, but no fuses to protect line. When the motor has reached full speed (or nearly) the starting apparatus is cut out and replaced by fuses. This reduces the excess fuse capacity at starting and also heating of fuse which reduces its carrying capacity.

I usually allow the following fuse capacity under the above conditions: 2 amp. per H.P. for 440 volts, and 4 amp. per H.P. for 220 volts. This may be raised somewhat as this type of motor will stand 100 per cent over load for short periods. If the overload comes on slowly and the fuses are large, the motor will heat to a dangerous point before blowing the fuses. As an instance in point, I will cite a 90 H.P. motor which would under proper operating coonditions pull just full load, 100 amps. at 440 volts. This motor at times would pull as high as 350 amps. for one or two minutes at intervals of about five minutes. It has stood for this treatment for over a year and has given no trouble.

A READER.

Raising P. F. by Synch. Condenser, Ans. Question No. 214.

Editor Southern Electrician:

It is entirely practical for T. C. M. to raise the power factor of the system referred to in question 214 of the May issue, from 70 per cent to 90 per cent by means of a synchronous motor. The 38 horsepower load need not be given questionable consideration because of the motor installed is of a size sufficient to raise the power factor it will carry the 38 horsepower load, it being a small per-cent of its capacity available for mechanical load.

The size of synchronous motor may be determined as follows: With a delta connection and 70 per cent. power factor, the apparent power is$=140\times2300\times\sqrt{3}=556$ K.V.A. The wattless component referring to the diagram is A.C. which equals $\sqrt{(556^2-400^2)}=392$ K.V.A. This wattless energy is now being supplied by the generators.

When operating at 90 per cent power factor, the apparent load is $400/.9=445$ K.V.A. and the wattless energy under these conditions equals $\sqrt{(445^2-400^2)}=195$ K.V.A. The capacity of this synchronous motor now can be taken as equal to the difference of the wattless components at 70 per cent. power factor and 90 per cent. power factor operation. Thus $392 - 195 = 197$ K.V.A. is the capacity of the machine.

It is claimed that the greatest efficiency of the motor can

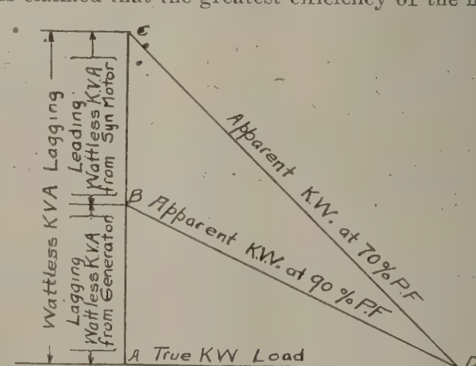


DIAGRAM OF ELECTRICAL RELATIONS.

be obtained when so operated that 71 per cent. of the capacity is used for mechanical load and 71 per cent. for correcting power factor. It would therefore be probably best if possible to install the motor where a considerable H.P. of induction motors could be replaced. While the capacity would be somewhat larger than 197 K.V.A. which is required from the synchronous motor as wattless K.V.A. leading, a synchronous motor of a size to supply this as 70 per cent of its rated input would be about 298 K.V.A. or a 300 K.V.A. machine. If only the 38 horsepower mechanical load is desired, however, the 200 K.V.A. machine is large enough. It is of course wise to install the machine on the customer's premises in order to reduce the transformer, aand line losses and to improve the regulation. However, it may be installed at a substation in case such is near the customer.

H. L. WILLIAMSON.

Cost and Design of Electric Signs, Ans. Question No. 210.

Editor Southern Electrician:

Permit me to supply in a meagre way the information requested by H. H. C., in question 210 of your April number of the SOUTHERN ELECTRICIAN. Electric signs are universally sold by the manufacturers to central stations at a certain price per letter, depending on the size of the letters. The following is a scale of list prices for each letter:

12 inch	$ 6.00	per letter
16 inch	8.00	per letter
18 inch	9.00	per letter
20 inch	10.00	per letter
24 inch	11.00	per letter
30 inch	15.00	per letter
36 inch	20.00	per letter

A discount ranging from 15 per cent to 40 per cent is given to the trade on above prices.

height. The total cost of this sign, using Tungsten, low voltage lamps, would be as follows:

Item No. 1. Sign, 24-16 inch electric letters, with hanging ring complete	$192.00
Item No. 2. 168-4 c.p. Tungsten lamps at 40c ea.	67.20
Item No. 3. 1 K. V. A. low voltage transformer, ratio 110/10	18.00
Item No. 4. Erecting and connecting	15.00
Total	$292.00

Sketch No. 2 shows a sign reading J. J. Brown, Shoes, in a 12 inch electric letter, with a rabbit jumping border. The cost of this sign is as follows:

Item No. 5. Sign with motor and flasher and hanging ring	$361.00
Item No. 6. 366-4 c.p. Tungsten lamps at 40c ea.	146.40
Item No. 7. 1½ K. V. A. transformer, ratio 110/10	18.00
Item No. 8. Cost of erecting	25.00
Total	$557.40

Sketch No. 3 is a sign similar to sketch No. 2, but has a crawling snake border, the letters being of the same size. The cost is as follows:

Item No. 9. Double sided sign, with motor and Flasher and complete hanging ring	$288.00
Item No. 10. 258-4 c.p. Tungsten lamps at 40c	103.20
Item No. 11. 1½ K.V.A. transformer, ratio 110/10	25.00
Item No. 12. Cost of erecting	25.00
Total	$441.20

The prices above are list in every case and, as stated before, are subject to discounts. If H. H. C. is connected

DESIGNS FOR A SMALL SIGN.

Stationary or flashing borders are charged for on the basis of so much per linear foot on both sides of the sign, the average price being about 50 cents per foot for stationary, and $1.50 per foot for flashing borders. The motor and flashers range from $10.00 up, depending on the size, etc.

In question 210, H. H. C. has not stated the size of letters required. Therefore I beg to suggest the following: In sketch No. 1, which is shown above, I have assumed the letters to be of grooved type, 16 inches in

with an electric company he would be entitled to discounts that would reduce the cost considerably.

The cost of erection will vary and depends entirely upon the type of building and local conditions. The cost of maintaining such signs would depend on prevailing rates, but a number of companies connect such signs on their circuits on a flat rate basis. A profitable rate for 4 c. p. Tungsten lamps would be 8 cents per lamp per month, giving free renewals, the consumer purchasing the first installation of lamps. The sign could burn an average of 135 hours per month, same being turned off by the company at stated hours. This rate is given by the Central Station with which the writer is now connected. For further information on signs I would suggest that H. H. C. address T. E. Valentine, Valentine Sign Co., Atlantic City, N. J.

E. J. MORA.

Lighting Arrester Trouble, Ans. Ques. 217.

Editor Southern Electrician:

Replying to the trouble experienced by W. R. K., with electrolyte lighting arresters, I will give the following suggestions: There are so many operating conditions which would cause objectionable potential stresses between conductors and ground, that is impossible to accurately define the cause of the burnouts mentioned, without more specific information. In general, however, generators of such high voltage and small capacity necessarily have a very high self-inductance, which permits the high-frequency currents set up by charging the arresters to induce extremely high potential stresses between the machine winding and ground, and between the end turns of the generator coils. In the first case this results in the insulation being punctured to ground, and in the second case, in short-circuits between turns, but in either case allowing heavy currents from the generators to flow through the damaged coils and burning them up, without flowing through the arrester fuses or the circuit breakers.

Installing properly designed choke coils in the generator leads, and grounding the generator neutrals, should materially lessen the dangers of burnouts. It is possible that the insulation of the generator coils has deteriorated to such an extent that it would be advisable to re-wind the machines with new coils. However it would be wise to make more thorough investigation before reaching a decision. Other considerations which would enter into the study of this trouble would be the capacity effect of a cable system, and the resonance effect of a combined cable and overhead system, either of which conditions would have a decided bearing on the case.

If any further discussion of the case is desired, I will be glad to give any information that I can, or will be glad to correspond with the person having the trouble.

C. H. BROWARD.

Lighting Arrester Trouble, Ans. Ques. 217.

Editor Southern Electrician:

The trouble experienced by W. R. K. is one which seldom exists, for apparatus of standard design should not be damaged when charging the electrolytic arrester. However, the explanation may be something as follows: The effect of lightning which is similar to the action of electrolytic arresters at the time of charging, in case an arc is found to ground and not a solid contact, depends upon the size of the generator to a marked degree. In small generators such as mentioned by W. R. K., where there is more than one turn to a coil, a high voltage is set up between turns and the high frequency disturbance would cause a greater effect with the arrester in good condition than it would with an arrester in bad shape. This is due to the fact that the current is small and absolutely static in character, so that with an arrester that has not been charged according to instructions and in which the film is somewhat deteriorated, a power current flows which tends to dempen the vibration ensuing from the static current.

In charging electrolytic arresters, the high frequency vibrations set up should be of so small amplitude that apparatus in good condition should never feel the effect of the disturbance due to such charging. The writer is familiar with the electrolytic arrester built for the voltage referred to, namely, 11,000 to 13,200, and believes there is no arcing ground. A solid contact is made which is different from the charging arrangements on the high voltage arrester, so that owing to this solid contact very little vibration should ensue except when the circuit is made and when it is broken on charging the arrester. A high frequency disturbance therefore does not necessarily set up the stress to ground. The major portion of such stress is between the end turns which usually cause a break down if the insulation is weak, burn out the coils and the result is usually upon examination that a ground is formed. This ground is usually an indirect result caused by the burning of the coils from the power current of the generator. The best remedy for a case where this exists is to rewind the generator with new insulation and thus overcome any deterioration which may have taken place.

In handling high voltage apparatus, there is at the present time a tendency to neglect the periodic insulation tests both on generators and transformers and the result is that at times the machines break down when they can be spared least. In other words, the operating company should make it a practice to periodically make high voltage tests for insulation and weed out all weak coils, the testing being done at a time when the machines can be spared from service for the repairing.

It seems to the writer that the machines to which W. R. K. refers have been subjected to severe conditions, either from load or abnormal line or cable characteristics and possibly the insulation has deteriorated more than he has supposed. The generators involved in the trouble are extremely small for the voltage and are very susceptible to a disturbance of any kind involving high frequencies. It would be altogether possible that W. R. K.'s trouble can be remedied in whole or part by providing choke coils of the oil insulated type, which are very powerful and with series transformers the waves resulting from charging the arresters would be flattened and thus preventing trouble. To solve this trouble absolutely would demand a careful investigation to determine the exact conditions. It hardly seems that the arcing could cause all the trouble mentioned, unless it is aided by the capacity effect of a large cable system or resonant effect which might result from a combination of cable and overhead lines. If it is a cable system, the generator should certainly be grounded at the neutral point. Much more data should be at hand in any case before this trouble can be definitely cleared up.

L. A. M.

Distribution System, Ans. Ques. 202.

Editor Southern Electrician:

In regard to question 202, if the street lighting is spread out on a large area, tungsten lamps should be used. The transformer secondary voltage should be 500 volts and the system wired for 3-wire distribution using 250-volt lamps. Motors from 5 to 15 horsepower should be 220 or 440 volts, 3-phase, and over 20 horsepower 2,200 volts, 3-phase. The line construction should be for transmission of 2,300 volts for load up to 300 horsepower, for over this figure voltage should be stepped up to 10,000 volts. This is general practice for long distance work in California.

H. N. SNYDER.

New Apparatus and Appliances.

Murdock Safety Cabinet.

The illustrations presented below show a type of safety cabinet designed and placed upon the market by the William Murdock Electric Manufacturing Company, St. Louis, Mo. The object of the designers of this cabinet was to create a panel board that could be used for small installations and give them the same features of safety and economical distribution of electrical current as found in large installation, through the use of appropriate panel boards.

In general the Wurdack Safety Cabinet consists of a small special panel board contained in a sheet iron fire proof cabinet with space provided for the installation of the current measuring meter in the cabinet. It is intended primarily for the control of lighting circuits in residences, apartments and stores. The main entrance fuses, the main switch and all branch circuit fuses are mounted on a slate panel. This panel is mounted in the lower part of a sheet iron box. In the upper part of the box is provided a wood back to which any watt-hour meter can be attached. The panel is furnished with wire leads for connection to and from the meter; also lugs for all other wire connection. Over the front of the box fits a two part trim. The upper half has an extended portion made to accommodate any standard 30 ampere meter. The lower half has a door covering the main fuses, a hole through which the handle of the main (rotary) switch extend, and a door covering the branch circuit fuses. When main feed wires are run into the box in conduit, the safety cabinet provides an absolutely enclosed job, all connections between every device being thoroughly protected aand therefore all possible danger overcome. The cover or trims are arranged so that they can be sealed with one seal at the top; and the door over the main fuses may also be sealed, thereby preventing any tampering with the service by an unauthorized person. The door over the branch fuses is held with a plain catch and is aacceessible to everyone.

FIG. 1. CABINET CLOSED.

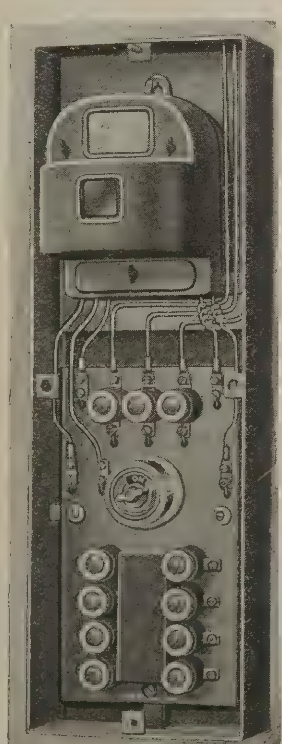


FIG. 2. CABINET OPEN.

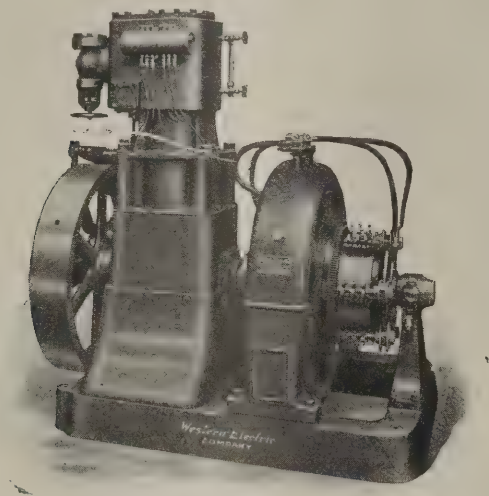
The path for the flow of current through the cabinet is as follows, referring to the cut: From main entrance wires through main fuses, through main switch, the main switch being 3-pole on a 3-wire cabinet. The two outer legs now pass up by two wires to the left, to and through the series coil in meter, by two wires at right, back to the circuit fuses at lower part of panel. The neutral wire after passing through the main switch goes directly to circuit fuses at bottom of panel. A potential tap is, however, taken from this neutral and run to the meter for the potential coil. This potential tap is the middle wire of the three wires to the left—the outer two of these three are the series wires referred to above.

The current is turned on from the outside by means of the main switch which protrudes through the trim. Should a branch circuit fuse blow, the customer renews it himself by opening the lower door. One set of fuses is furnished with every safety cabinet.

Steam Driven Direct Connected Generating Unit.

To meet the demand for a direct connected generating set, especially adapted for power and lighting service in isolated plants or marine installations, and as exciters in large central stations, a new steam driven set has just been placed on the market, known as the Western Electric Hawthorn direct connected generating unit. These sets are furnished with 110 and 125 volt direct current generators, ranging in capacity from 2½ kw. to 75 kw., direct connected to single cylinder or tandem compound, vertical engines which operate condensing or non-condensing at steam pressures of from 35 to 160 pounds.

The engines are of the vertical marine type so constructed as to insure perfect alignment, balance and adjustment for possible wear. Perfect alignment of the parts is attained by casting the cylinder, valve chest and crosshead guides in one piece, and machining them at a single operation. The piston rod and crosshead and likewise the crank shaft and half coupling are forged from one piece of best machine steel, and by careful and accurate machining of all parts, perfect alignment is further assured. A balanced piston type valve, accurately ground to fit in the steam chest, produces close regulation and freedom from excessive friction. The piston used is equipped with hard cast iron spring rings which effectively prevent leakage of steam. A simple aand efficient fly-wheel governor maintains a constant speed by automatically varying the steam admission and compression. This is effected by the motion of the eccentric pin, mounted on a carefully balanced fly-weight which is very sensitive to slight variations in speed. The governor requires very little aattention as there are practically no parts subject to wear. The engines are furnished with either the gravity or the forced system of lubrication, and adjustable sight feed tubes allow the regulation of the flow of oil to the various parts.



Small Steam Driven Generator Unit.

The generator frame of the smaller sets is cast in one piece of high grade iron. The frame of the large sets is of cast steel and is split horizontally. Soft cast steel poles are rigidly bolted to the frame. The armature is built of high grade sheet steel laminations, pressed on an iron spider and provided with numerous ventilating ducts. The field coils are very liberally designed, provided with many ventilating ducts and thoroughly insulated. The brush rigging is supported by the bearing, except in the 50 kw. set, on which it is supported by the magnet frame. Individual spring adjustment on the brush holders permits the removal of the brushes for inspection and their return without altering the brush tension.

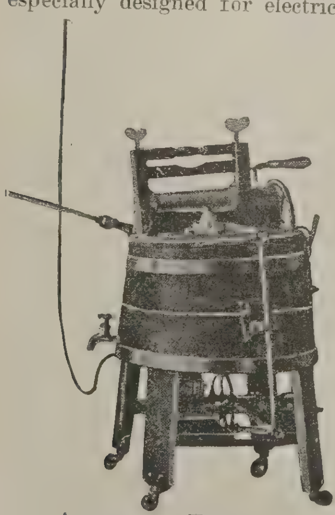
Automatic Electric Washer.

The accompanying illustration shows a type of electric washer manufactured by the Automatic Electric Washer Co., 336 Washer Bldg., Newton, Iowa. The washer is especially designed for electrical power drive, with an attachment by means of which the washer can be run by hand if the current gives out during a washing. The washer has numerous advantages which appeal to a customer. The lid is entirely free from gearing so that there is no chance for bearing oil to drop through and spot the clothes. The motor and all gearing is mounted on a platform underneath the tub, and below the center of gravity, making it impossible for the engine to pull the washer over. The motor tub is of Louisiana cypress, with special leak-proof bottom and the inside is corrugated like a washboard giving the clothes the right amount of friction, without injuring them. Direct lever control makes the machine safe as a touch of the lever, conveniently located at the side, starts and stops it or communicates the power to the wringer.

Another important feature of the washer is the reversible wringer, this also being controlled by a lever. Should clothes become lumped a slight motion of the lever, located at the side of the wringer, reverses the rolls and thus prevents crushing buttons. Interested dealers can secure valuable information and get a free book "How to Wash" that the household would appreciate by writing the Company, 336 Washer Bldg., Newton, Ia.

New Three-Phase Motor Starter.

A new three-phase motor starter has been placed on the market by the Detroit Fuse & Manufacturing Company, Detroit, Michigan, which takes care of the heavy starting load by paralleling the fuses and making it possible to fuse a three-phase motor at its running load. The motor starter is completely enclosed in a cast iron box equipped with rubber gaskets making a fume proof and moisture proof construction. It can be installed where exposed to very severe conditions, and is quite substantially made, so as to hold up under the roughest of handling. The mechanism is controlled by a lever, as shown in the cut. When throwing on the switch, the fuses are paralleled by a copper bar as is noted in the small sketch directly above Fig. 1. It is necessary to hold this lever down until the motor has reached speed, at which time, by removing the hand the lever is automatically thrown out and the paralleling device thrown out of circuit. This leaves the fuses protecting the motor, as is noted in Fig. 2. When it is desirous of throwing off the switch, it is only necessary to pull out the lever as is noted in Fig. 3.



Automatic Electric Washer.

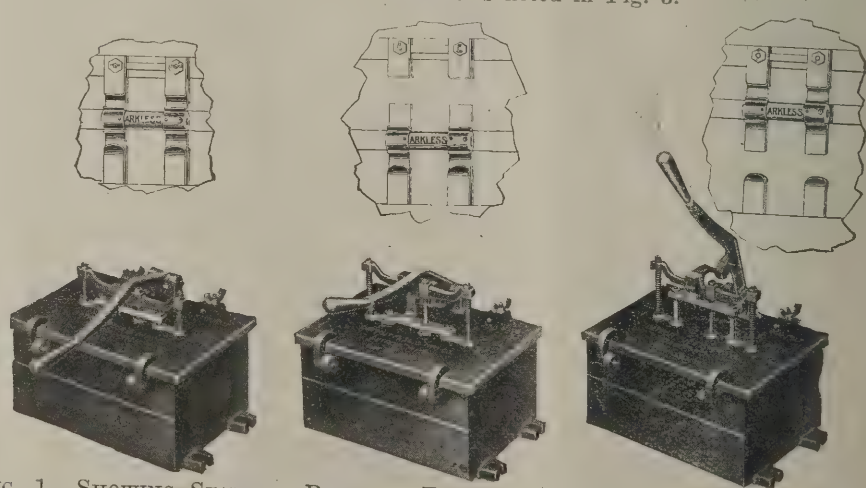


Fig. 1. Showing Starting Position. Fig. 2. Showing Running Position. Fig. 3. Showing Off Position.

This switch is a quick make and quick break type with no intermediate position, and can be operated successfully by the most ignorant workman. It is claimed to be entirely fool proof, with no weak parts that can get out of order.

Universal Lighting Fixtures.

It will be appreciated that it requires considerable investment to carry a complete assortment of ordinary fixtures in the varied number of lights necessary to meet the varied requirements which are constantly arising. In Wakefield fixtures, manufactured by The F. W. Wakefield Brass Co., of Vermilion, Ohio, it has been the aim to solve this problem. The idea originally conceived and eventually carried out was to have a standard size body which could be arranged for carrying either 2, 3 or 4 arms and which would constitute a foundation upon which any of the different designs could be built.

FIG. 1. WAKEFIELD FIXTURE, ROUND BODY TYPE.

The original round type body was a solid brass casting in the shape of a cartwheel with provisions for carrying a varying number of lights as designated above. This method of course to have the varied number of lights in correct position would leave in any of the different styles some unused outlets. These outlets are filled with a small ornamental screw plug which can be removed at any time with a screw driver, for utilizing the outlet. The outlets are tapped for the insertion of any of the round threaded type of fixture arms which are fitted with hexagon arm backs threaded to fit the body.

The original idea has been broadened out to cover the square type of fixtures, the body of which differs somewhat from the round, the principle however remaining the same. That is, the provision for inserting with two or four arms, the unused outlets in the case of the two light being covered by ornamental fitings.

The features above described permit the interchanging of the various designs of stems and arms in a varying number of lights to each fixture and eliminates the necessity for carrying individual two light, three light, and four light fixtures in stock. All stems have provision for bottom light, pendant switch or cord for attaching portables, toasters, irons or other electrical accessories.

Mazda Series Regulator.

For the purpose of regulating Mazda lamps in series, the Packard Electric Company of Warren, Ohoi, has placed on the market a regulator especially designed to keep the current practically constant for all ordinary conditions. The regulator is essentially an inductance in series with the lamps, working in the secondary circuit of a transformer having several taps for the accommodation of partial load conditions. The inductance is also tapped at various points, and these taps are brought to a gang plug switch, making it very convenient to use any desired point. The switchboard is conveniently arranged with an ammeter operated by a series transformer. The two stab switches, properly fused, located below the ammeter, control the primary circuit leading to the transformer.

Due to the fact that the resistance of the mazda lamp increases as it gets hot, it is especially adapted for use on series circuits, when lamps burn out and are short-circuited, by their film cut-outs. The increase in resistance in the remaining lamps prevents to a large extent, an abnormal rise of current. That this is not the case with carbon lamps is shown by the curves given below. Curve (1) represents carbon lamps without regulation. (2) shows current rise with constant resistance. (3) shows mazda lamps without regulation. (4) shows the normal operation of the lamps governed by the series regulator. The horizontal figures show per cents of lamps short circuited, and the vertical figures the rise of current in the remaining lamps.

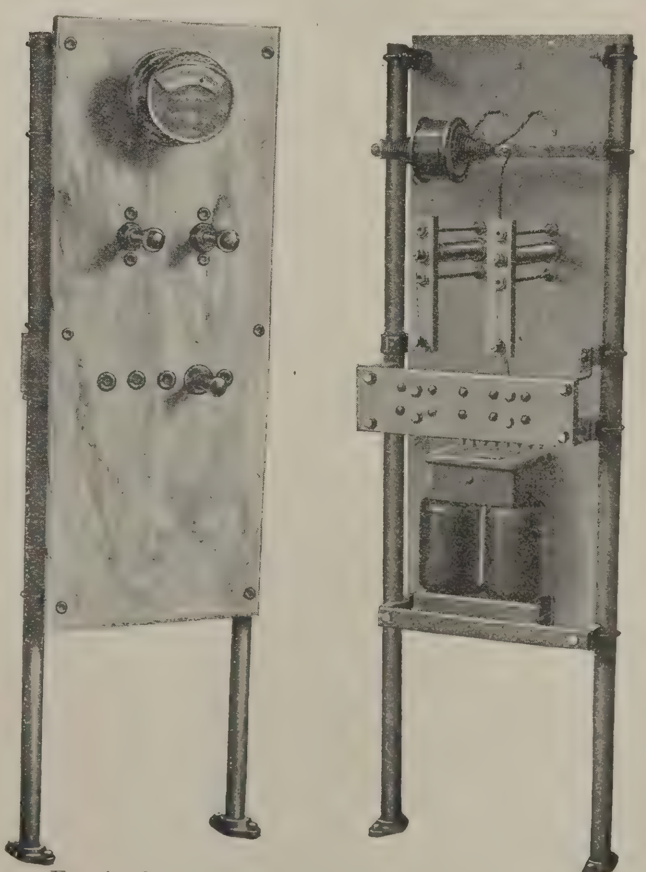


FIG. 1. FRONT AND REAR OF SERIES REGULATOR.

The regulator is claimed to keep the current practically constant for all ordinary conditions, and under abnormal conditions, it will still limit the current to a safe amount. Provision is also made to reduce the current to normal value, if desired, while the large percentage of lamps is still out. In other words, the regulator is automatic. However if a change in current is desired, it can be easily accomplished.

The claims made for the system, which has now been in successful operation for over a year, are, no moving parts, high efficiency and power factor, normal power factor on partial load, long life and dependable service and low cost.

Reppell Bell Ringer.

The Reppell Electric Co., Kansas City, Mo., is placing on the market the Reppell bell ringer for operating door bells, door openers, buzzers, enunciators, electrical toys, etc. The device is easy to install, and can be done by any one. Once installed the device does away with all batteries and performs its work with almost no consumption of current, in fact, the manufacturers say that the consumption of current will not amount to one cent a year. The president of the company, Mr. L. G. Reppell, has been in the electrical construction business for many years, and members of the firm are among the prominent business men of Kansas City.

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.

ATTALLA. It is understood that improvements to the electric light plant and waterworks system of the Etowah Light & Power Co. is under way, being estimated that an expenditure of $50,000 will be made.

COLUMBIA. A company is being organized by F. S. Twitty for the construction of an electric power plant to cost about $15,000.

EUFAULA. In accordance with the annnouncement made in the last issue regarding the expenditure of $50,000 for an electric light plant for the city, it is understood that bids will be received until June 7th by the city council for the construction of the municipal plant. The engineer is W. L. Upton of Birmingham, Ala.

FORT MORGAN. Bids will be received until 1 P. M. June 2nd at the office of the constructing quartermaster, at Fort Morgan, Alabama, to cover a motor driven deep well pump, electric transmission lines, switch panel, transformers, 4-inch cast iron water main, and other apparatus according to plans and specifications which can be obtained.

MARION. It is understood that the Marion Electric Company has been incorporated with a capital stock of $10,000 for the purpose of operating an electric and gas plant. The incorporators are T. J. Krause and R. K. Cox.

MONTGOMERY. The Lee Street Terminal Company has been incorporated with a capital stock of $80,000. The company proposes to construct and operate electric and steam railways in Montgomery and the officers are W. J. Hannah, president; S. H. Roberts, vice-president; F. B. Powels, secretary and S. W. Winchester, treasurer.

FLORIDA.

FORT MEADE. The Fort Meade Electric Company has been incorporated with a capital stock of $10,000 and has purchased the electric light plant from S. T. Rivers. The president of the company is J. C. Chancey, the treasurer A. B. Canter and secretary C. J. Wilkins.

FORT PIERCE. The city has plans under consideration for a bond issue of $25,000, the proceeds to be used for a waterworks system.

PALATKA. The city council has been petitioned by S. P. Clark of Jacksonville for a franchise to light the streets with electricity. A plant is proposed, the construction of which will cost $40,000.

QUINCY. A location has been secured at Fort St. Joe by the Peoples Ice, Fuel and Supply Co., of Quincy, Fla., for the purpose of erecting an electric light and ice plant. The president of the company is Robert Sylberter.

SOUTH JACKSONVILLE. The citizens have recently voted an issue of $60.000 in bonds; the proceeds to be used for the installation of an electric plant and waterworks system.

ST. PETERSBURG. A vote will be taken June 13th on the issue of $5,000 in bonds, the purpose being to extend the waterworks system.

WEST PALM BEACH. It is understood that an application has been made to the city council for a new franchise by the Aiston Ice & Electric Co. Extensions are planned for the plant including the installation of additional machinery to amount to about $15,000.

GEORGIA.

ATLANTA. Plans have recently been completed for the construction of a hydro-electric plant to cost $3,000,000.00 by the Atlanta Hydro-Electric Power Co. A dam and power plant sufficient to develop 30,000 horsepower will be constructed and energy transmitted to Atlanta. The company has offices in the Candler Bldg., Atlanta, Ga.

BARNESVILLE. At the election recently reported in these columns to be under consideration, $15,000 in bonds was voted for the purpose of making extension and improvements to the municipal electric light plant.

BUCKANAN. The city council has decided to install an electric light plant. The committee to purchase and install the plant is composed of G. N. Moore and H. S. McCalman.

COLQUIT. The city is to erect an electric light plant to cost $75,000. The mayor, T. E. Wilkins, can give other information.

CARTERSVILLE. The Blue Ridge Power Company is to construct a 150-foot dam near Cartersville for the development of a plant which will generate 30,000 horsepower of electrical energy. Information can be obtained from William A. Carlisle, of Gainesville, Ga., who is interested.

ELBERTON. A company has been organized known as the Elberton and Eastern Railway Company, the purpose being to build an electric road to connect Elberton, Tignall, Washington and Lincolnton. The incorporators are N. A. Pharr of Washington, Ga.; J. A. Morse, W. J. Adams and J. J. Wilkinson of Pignall; W. O. Jones, Z. B. Rogers and others of Elberton. The company is capitalized at $500,000.

FORT VALLEY. An issue of $40,000 in bonds has been voted by the city for the construction of a waterworks system.

LOGANSVILLE. The Farmers and Merchants Bank desires prices on an electrical equipment for a bank building. J. B. Hodges is the cashier.

MACON. The Singleton Smith Company of Macon, Ga., desires prices on a 25-kilowatt 2,200-volt, single phase, 60-cycle, belted type alternator.

MACON. It is understood that the Macon Railway & Light Company is to replace the lighting system now installed by a new magnetite system.

MARIETTA. The citizens of Marietta have voted to the issue $35,000 in bonds for the purpose of completing the water and sewer systems and to install an electric light plant. It is understood that $20,000 will be devoted to the electric light plant.

OGLETHORPE. A bond issue of $18,000 has been voted on for the construction of a waterworks and electric light plant. The bids for construction and equipment will be open on June 1st and information can be obtained from the mayor, J. P. Nelson.

KENTUCKY.

JENKINS. The Consolidated Coal Company is reported to be about to develop a water power on the Elkhorn Creek for transmitting electricity for light and power. The plans have not yet been decided upon as to the water power electric plant. Information may be obtained from A. T. Watson, Fairmount, W Va.

LANCASTER. Announcement has been made by the principal stockholders of the Kentucky Electric Light Company that the plant which was destroyed by fire on April 20th, will be rebuilt at once. An expenditure of $10,000 will be made as the equipment was a total loss.

LEXINGTON. The Lexington Railway Company, the Kentucky Traction Company and the Blue Grass Traction Company and the Lexington Utilities Company have been consolidated. The new name of the consolidation will be the Kentucky Traction and Terminal Co.

LIBERTY. An electric light plant for liberty is the plan of Herren and Cundress.

LIVERMORE. The installation of an electric light plant is being contemplated by the Smith Cooperage Company of Louisville.

LOUISIANA.

BOGALUSA. It is understood tnat the bank of Bogalusa desires prices on electrical equipment for a bank and office building.

ELTON. The Elton Telephone Company has been organized and will furnish service to Elton and surrounding countries. W. H. Tupper, Geo. Kinver, and S. P. Powles compose tne company.

OPELOUSAS. The municipal electric light plant and waterworks system will be considerably enlarged and the output of the station nearly doubled, by additional equipment.

PATTERSON. The Patterson Light & Power Company has been incorporated with a capital stock of $8,000. A. H. Thompson is president; W. D. Roussel, vice-president; C. S. Williams, secretary and treasurer.

SHREVEPORT. Anderson Offutt of New Orleans has been engaged to make estimates of the cost of constructing a municipal electric light plant at Shreveport.

MISSISSIPPI.

BASSFIELD. Contracts will shortly be let for the erection of a complete system of waterworks for Bassfield. X. A. Cramer, of Mongolia, Miss., is the engineer in charge.

FOLWELL. It is understood that equipment sufficient to provide for the necessary requirements in a saw mill, machine shop, a water system and electric light plant is required by C. W. Robinson and M. C. Anderson, of Folwell.

JACKSON. The Central Cotton Oil Company is in the market for a second-hand, 2,200-volt generator sufficient to give 100 to 150 horsepower.

JACKSON. The Capitol Manufacturing Co., Mr. J. M. Hartfield, president, is in the market for a 20-horsepower, 3-phase motor.

TUPELO.—The citizens voted on April 22nd, a bond issue of $50,000 for the purpose of making improvements to the municipal electric light plant.

NORTH CAROLINA.

BOONE. D. D. Dougherty, principal of the Appalachian Training School desires a small alternator. Information can be obtained from him furtner.

GREENSBORO. The North State Hydro-Electric Co., has been incorporated with a capital stock of $300,000. The incorporators are A. C. Wyckoss, H. L. Parker and S. H. Briggs, all of Raleigh. It is understood that the company is a subsidiary of the Carolina Power & Light Co., and the Yadkin River Power & Light Co.

GREENVILLE. The American Spinning Company is to change motive power of one of their mills from steam to electricity. This will require the installation of 600 horsepower in motors. The plant will be operated by electricity from the Southern Power Company's plant.

HENDERSON. The North State Hydro-Electric Co., of Raleigh, N. C. has taken over the plant of the Henderson Light & Power Co.

SOUTH CAROLINA.

CHESTERFIELD. The Chesterfield Light & Power Company has been incorporated with a capital stock of $5,000 by W. D. Craig, D. P. Douglas and J. H. Welsch.

EDGEFIELD. On June 18th and election will be held to vote on the issue of bonds to the extent of $15,000 for the purpose of installing an electric light plant.

GREENVILLE. The secretary of state has been applied to by the Greenville, Spartanburg and Anderson Railway for permission to increase capital stock from $300,000 to $4,000,000. It is also understood that the company is to construct an electric railway from Belton to Greenwood.

TENNESSEE.

CANTON. Authority has been given by the state legislature whereby bonds may be issued for the construction of a waterworks system.

CHATTANOOGA. W. B. Davis, president of the Industrial School desires prices on a lighting equipment for the school.

CHATTANOOGA. A franchise has been secured by C. E. James for the construction of an electric line in the city of Chattanooga and also of suburban roads leading out from it. It is understood that work will begin within the next six months.

CLINTON. The Tennessee legislature has been petitioned to authorize an issue of bonds for either purchasing or erecting an electric light plant for Clinton.

CUMBERLAND GAP. Plans are underway for the erection of a hydro-electric plant for the purpose of supplying power to manufacturers near Cumberland Gap. The plant will be located on the Cap creek.

BOOK REVIEWS.

ELECTRIC MOTORS. By Francis B. Crocker and Morton Arendt. Published by D. Van Nostrand Company, New York. 291 pages, 158 illustrations. Price $2.50.

This work takes up the action control and application of electric motors and is the outgrowth of lectures on this subject at Columbia University. The aim of the authors has been to present a text on the operation of electrical machinery of service to electrical engineers installing and operating electrical plants. So well have they understood the features of interest to this class of readers that a hasty glance through the volume is only necessary to reveal a compilation of valuable matter arranged in an easily accessible and intelligent manner. While a technical subject has been treated, the explanations of alternating current motors has been accomplished without involving complicated mathematical analysis. This feature makes it a useful reference to the largest number of engineers.

The work covers direct motors, single and polyphase induction motors, synchronous motors, and commutating alternating current motors. About half of the volume is devoted to direct current motors, in which the action and control make up the principal part of the discussion. The portion of the work devoted to alternating current engineering is decidedly complete, numerous curves and illustrations being given in connection with the discussion of any type of alternating current motors. We heartily recommend the work to those who desire a reliable reference on electric motors.

ELECTRICITY, EXPERIMENTALLY AND PRACTICALLY APPLIED. By Sidney Whitmore Ashe. Published by D. Van Nostrand Company, New York. 341 pages and 422 illustrations. Price $2.00.

This book presents the practical side of electrical engineering by means of experiments. Due to the simple and explicit arrangement of the information, the text will appeal to those engineers in practical work who have little knowledge of the theory of electrical apparatus. Due to the fact that the author has been connected with the instruction of practical men, his ideas of the ways to interest them in the subject are well founded and should appeal to those interested. Many of the experiments presented in the volume are those deeloped in connection with educational courses given to employees of prominent lighting companies.

INTERNAL COMBUSTION ENGINES. By R. C. Carpenter and H. Diederichs. Published by D. Van Nostrand Company, New York City. 600 pages and 379 illustrations. Price $5.00.

The third edition of this work has recently been published, tne first two editions being considerably enlarged aand thoroughly revised. The work takes up the fundamental and theoretical principles in regard to construction and operation of the internal combustion engine and describes the various methods of applying these principles to practical construction. Very little material is given on the design of this apparatus, the work dealing principally with the practical features of the subject and arranged in prominent divisions which take up thoroughly the points of interest. The first five chapters are devoted to the theory of thermo dynamics and a discussion of the various cycles. Chapters 6 to 10 take up combustion and fuel mixtures. Chapter 11 and 12 take up the history of the gas engine and describe the important forms now or the market. Chapters 13 and 14 take up ignition and governing. Chap. 15 takes up information in connection with the cylinder dimension of a gas engine to develop a certain horsepower and also information to determine the probable power of any given engine. Chapters 16 and 17 take up the testing of gas engines and the results of tests on engines and producers. The final chapter, which is No. 18, takes up the cost of installation, erection and operation dealing with producers and engines. The work is an important and valuable treatise on the subject of internal combusion engines.

PERSONALS.

PRESTON S. MILLAR, assistant manager of the Electrical Testing Laboratories at 80th St. and East End Ave., New York, has recently made a business trip throughout the Southwest visiting the central stations. Mr. Millar, as a prominent illuminating engineer and general secretary of the Illuminating Engineering Society, is interested in central station conditions especially the advances made in illumination. He expressed himself as favorably impressed with the general illuminating effect produced by Atlanta's Great White Way, mentioning especially the thickness of the opal globes used, as illuminating glare and producing a uniform intensity.

W. M. WHITE, formerly of the I. P. Morris Company of Philadelphia, has become associated with the Allis-Chalmers Company as manager and chief engineer of the hydraulic turbine department. During the past ten years, Mr. White has been closely in touch with hydraulic turbine development in this country and for the past five years has had entire charge of the designing for the I. P. Morris Company, in which position he has designed the hydraulic machinery for some of the largest installations in the country. These include such notable plants as that of the Hydraulic Power Company, and the Toronto Power Company at Niagara Falls, the Great Western Power Company of California, The Washington Power Company of Spokane, Wash., and the Shawinigan Falls Power Company of Montreal, Canada. Mr. White also designed some of the large centrifugal pumps for the

M. O. HUTCHINSON, who for the past 10 years has been closely identified with the electrical supply and contracting business in Atlanta, is to open up June 1 an electrical supply house in the Rhodes building. The firm will be known as the Fulton Electric Company and a general electrical supply business both retail and wholesale will be carried on.

OBITUARIES.

ROBERT WEBB MORGAN died suddenly of pneumonia on April 17, after an illness of only six days. Mr. Morgan was born at Tarrytown, N. Y., 1864, his father being N. Dennison Morgan, one of the leading financiers of New York of his time, and a founder of the Mutual Life Insurance Company. His mother was a daughter of the late Gen. James Watson Webb, minister to Brazil. Mr. Morgan was educated at St. Paul's School, Concord, N. H., and later at Garden City, N. Y. Previous to his engaging in the electrical business, he was purchasing agent for the Wagner Palace Car Company. After the consolidation of this company with the Pullman Company, he organized and was president of the Globe Printing Company. In 1901 he established the Anchor Lamp Company, and was its president; and in 1908 the Aetna Lamp Company, of which he was also president. Mr. Morgan lived at Bronxville, N. Y., and was buried at Kensico, N. Y. He leaves a widow. He was a member of the Society of Colonial Wars, and was of the charter members of the Military Order of Foreign Wars of the United States, of which organization he was deputy secretary.

The friends of James Rutherford Gordon and those connected with the electrical industry in the South were grieved to learn of his sudden death at Savannah, Georgia, on May 16th, 1911. Mr. Gordon was born in Canada 56 years ago and has been actively connected with the electrical business throughout his life. For 25 years he was associated with the sales department of the Westinghouse Electric & Mfg. Co., being district manager of the Southeastern States with headquarters at Atlanta for over 12 years. In 1908 he resigned from the Westinghouse Electric & Mfg. Co., and became district Power Apparatus Sales Manager for the Western Electric Company with office at Atlanta also. After filling this position for about a year and a half Mr. Gordon resigned to take up important work in connection with hydro-electric development. He was a high degree mason and influential in various circles taking an active part in the recent formation of the Travelers' Bank and Trust Co.

He is survived by a wife and son, Jno. H. Gordon. The interment took place at McKeesport, Pa., on May 21st.

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SOUTHERN ELECTRICIAN

PUBLISHED MONTHLY

Vol. 43 JULY, 1911 No. 1

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Low Power Factor Loads.

A more or less familiar engineering problem in connection with a central electrical system, is the condition brought about by complex industrial requirements. With the increased use of the induction motor and other induction apparatus on which the load is not always maintained at or near its rating, these conditions are emphasized and an unfavorable power-factor the result. Evident as these conditions seem to be in most plants, it is strange to note that they are often indifferently considered.

Ultimately two serious difficulties result. The capacity of the electrical part of the system is limited by loading it up with unproductive current, that is, current from which no revenue is derived and the voltage regulation is impaired. The rating of electrical apparatus depends primarily on the heating produced by the load and this heating depends entirely upon the current. The current load on a generator will only correspond to the energy load on the prime mover when the kilo-volt-amperes equal the kilowatts or when the power-factor is 100 per cent. At any lower power-factor a generator carries more load relative to its rating than the prime mover.

Unequal loading of generator and prime mover is not the only bad effect of low power-factor. The revenue of the station is effected since the customer measures power by a wattmeter and refers to the kilowatt station load instead of the kilo-volt-ampere load. These particular conditions referring to power-factor and its relation to size and efficiency of prime movers, generators and conductors, have long been understood, however, commercial methods to raise the power-factor of systems having induction motor and transformer loads, have not kept pace in the past with the progress of other improvements in the generation and transmission of energy. Elsewhere in this issue the electrical relations of alternating current motors are taken up and the beneficial results from the operation of the synchronous motor when used as a rotary or synchronous condenser where low power factor exists, commented on in some detail. That central station managers are beginning to recognize the value of synchronous motors on their systems is shown by the increased use of this type of motor in motor generator sets, in industrial applications where large units are required and particularly in recently successful installations where they are used running without mechanical loads entirely for the corrective effect as a synchronous condenser.

There is little excuse for the low power factors found in so many plants at present and the state of affairs would not exist if all the features were generally realized. The relative cost of synchronous condensers as compared with the investment losses in generators and conductors through low power factors, depends of course, upon the percentage of inductive load on a system, however, where there is a suitable mechanical load for the synchronous motor, there is now little question regarding the advisability of installation with improvement of power factor a consideration.

American Switchgear Structures and Distant Control Apparatus.

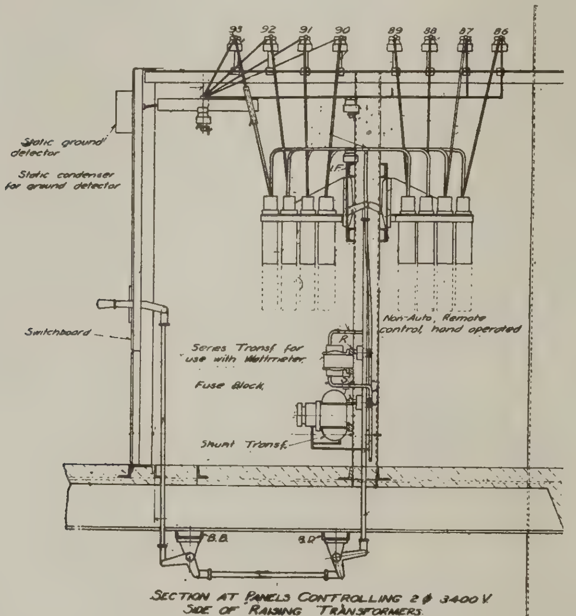
(Contributed Exclusively to SOUTHERN ELECTRICIAN.)

BY STEPHEN Q. HAYES.

THE PROPER location and arrangement of the structures for switchgear, busbars and wiring in electrical power plants, is a feature of great importance in their design, particularly where the station is of such size as to require the use of the distant control apparatus. In nearly all direct current power plants and in most of the smaller alternating current stations in America, the switching appliances are located on panel switchboards and the proper location of the apparatus is a comparatively simple problem and is practically determined by the location of the panel switchboard.

In alternating current installations when the voltage exceeds 2,400 volts or the amount of power is more than 2,500 K. V. A. it is frequently found necessary to take more space for the switching equipment than can be found on the back of a panel board and this naturally led to the development of distant control apparatus. As the voltage or amount of power increases beyond the figures just mentioned the use of distant control apparatus becomes more nearly universal. In plants of moderate size, hand operation is usually employed but when the amount of power reaches 10,000 K. V. A. or more, some auxiliary source of power, usually electrical, is found advisable owing to the physical exertion required to manipulate large apparatus, the desirability of concentrating the control of scattered apparatus or for other similar reasons.

Instead of attempting the description of the many types of panel boards, control desks, pedestals and posts comprised under the broad term of "switchboards," or the switches, circuit breakers, rheostats, meters, etc., comprised under the term "switchgear," this article deals exclusively with the "layout" or the arrangement of the structures for the breakers and busbars as well as the relative location of the generators, transformers, feeders and switchgear. The different manufacturing companies have their own methods of arranging the switchgear to best advantage, and local



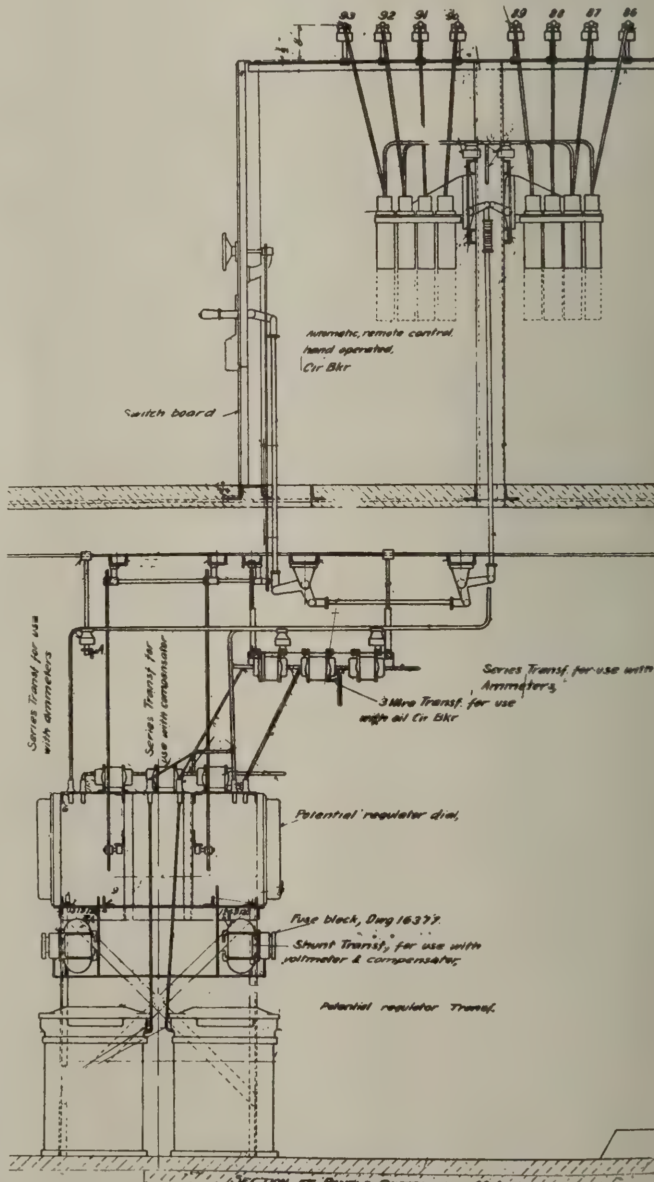


FIG. 1. CIRCUIT BREAKER STRUCTURES OF MANILA CONSTRUCTION CO.

This article is the first of several on the subject of American Switch-gear Structures to appear in these columns. The subject forms a part of division three of an exhaustive article on switch-gear structures submitted to the Electrical Age previous to its consolidation with Southern Electrician. Part one, describing switch-board panels, pedestals, and control desks; part two, describing circuit breakers and other apparatus, and that section of part three describing general features of circuit breaker and busbar structures, and examples of European structures, were published in the Electrical Age of January, February, March, April and May, 1910. The subjects to be discussed in the following articles are the requirements and general conditions in American plants using switch-gear structures on systems of 2,200 volts up to 120,000 volts.—Editor.

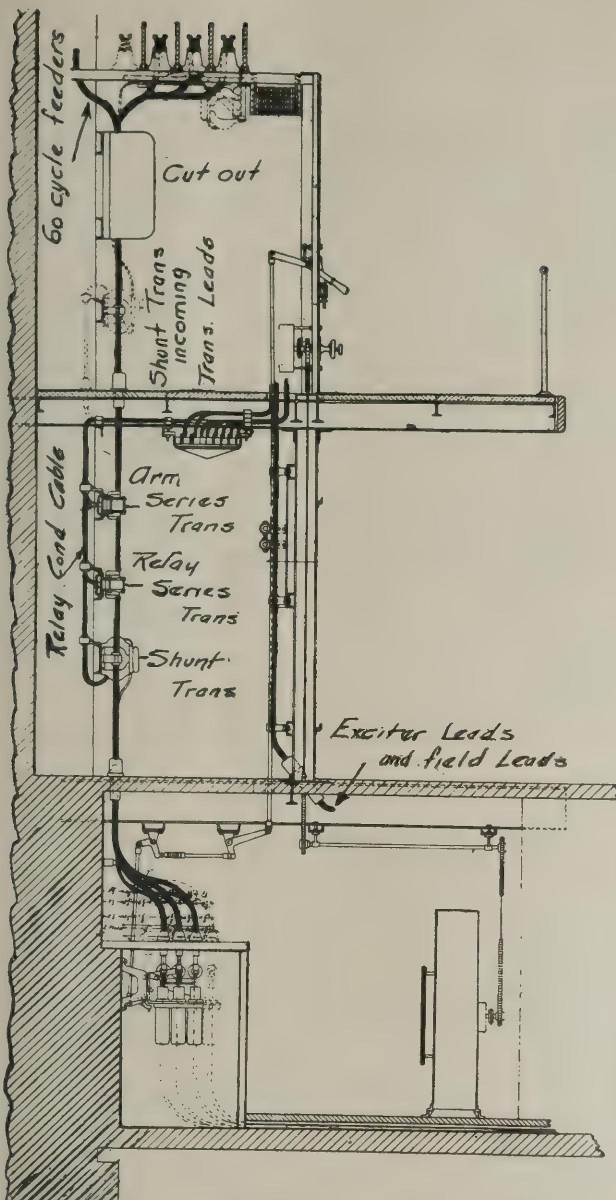


FIG. 2. SWITCH GALLERY OF SHAWINIGAN WATER POWER COMPANY.

conditions as to space available, arrangement of building and similar features modify the arrangements. While there are many manufacturers of switchgear in America, most of the large stations are equipped with switching apparatus furnished by one or other of the two largest manufacturers, and as it is obviously impossible to show all of the designs of both companies, a fairly complete series of the designs of one company is illustrated and described.

While various types of switchgear have been developed from time to time to handle alternating current circuits of large power and high voltage, the oil switch and oil circuit breaker have practically superceded all other types of switchgear for alternating current service. In most cases the circuit breakers, particularly for high voltage, are arranged with each pole of the breaker in a separate compartment, and the busbars and connections are almost invariably arranged so that each phase occupies a separate compartment. The smaller breakers are, however, arranged either with all contacts in the same tank or with each pole of the breaker in a separate tank but all tanks in the same compartment.

In the smaller oil breakers, both hand operated and electrically operated, the leads are brought out of the top of the tank and the breakers are designed so that they can be attached to a wall or metal framework, or can be placed in a structure and the breakers can be arranged with all the poles in the same compartment or with each pole in separate compartments. Owing to the general similarity in the design of these small breakers the station layouts shown for this class of work are fairly typical of American practice. For large capacity breakers of moderate voltages, the designs of the two largest companies are radically different due to the fact that one type of breaker has its leads brought out at the bottom while the other has its leads leaving the top of the tank and taken out through the back wall of the structure to permit the connections being run up or down. This difference in the manner of bringing out the leads is the cause of considerable difference in the design of the circuit breaker and busbar structures used with these breakers. The same remarks hold true regarding the high voltage breakers of large capacity, one type being bottom connected and intended to be placed in a masonry structure, while the others are top connected and self-contained. Unless otherwise stated all of the following descriptions and illustrations show top connection equipments, with one example to facilitate the direct comparison of the arrangements used with different types of breakers.

A typical arrangement of distant mechanical control applied to circuit breakers and step type potential regulators mounted on a metal framework is shown in Fig. 1. This type was the installation supplied in 1904 to the Manila Construction Co. The view on the left shows a section through the 3,400-volt two-phase feeder circuits. Each feeder is provided with two 4-pole oil circuit breakers so that it can be connected to either of two two-phase busbars. Sprocket operated face plates with suitable transformers form two single-phase potential regulators to allow for the independent regulation of the voltage on the two phases. The shunt and series transformers for the ammeters, voltmeters and compensators are located in the basement on suitable framework.

The arrangement of the switching galleries shown in Fig. 2 is in the Montreal receiving station of the Shawinigan Water & Power Co. This board erected in 1903 controlled some 800 K. W., 2,300-volt, frequency changer sets while the later additions with electrically operated oil breakers took care of some larger sets. The panel board on the operating gallery contained the handles for the oil breakers, located in concrete compartments in the basement, and hand-wheels for the sprocket operated rheostats also in the basement. The main alternating current busbars were located on porcelain insulators supported on braces and separated by barriers. The disconnecting switches separated by barriers were located on the back wall of the operating gallery while the series and shunt transformers, exciter, busbars, leads, supports, etc., are located back of a grill work partition on the main floor. The hand operated breakers used in this installation had all of their poles located in the same compartment.

As a final example of distant mechanical control for circuits of moderate capacity, Fig. 3 shows a section through the switching platform of the Atlanta Water Power Co. This plant installed in 1904, contains 7—1,500 K. W., 2,200-volt, 25-cycle, three-phase generators, 6—1,500

K. W., 2,200/22,000-volt, single-phase step-up transformers and two transmission lines. The breakers used in this installation had each pole in a separate compartment and the two sets of three-phase busbars were provided with barriers, supports and connections arranged in the manner shown. Ordinarily in a plant of this size a somewhat greater amount of space is desirable for the breakers and busbars than was allowed in this case but all of the steel work for the gallery had been ordered before the design of the switching gallery had been determined.

Some of the installations of the smaller electrically operated breakers that follow have been practically duplicated with hand-operated equipments, so the descriptions and cuts with a few minor modifications would apply to either type of control. Fig. 4 shows the front and rear elevations and section of a part of the structure supplied for use with the breakers and busbars on the new Terminal Station of the railroads running into Washington, D. C. This equipment is used for the control of four 500 K. W., 2,300-volt, 3-phase generators, nine 3-phase feeders, and six 1-phase feeders. While the capacity and voltage of these machines would have readily permitted the use of hand-operated oil circuit breakers, other considerations caused the adoption of electrical operation for the breakers and the enclosing of the busbars. The relative location of the circuit breakers, disconnecting switches, series transformers, shunt transformers, busbars, etc., are clearly shown in this cut. The busbars of laminated copper strap are supported on petticoat insulators and porcelain floor tubes are used for insulating the leads where they pass through the back wall of the structure. As may be noticed, the breakers used are self-contained and all three poles are in the same compartment, the disconnecting switches are mounted directly on soapstone bases.

The front, side and rear views of a structure for 3-phase, 6,600-volt solenoid operated oil circuit breakers having an ultimate breaking capacity of 10,400 K. W., is shown in Fig. 5. The fireproof masonry compartments and the busbars, connections, etc., are separated by shelves, walls, septums, etc., in such a manner that no two conductors of opposite polarity are in the same compartment. As may be noted the busbars of laminated copper strap are supported on the insulators that act as bushings for the leads through the walls. The disconnecting switches, partly

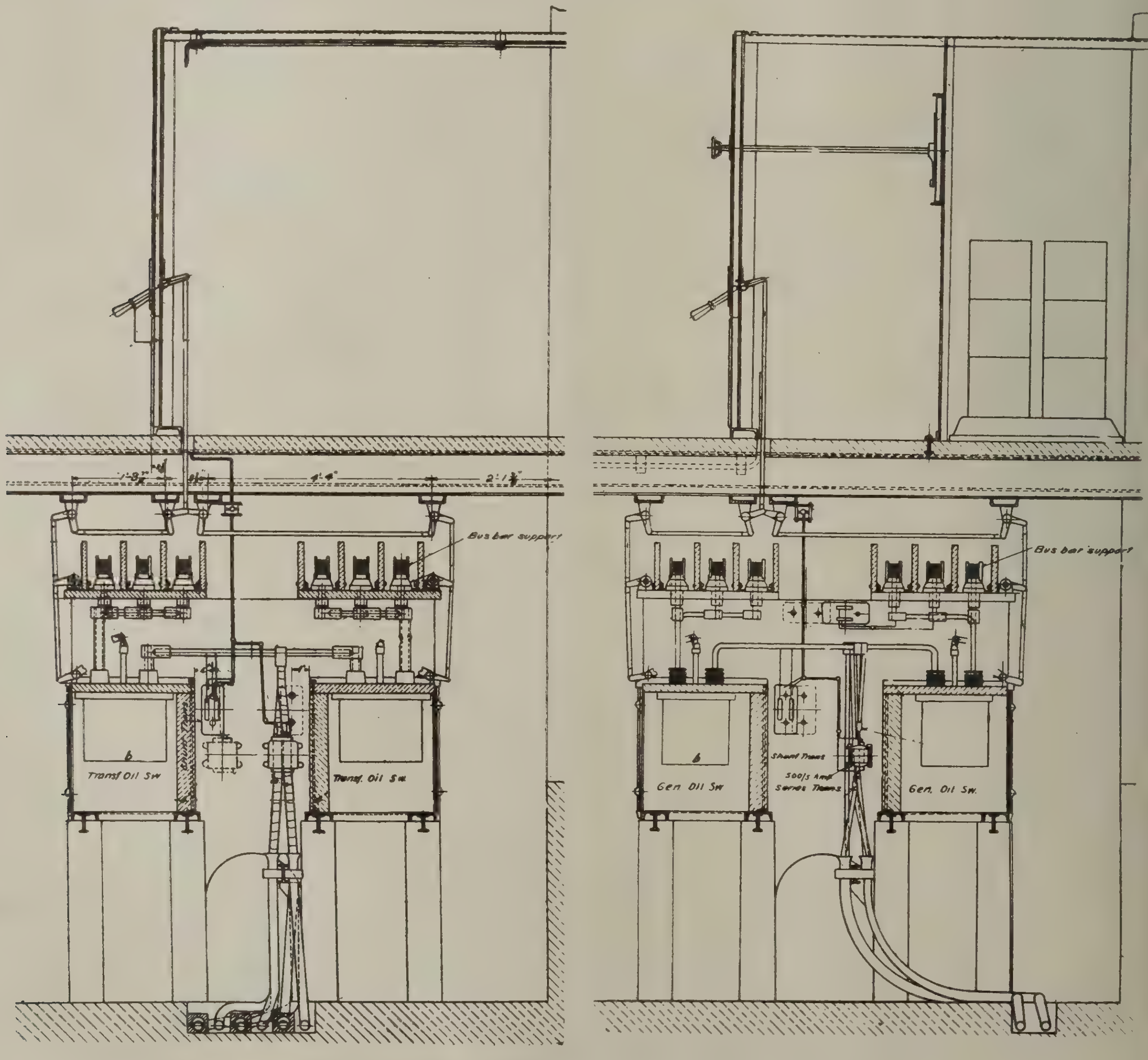


FIG. 3. SWITCH GALLERY OF ATLANTA WATER POWER CO.

front connected and partly rear connected, were mounted on porcelain pillars placed on soapstone bases and arranged for completely isolating any breaker.

The switching gallery as originally installed in the plant of the Union Electric Light & Power Company of St. Louis, controlled a large number of large capacity 6,600-volt generators and feeders. In this plant, one of the earliest installed with this type of switchgear, each generator and feeder circuit was provided with one main breaker and a pair of selector breakers so that there were always two breakers in series between any generator or feeder and the busbars. The large electrically operated oil circuit breakers have been found so reliable that the use of two circuit breakers in series has usually been found unnecessary and these additional breakers have been dispensed with in most large plants of recent design. The generator control pedestal, the instrument posts, the feeder panels and the generator breakers, both main and selector, as well as the generator busbars are placed on the top floor, Gallery C. The main busbars are located on the first mezzanine floor, Gallery B. The feeder selector breakers with their disconnecting switches, and the electrically operated field rheostat face plates and resistances are located on the second mezzanine floor, Gallery C. The feeder main breakers and the exciter switchboard are located on the engine room floor.

The generator, control stands and instrument posts are so located on the top floor so that the operator faces the engine room and can watch the action of the machine he is controlling. Within the last few years the front of this gallery has been enclosed in glass and the instruments located on panels attached to the framing of the windows. The three conductor generator leads were brought under the engine room floor to cable bells located just above the floor line. From this point single core cables were run up the pilasters to Gallery C and in the false floor to the series transformers of the main generator breaker. These generator breakers were arranged in groups of three side by side, the current passing through the main breaker to the generator bus above it. The current from this generator bus passes through either or both of the selector breakers to either the front or rear bus on Gallery B or to both buses.

The feeder breakers on Gallery A are provided with selector knife switches so interlocked that the breaker can be connected either to the front bus or the rear bus but not to both. The feeder breaker on the main engine room floor is connected in series with the breaker on Gallery A and the cable bells for the three conductor feeder cables are located in the back of these breakers.

In the location of the various series transformers, shunt transformers, fuse blocks, busbars, supports, floor tubes, great care has been taken to carefully isolate all busbars, leads and transformers, by means of shelves, septums and

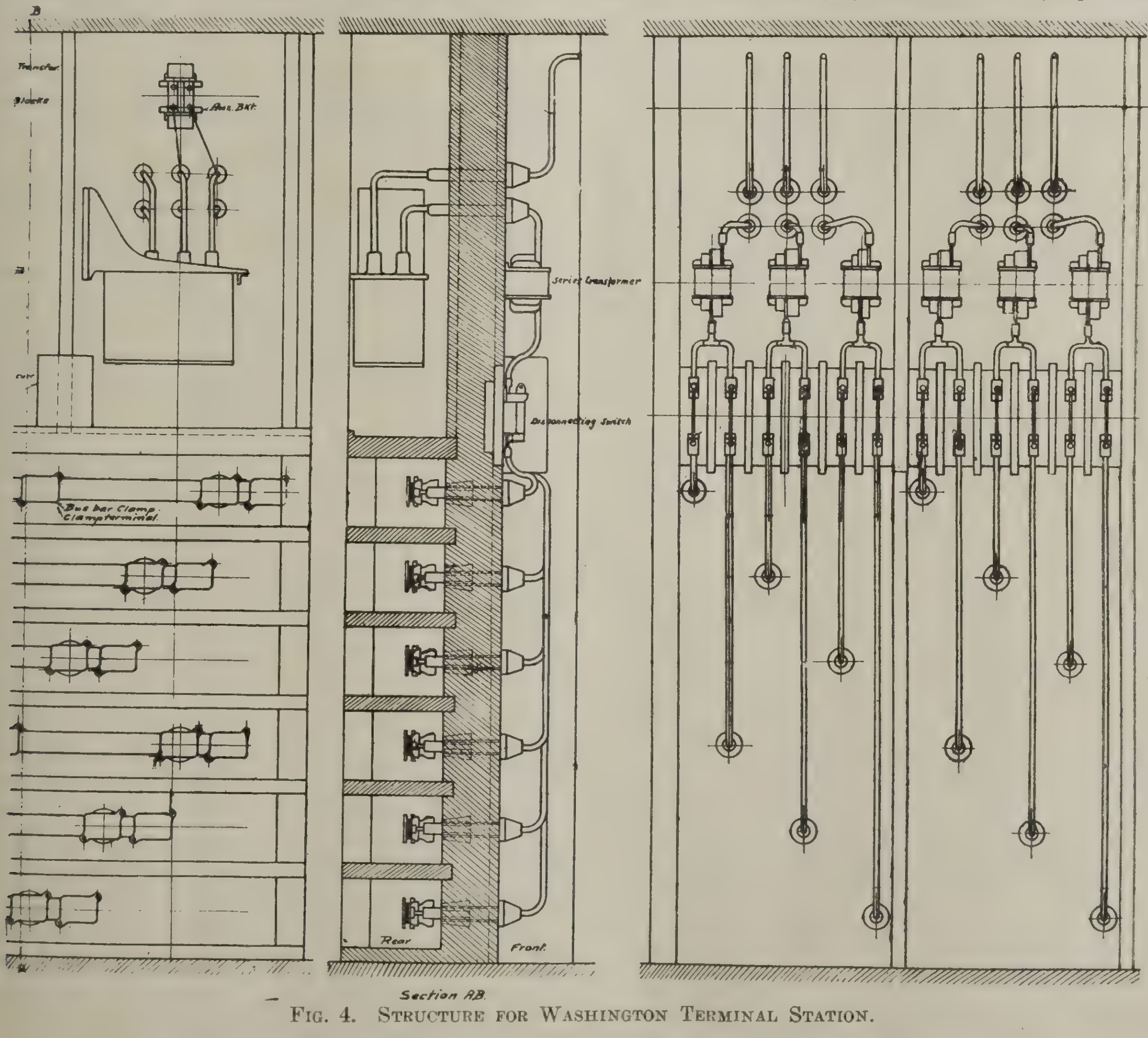


FIG. 4. STRUCTURE FOR WASHINGTON TERMINAL STATION.

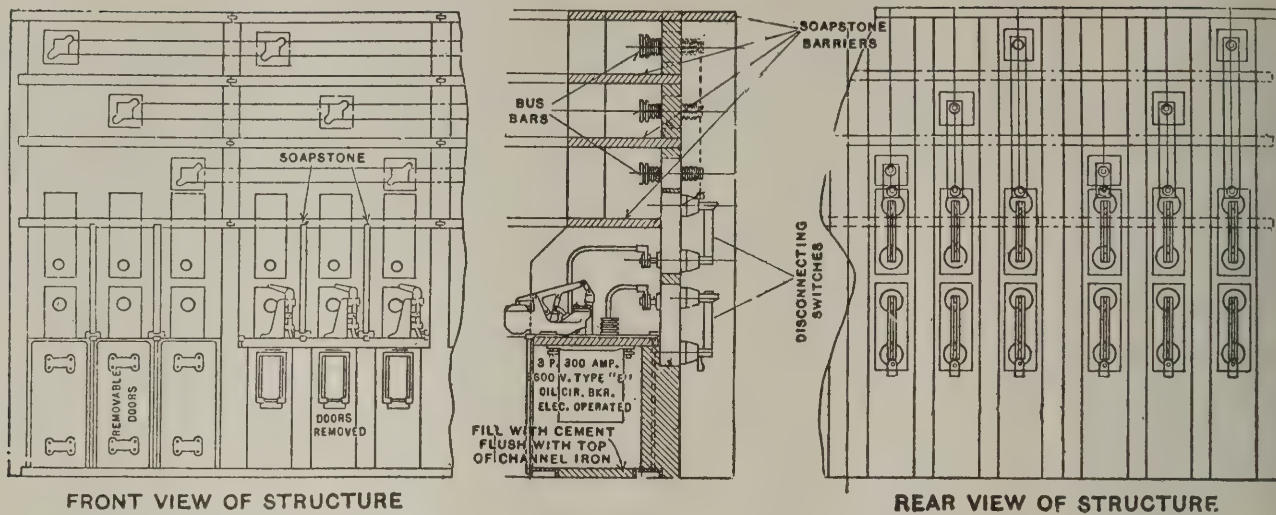


Fig. 5. Structure for Small 6,600-volt Installation.

barriers, so that no two conductors of different polarity may be in the same compartment. The busbars and wiring while completely isolated are not completely enclosed, but are visible and accessible without removing any doors.

Fig. 6 is a section taken through the switching galleries of the Williamsburg Power House of the Brooklyn Heights Railroad, and shows the arrangement of the oil circuit breakers, busbars, series and shunt transformers. As may be noted, the busbars are located in a gallery between the two breakers, and are completely enclosed except for doors that are placed opposite each terminal and insulator, and in front of the disconnecting switches. This station at present contains two 7,500 K. W., 25 cycles, 6,600 volts, 3-phase turbo generators, three 10,000 K. V. A., 6,600 volts, 3-phase turbo-generators, and provision is made for five additional turbo-generators each of which will prob-

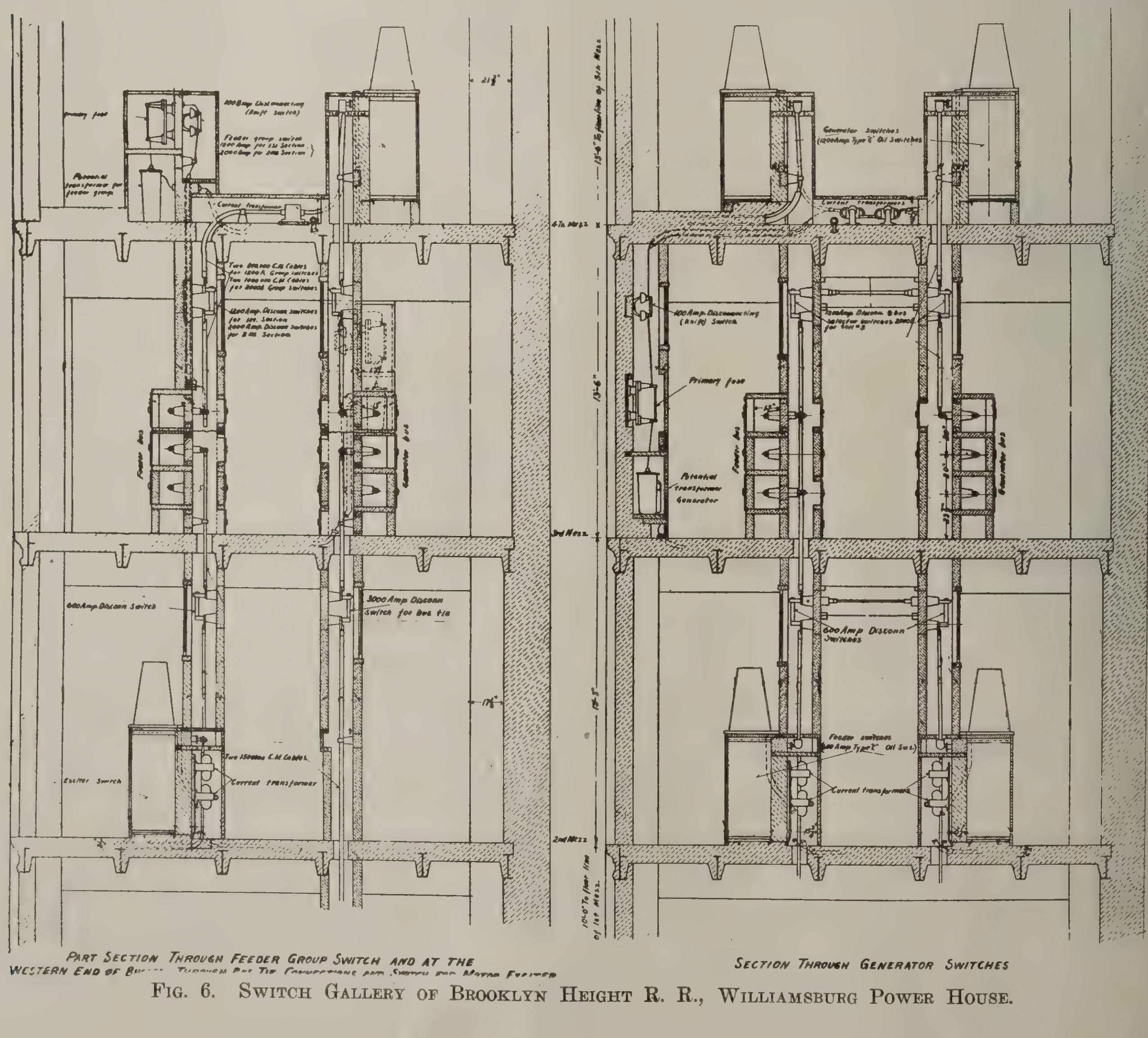


Fig. 6. Switch Gallery of Brooklyn Height R. R., Williamsburg Power House.

ably be of 10,000 K. V. A. capacity. It is probable that the three-phase generators that are now connected for 6,600 volts will later be reconnected for 11,000 volts and all of the circuit breakers, busbars, and disconnecting switches, have been designed with this end in view.

As shown in the right hand portion of the cut the generator circit breakers are located on the top gallery and the leads are brought in suitable ducts to this point. The current transformers for the generator circuit are located under a false floor and the leads after passing through these transformers go into the oil circuit breakers, and then drop down through the floor to disconnecting switches, and to the busbars. In addition to the generator breakers on the erator bus, which generator bus can be connected through a second breaker to the main bus or through either of two other breakers to two sets of group buses, each group bus supplying current to five feeder circuits. The generator busbars are located directly above the breakers in the upper gallery. The main busbars are the top sets on the middle gallery and the feeder group busbars are the lower sets on the middle gallery.

As may be noted the bus structures are arranged back to back in such a manner that the main busbars form one continuous ring sectioned by means of knife switches and circuit breakers while the group busbars can b~ ɔonnected to form a second ring.

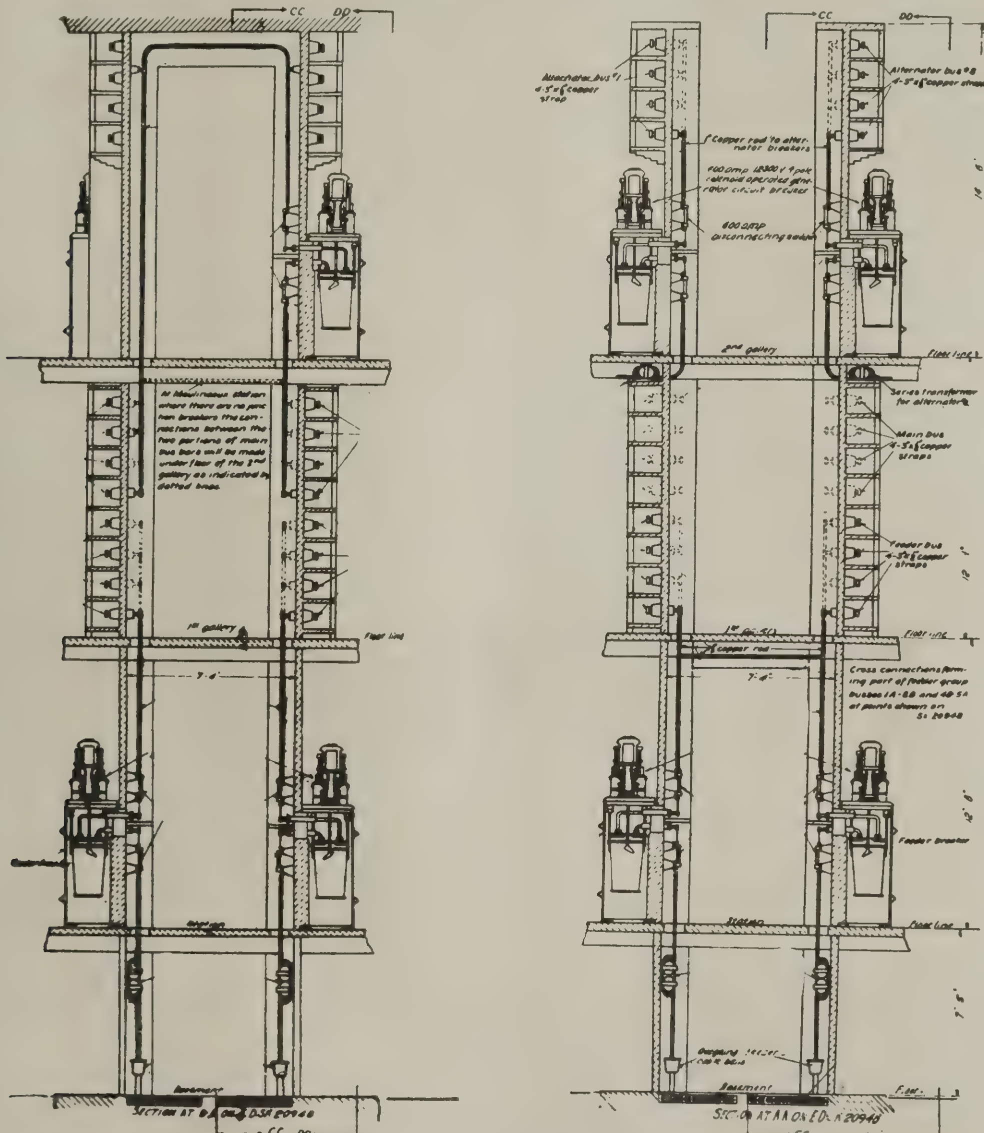


FIG. 7. STRUCTURE FOR 12,300-VOLT PROPOSED PLANT.

top gallery, group breakers are also installed, while on the lower gallery are located the feeder breakers, and the bus tie breakers.

In Fig. 7 is shown the front view and the section through the switching galleries of a proposed heavy capacity 12,300-volt two-phase generating station. This station has been designed to contain the necessary switching equipments for the control of 8—8,000 K. V. A. turbo generators and forty feeders with a large number of local service circuits. The connections are so made that each generator feeds through its own circuit breaker on to a generator bus

With the arrangement shown in Fig. 7 the disconnecting switches for isolating the individual breakers are located directly in the masonry compartments back of the breakers so that it is practically impossible for trouble to arise due to the station operator pulling the wrong disconnecting switches when he desired to inspect or repair a breaker.

The continuation of this subject will take up other systems and include a discussion of open and closed systems of wiring for voltages above that for which generators can be wound.

Report of the N. E. L. A. Convention at New York City.

(*Reported Especially for Southern Electrician.*)

BY G. C. RAMSEY.

THE THIRTY-FOURTH convention of the National Electric Light Association, although now a thing of the past, looms up in our recollection after a casual survey of things that took place, as one of the most successful and beneficial gatherings that could be hoped for in the interest of the central station industry. Larger and more influential in every way, the Association has become year by year, until the record of the past year, the first of its second quarter century, as to increase in membership stands at nearly 45 per cent of the total enrollment, at present 8,800.

The New York Convention was held at the Engineering Society's Building, the commodious assembly rooms of which provided excellent accommodations for the large gatherings at each session. The Foyer on the ground floor of the building, was devoted to registration. Here the delegates claimed their badges, papers, etc., and those who had not registered by mail went through the usual formality. In accordance with the general plan of previous registration details, each male registered was presented with an envelope, containing badge, a copy of the proposed proceedings, and an entertainment program. Each lady registered received an envelope containing a badge in the form of a neat pin, an entertainment program, and a beautifully printed and illustrated book entitled "Glimpses of New York." Although the Convention held at St. Louis last year was considered at that time a decided success and a record breaker for the Association, the total registration by mail this year was 2,754, a number larger by over 100 than the total registration at St. Louis. The final registration at New York of 5,150 members makes a decidedly new record for numbers of members gathered for a Convention as yet.

The New N. E. L. A. President, John F. Gilchrist.

The following statements as to the past and present of the new N. E. L. A. president is taken from the N. E. L. A. Convention Daily.

Mr. John Foster Gilchrist, promoted from first vice-president to be president of the National Electric Light Association is a man who has made the electric-service industry his life work and who has won his spurs on merit. He is assistant to the president of the Commonwealth Edison Company, Chicago, and takes an active part in the administration of that large and progressive organization, being, among other things, chairman of the advisory committee of the company. He is a native Chicagoan, having been born in that city March 14, 1868, and throughout his entire business career he has been connected with the Commonwealth company and its predecessor, the Chicago Edison Company.

Mr. Gilchrist obtained his secondary education in the Chicago high schools and later in the law department of Lake Forest University. He entered the service of the Chicago Edison Company as an office boy in 1887, and he has been connected continuously with the company from that time until now, working up to his present responsible position by his own ability, resourcefulness and energy. From 1894 to 1896 he was assistant to the manager of electrical sales, and in the year last named was made contract agent for the company. In this capacity Mr. Gilchrist made a notable record, and in 1906 he was promoted to be assistant to the president, a position he still occupies. Mr. Gilchrist has, however, other business interests, being secretary of the Economy Light & Power Company, of Joliet, Ill.; treasurer of the Federal Electric Company and the Federal Sign System, and second vice-president of the Illinois Valley Gas & Electric Company.

Mr. Gilchrist has been active in the affairs of the National Electric Light Association for a number of years,

JOHN FOSTER GILCHRIST, PRESIDENT OF N. E. L. A. AND ASSISTANT TO PRESIDENT OF COMMONWEALTH EDISON COMPANY.

having served successively as secretary and treasurer, second vice-president and first vice-president, and he is now entering on the administration of the highest office in the gift of the association. At the Atlantic City convention of 1906 he contributed an elaborate illustrated paper on "Electric Signs," which was, in fact, an exhaustive report on the electric-sign service of the country at that time. In this paper the author spoke of electric signs as a highly desirable source of business for the electric-service company. The free installation of signs was recommended, as were the employment both of canvassing solicitors and of advertising to get the business. Where harmful ordinances and unfavorable city councils are encountered, the experience of other cities, Mr. Gilchrist held, should be cited. A number of tables containing statistical information were given, together with an outline of a city electric-sign ordinance and a sign-lighting contract, forming a useful compendium.

The report of the committee on rate research, presented by Mr. Gilchrist as chairman at yesterday morning's general session, is a brilliant and exhaustive study of the rate problem confronting American electric-service companies. In addition to his activities in the parent association, Mr. Gilchrist has taken a lively interest in the Commonwealth Edison branch of the National Electric Light Association, which has had a remarkable growth and is one of the largest company branches in the association. Nor has he confined his society work to this association. At the Baltimore convention of the Illuminating Engineering Society, held in October of last year, he read a paper on "Practical Value of Illuminating Engineering to the Central Station."

In 1896 Mr. Gilchrist was married to Miss Emma Lock Boyd and they have two children. In addition to his membership in the National Electric Light Association, Mr Gilchrist is an associate of the American Institute of Electrical Engineers and a member of the Illuminating Engineering Society, of which he has served as a director. He is also a member of the Union League, Chicago Athletic, Chicago Yacht, Homewood Golf and South Shore Country clubs in Chicago and the Industrial and Engineers' clubs in New York. Altogether he is an excellent example of the men of affairs who are bringing things to pass in American electrical accomplishment of the present day.

Convention Proceedings, General Sessions.

The formal call to order of the convention took place Tuesday morning by the introduction of John Puroy Mitchell, President of the Board of Aldermen, who welcomed the Convention to New York City, on behalf of the Mayor and its citizens. Mr. Mitchell said that the city was indebted to the electrical industry for municipal and individual comfort, wealth and progress, and that the city of New York seldom was privileged with the opportunity of extending a welcome to an organization of such national scope. He expressed a hope that each day of the visit would be enjoyed and of as much pleasure and value as it would be to the city, giving able expression to the results which would be derived from the adoption of plans to facilitate civic and general economic progress. President W. W. Freeman answered the welcoome to the city in fitting terms. He then appointed J. F. Gilchrist to the chair while he delivered his annual address. In his review of things which happened during the past year, President Freeman said that the Association's present membership of over 8,500, put it in the lead of electrical and engineering associations of the world. He further stated that, in his opinion the several years to come will increase its membership to at least 25,000. The natural evolution of the organization has pointed out imperative needs for changes, which must soon be anticipated and considered carefully. The problem of meeting en masse presents constantly increasing difficulties, and while there is inspiration in a large meeting, there is also some disadvantages in loss of individuality and in loss of that free discussion which is possible only in smaller meetings. Furthermore, the increased expense of the annual meeting is not unimportant.

Referring to geographical and company sections he pointed out that with the increased growth of such sections they would in the future probably cover satisfactorily much of the important educational work now performed by the national organization. The suggestion is, therefore, that ultimately the national convention should be limited to numbers of representatives of member companies, the purpose being to discuss broad questions of policy and issues of common interest without reference to details of engineering and commercial practice. The field for such work is within the scope of the conventions of the geographic and other sections. The policy of national special sections was outlined such as the present commercial and power transmission sections, stating that the geographical sections are generally too restricted to provide comparative experience to both large and small companies. Both ideas are in operation and working toward the ultimate solution of the problem at hand.

The company section idea by its tremendous growth has proven sound and successful. The geographic sections are growing in favor, several of such sections having been formed during the past year with others in prospect for the immediate future. In referring to the national special sections of the Association, including the commercial and the power transmission section, President Freeman stated that these sections have made their influence felt as was especially notable in the public conference in New York, on April 8, where there was an important discussion of the proper attitude of the Government toward the development of water powers. He praised especially committee work, stating that never before had the Association had so many committees and never before had they been so distinctively active and efficient in their duties. Commenting upon the report of the Public Policy committee, Mr. Freeman said that this report speaks for itself, and places it in the forefront of modern industrial advancement.

The concluding remarks of President Freeman, included an expression of appreciation for support received during the year from Secretary Martin and the office staff of the Association. He said that a clearly recognized feature of the electric lighting business is the enthusiastic loyalty of its men. No other industry has succeeded in attracting so many young men of talent and enterprise, embued with the conviction that theirs is the best business in the world and holds the largest opportunity for advancement and rewards. He voiced the opinion that the record of the first quarter century of the business, great as it may appear, is only a start and that the past achievements are but promises of future accomplishments.

Every seat in the auditorium was occupied during President Freeman's address, and it was received with great appreciation and applause. Upon its conclusion, Arthur Williams of New York made a motion to refer it to a committee for consideration, the committee to make its amendments. Such action was taken and the committee appointed, consisting of H. M. Byllesby of Chicago; A. A. Dion of Ottawa, Canada, and Geo. H. Harries of Washington.

The chairman of the entertainment committee, Arthur Williams, of New York, reported on the entertainment arrangements and expressed the hope that the reputation which New York has held in the past as a cold and undesirable city in which to hold conventions should be eliminated. After Mr. Williams, the report of the committee on membership was presented by H. H. Scott. According to his report, the Association has a total membership of 8,665, a gross gain in new members during the year of 3,914. The company sections have a total membership of 5,440, indicating that the growth will come largely in the future from the formation of company sections.

The report of the Association's secretary, T. C. Martin, showed the immense amount of work handled by the Association's offices as the result of the increasing growth and expansion of activities of the Association. During the last year, 7,000 copies of the proceedings have been circulated and the monthly bulletin now nearly 100 pages, has reached a circulation of 10,000. The Question Box revision has been finished and the work will be issued in book form. The standard classification of accounts adopted by the Association has been put into book form, also a revised edition of the solicitor's handbook has been completed. All this has been the work of the past year.

The report of the insurance expert, W. H. Blood, Jr., of Boston, emphasized the fact that comparatively little attention has been paid to the scientific rating of electirc light and power risks by the underwriters. Few of the bureaus have adopted the new schedule brought out by the Central Traction and Lighting Bureau of last year with a base rate of 8 cents in place of rates running from 25 cents to $1.25. Among those adopting it, is the Southeastern Underwriters Association. Mr. Blood stated that the schedule has affected a reduction of approximately 35 per cent in premiums, and urged that members endeavor to have it applied to their properties, where superior construction so warrants.

The scheduling of the report of the committee on overhead line construction for the technical sessions made it unnecessary to go into this matter exceept by abstract. Farley Osgood of Newark, N. J., brought out the fact that the work represents three years of labor and has been approved officially by telegraph, telephone and railway companies.

The report of the committee on uniform accounting was given only in abstract by J. L. Bailey of Baltimore, since it came up for consideration and discussion in the first accounting section. The abstract will be found in this issue under that heading.

The report of the Association's Secretary, T. C. Martin, on progress covered 98 pages and contained as usual the meat of information on the industry in this country and abroad. The abstract of the report read by the author, showed a general growth of the industry in the United States, comparing same with England, Germany, Austria, Belgium, Switzerland and Japan. The questions of regulation, rates and franchises as affecting electric light and power companies were touched upon as well as the important question of conservation and its meaning. The advancement and development in new generating stations and systems which have been evidence of the past year's activities were taken up in some detail. Illumination and other problems affecting central stations, were dealt with, making the report one from which considerable benefit can be derived through a careful study.

A paper entitled, "Masters and Men," by Paul Lupke of Trenton, N. J., was read by Secretary Martin and represented observations as the author so states of one place between the upper and nether millstone. Commenting upon welfare work in general, it was Mr. Lupke's opinion that any such work no matter how liberal its construction, should be surrounded with safeguards, the necessity of which is apparent to masters but baffling to men. The report was an emphasis on the state of affairs which exists, namely, that a large number of masters do not realize the condition of men whose wealth varies from maximum to zero, or even to a negative quantity between times of pay days.

The presentation of the portrait of Miss Harriet Billings, the assistant secretary and treasurer of the Association, whose valuable services the Association has enjoyed since 1891, followed Mr. Lupke's paper, W. T. L. Eglin, of Philadelphia, giving presentation remarks. The painting is a gift of H. L. Dougherty, of New York.

SECOND GENERAL SESSION.

The second general session was called to order by President Freeman Tuesday afternoon at 2:30 o'clock. The report of the Bulletin and Question Box by the editor, M. S. Seelman, Jr., of Brooklyn, took up the work connected with editing the Question Box and caring for the correspondence. Mr. Seelman emphasized the value of the Bulletin as a clearing house of information, register of progress and record of the organization's doings, and emphasized the desire to meet needs of members by supplying information. The report on Question Box revisions by Paul Lupke, of Trenton, N. J., was presented by A. J. Campbell, of New London, Conn. The publication is soon to be issued, and will be the first step toward the compilation of a hand book of considerable value to the operating engineers in connection with the industry. Arthur Williams, of New York, on behalf of the Library Committee, referred to the continued gifts of W. D. Weaver, editor of the Electrical World, to the N. E. L. A. library. It was the opinion of the committee that the best policy for the library is one of co-operation with the Engineering Society's Library, by contributing a stated sum yearly for purchase of publications of particular interest to the central station industry.

The report of the handbook committee was presented by Geo. Williams and emphasized the addition of electric vehicle, load factor, diverse factor, garage and illumination material in the latest issue. The handbook has been made up to provide the solicitor with principles of central station practice, technical and commercial, and should be particularly valuable to those stations where no expert illuminating engineer is available in the organization. Considerable discussion was entered into as to the best means of adding additional material to the handbook, a loose binder on the original copy was suggested and a suggestion offered that a new bound volume be distributed at intervals throughout the year, providing there was any considerable revision required. The general consensus of opinion seemed to be that the best plan would be to send out an entire new page to take the place of the page containing obsolete matter, the old one to be cut out and the new one pasted to the old stub. The matter was referred to the committee.

The chairman of the committee of award of the Dougherty Gold Medal, W. C. L. Eglin, of Philadelphia, reported that out of the twenty-nine papers submitted to the committee, that each member of the committee had selected independently the paper entitled, "Load Factor Diversity and Power Factor," read by Chas. J. Russell of the Philadelphia Electric Co., before the Philadelphia Company section April, 1909. The fact that the medal was awarded to Mr. Russell was kept from him until the announcement was made at the Convention. In acknowledging the honor, Mr. Russell showed that it was unexpected and that he was very much surprised. He made a very interesting talk on the importance of the rate question, and the lack of standard rate making.

A paper on company section bulletin was read by E. A.

Edkins, of Chicago, the origin and growth of these publications were commented upon and the statement made that over 500 house bulletins or organs are now published in this country, the characteristic ones being published in Chicago, Boston, Denver, Toronto, Philadelphia, Brooklyn. The result of publication in increased efficiency and the cultivation of relations between those connected in the discussion of public cases were features commented upon. Following the paper an interesting discussion of the subject followed. J. D. Israel, of Philadelphia, commented upon the interest created among their employees by lectures given by prominent outside men foreign to the industry at section meeting. He stated that the company had kept a record of the attendance and selected 15 of those with the best record sending them to the convention with expenses paid by the company. This was not held out as an inducement, and the men knew nothing about coming until the last minute. E. S. Smith, of Chicago, detailed the arousing of increased interest in section work in their organization by combining social and business features. He spoke

Frank M. Tait, First Vice-President N. E. L. A., the Dayton Lighting Co., Dayton, Ohio.

of the good work accomplished by the Section's Bulletin, and the interest created in such by interspersing interesting reading matter in the form of short stories. The Commonwealth Edison Company's section, he stated was an organization of 1,090 members. R. S. Pack, of Toronto, Canada, called attention to the importance of handling section organizations, from the standpoint of the men, showing them that it is as much for their benefit as for the company. It was his opinion that the backbone of the Association was the company section, and favored the publishing of a monthly bulletin, rather than one to cover a longer period such as a quarterly. The question of interesting line men was taken up by Farley Osgood, of Newark, N. J. The closing discussion on the subject was given by Samuel Insul, who spoke very highly of the value of the Dougherty suggestion for establishing company sections, and advised that the section plan be taken up by the larger companies. He also urged larger representation of company sections at conventions and the education of the man at the bottom for future executive positions. At the close of the session, President Freeman said there had been over one thousand in attendance at the three sessions on Tuesday.

THIRD GENERAL SESSION.

The third general session, as well as the other two general sessions, was presided over by President Freeman as chairman, and called to order on the afternoon of Friday. At this session, the chairman of the committee, on the president's address, H. M. Byllesby, of Chicago, reported for his committee on the official remarks of President Freeman in his address. A paper entitled "Breadth of Vision in Public Utility Appraisals," was then presented by H. M. Byllesby. Although this paper was not on the program, it was an important one and contained interesting information on the subject, including methods of determining value, an explanation of the problem of public utility appraisals, discussion of watered stocks, the responsibility of members, the estimating of the cost of any projects and the fixing of values, proper protection for corporations, and the rate and wages for public service corporation. In view of the fact that the present tendency of the public is to mistake the tendency of legislation, whereby corporations are allowed to charge a rate, depending upon the values of property, Mr. Byllesby explained that these values comprise the naked physical worth, or the cost to reproduce, plus the values which they possess as existing, growing, earning property. The address was an important one, and was received with considerable enthusiasm.

Following Mr. Byllesby's paper, one was read by W. F. Wells, of Brooklyn, N. Y., on elements affecting the fair valuation of plants and property. The factors entering into the approximation of original cost and reproduction values of actual property, represented by a fixed capital amount, were the subjects discussed. In the discussion the confusion of terms in regard to values and the theoretical and actual depreciation were features brought out. The report of the committee on rate research was next submitted by J. F. Gilchrist, of Chicago. This report voiced the establishing of more uniform rates throughout the country. The committee recommended a floor-area rate as being the fairest and cheapest for residence use, stating that it was practical and easily understood. Accompanying the report was an exhibit of models, based on the three dimensions of kilowatt demand, kilowatt-hour consumption and customer's bill, illustrating various rate schedules.

A paper entitled "Some Reasons for Difference in Price for Different Services" was next presented by N. T. Wilcox, of Lowell, Mass. He pointed out the differences between residence and commercial service, and made plain that there were certain natural discounts, depending upon the size of the installation, cost of equipment and hours of service. Douglas Burnett, of Baltimore, presented an abstract of a paper entitled "Standardization of Electrical Sellings." In the remarks made, it was advocated that publicity of central station rates was advisable. Also proposed methods of figuring house wiring, signs, etc., were suggested on a unit basis, so that immediate estimate could be quoted to customers. From the discussion, it appeared that there was considerable support for accessibility of rate schedules for the public, it being advanced that generally people regard rates as obscure and difficult to understand.

"The Economies in Operation Possible Through Time Study," was the title of a paper presented by L. B. Webster, of Marion, Ind., in which he proposed and exhibited charts for comparing output of certain classes of labor, referring to such saving possible to accomplish through instruction to employees. Mr. Webster pointed out that the engine room, boiler room and outside plant departments offered opportunities for improving time efficiency. In the discussion which followed, H. S. Porter, a professional engineer pointed out some of the possibilities and difficulties of studying the efficiency of various operations outlined by Mr. Webster.

Through the report of Secretary T. C. Martin on memorials, a loss of 14 association members during the past year was disclosed.

F. W. Frueauff gave a report which took up proposed plans for a constitution of company branches, technical and commercial sections and proposed constitutional amendments which were already submitted to the Association during the executive session on Wednesday. This report was accepted and the report of the committee on overhead line construction was also received. Following this action, the nominating committee presented its report embodying recommendations for officers to serve during the coming year. The nomination committee's report was accepted and the convention named the following officers through a ballot. President, John F. Gilchrist, of Chicago; 1st vice-president, Frank M. Tait, of Dayton, Ohio; 2nd vice-president, Arthur S. Huey, of Oklahoma City, Okla.; secretary, T. C. Martin, of New York; treasurer, Geo. H. Harries, of Washington, D. C.; members of the executive committee, W. W. Freeman, of Brooklyn, Chas. L. Edgar, of Boston, Arthur L. Williams, of New York and H. H. Scott, of Easton, Pa. The final business of this session was carried out after J. F. Gilchrist had taken the platform and received the words of greeting for his coming administration from President Freeman. After the words of reply from Mr. Gilchrist, in regard to the honor of his election to the presidency, the convention was formally adjourned.

Technical Sessions.

The first technical session was called to order Tuesday afternoon and presided over by F. M. Tait, of Dayton, Ohio. The report of the meter committee was presented in two parts by G. A. Sawin, of Newark, N. J. The first part recorded practices of various operating companies and improvements in constructive detail by manufacturing companies. The second part took up the meter code recommended for adoption by member companies. This code covered general instruction for meter maintenance including information in regard to order of work, tools, supplies, adjustment, overload and installations, etc.

The report of the committee on grounding secondaries was presented by W. H. Blood, Jr., of Boston. The present opinion as to the advisability of grounding secondary alternating current circuits was advanced, it being stated that the only difference of opinion now existing being reference to the limiting voltage beyond which grounding should not be carried. It was the committee's opinion that it is unwise to ground circuits operating on an E. M. F. exceeding 150 volts. In the discussion of the subject which followed, it was explained that the underwriters have not demanded the grounding of circuits because the fire risk is not lessened by grounding. The desire was further expressed that the committee of the A. I. E. E., recommending grounding out all circuits having voltages below 250, and the Association's committee placing the limit at 150 volts get together on a common satisfactory limit. It was explained that a shock from 250 volts will hold a man to the conductor as readily as one from 2,500 volts and that from outward appearances it is as dangerous.

A paper on grounding of low tension circuits as a protective measure was presented by P. M. Lincoln, of East Pittsburg, Pa., in which the condition under which high voltage strains may appear between the low tension windings and core of the transformer was explained. He stated that the transformer circuit with insulation between the separate windings and between the windings and core act as the plate and dielectric of a condenser. On all circuits, therefore, not grounded, the voltage between the line and ground will be divided throughout the dielectric according to the capacity of the insulating material, so that a large part of the total E. M. F. may be impressed between the low tension winding and core on account of the condenser's effect.

"Recent Important Improvements in Single Phase Motors," was the title of a paper read by W. A. Layman, of St. Louis. In this paper, Mr. Layman outlined the principles of operation of two new types of single phase motors, one being of constant and the other adjustable speed. The motor characteristics were shown by means of a practical demonstration upon motors of the two types operated under severe conditions. According to the demonstration, the con-

Arthur S. Huey, Second Vice-President N. E. L. A., Vice-President H. M. Byllesby & Company, Chicago.

stant speed motor consumed a considerable component of leading wattless current at no load and operates at a power factor of .96 at full load. By use of the adjustable speed motor any desired speed was secured by the proper controller. The discussion following the paper brought out the fact that numerous applications of the adjustable speed alternating current motor are found and the probability was expressed that the manufacturers would soon respond to this demand as is being done in Europe.

F. D. Newbury of East Pittsburg, presented an interesting paper entitled "Relation of Modern Load to Station Equipment." The selection of generating equipment for an alternating current station was considered, Mr. Newbury stating that the average operating power factor of such a station was about 80 per cent. He further stated that by improving the power factor the KVA rating of the generators could be lessened, referring to the synchronous motor as advantageous in regulation of power factor. He referred to the manufacture of 60 cycle synchronous converters which now operate as well as the old 25 cycle type, crediting the improvement to increased rotative speed by reason of the number of poles being decreased and commutation improved. In the discussion following the paper, the disadvantages of electric spot welding were taken up in regard to a particular station load. It was pointed out that the welding energy should be supplied by a generator, induction motor driven and equipped with a fly wheel to minimize the excessive fluctuation in the demands on the generator which would be thus transmitted to the supply system.

SECOND TECHNICAL SESSION.

On Wednesday morning, the second technical session was held with W. C. L. Eglin presiding. The first subject taken up was the report of the overhead line, construction committee by Farley Osgood of Newark, N. J. As already mentioned under the heading of First General Session, this topic was briefly discussed on Tuesday. The report contained 195 pages and embodied reports of committees of the National Electric Association, the American Institute of Electrical Engineers, The American Railway Association, the Association of Railway Telegraph Superintendents, and The American Railway Engineering and Mantenance of Way Association. After the presentation of report by the chairman Mr. Osgood, a discussion followed and the suggestion made that the association adopt it in full for standards in construction to be followed by member companies. Several speakers both for and against the adoption took active interest and a number of important points were brought out. The opposition to the report was in the main limited to certain modifications. President Freeman attended a part of the session and before leaving emphasized the fact that a great deal of hard work had been spent on the report and that he could vouch for the enthusiasm which the committee had evidenced in the work. In his opinion the report was worthy of adoption at this meeting. The vice-chairman Mr. Eglin also spoke in favor of the adoption, pointing out that the men on the committee were thoroughly capable of handling the subjects. While it would be difficult to get specifications to satisfy all members, he felt sure that the report was best available at the present time and hoped that it would be accepted and used as a standard. After considering these suggestions, motion was made that the members of the technical session recommend to the executive committee of the association that the report be adopted, which motion was carried. The report was not adopted without further referring it to the executive committee on account of the opposition.

The next subject taken up was the report of the committee on preservative treatment of poles and cross arms, this subject being presented by W. K. Vanderpoel of Newark, N. J. The report was divided into two parts, one taking up preservatives and the other treatments, the treatments being considered under three headings, the high-pressure, the atmospheric-pressure and the brush treatment. In connection with the asmospheric-pressure treatment, general directions were given for central station companies and hints also were offered for the brush treatment which is the least effective but the cheapest of the processes. In the discussion which followed, the advantage of the wooden poles when compared with towers, in the matter of right of way, was discussed. It is claimed that for a 60,000 volt transmission line, a choice has recently been made for wood poles rather than towers on account of the less width of right of way. Concrete poles have proven satisfactory, however, transportation difficulties and cost of erection and removal are features to be considered. Dr. Alleman gave an appreciative talk on the fraud practiced in creosoting. Dr. Alleman sited cases where from three pounds to nine pounds of creosote per cubic foot was used when twenty pounds was specified. Another case was where entirely another oil than creosote was used. B. F. Pearson of Southern California said that he had found open pot methods followed by dropping cross arms in a cold treatment very good. He advanced several methods of preserving base of pole, one successful method being the wrapping burlap around the base of pole and then creosoting. Another method was to concrete base and a little above base.

The next subject was a presentation of the report of underground construction committee given by W. L. Abbotts of Chicago, the chairman. The report was a record of results of investigations dealing with conduit construction, cables the installation of cables, auxiliary subway equipment and operation. Specifications for cable joints, comparisons of various conduit material, and hints to prevent electrolysis were features dealt with. In the discussion which followed it was pointed out that the concrete conduit used in St. Louis was tried in Joliet under unfavorable circumstances and was abandoned. It has proven successful in St. Louis, however, and is being extended, as it presents fireproof construction but can be installed only under good weather conditions. The use of armored cables without conduit were mentioned as good practice where growth is not rapid. Mr. Eglin stated that troubles are frequently located by trouble hunters running over the route and detecting odor of burnt insulation, and that such trouble was more frequently located in this way than with exploring coils.

Following the report of underground construction committee, a paper entitled, "Load Reports of an Electric System," written by A. S. Loizeaux of Baltimore was presented by Douglas Burnett of Baltimore. Sample load-reports of an electric system including daily output summary, special day load curves, day load curves of large customers, monthly reports of energy generated and various other specifications of load formed material presented. The discussion brought out the fact that the keeping of reports of the kind described were becoming more and more important due to the formation of state commission and the frequency of questions arising which could be handled by them. The presiding officer Mr. Eglin, expressed the favorableness of the standardization of form of load reports and characteristic load curves for central stations.

The second technical session while scheduled in the program for Wednesday forenoon only was found altogether too long and too interesting to crowd into the short space and was therefore extended into the afternoon taking practically the whole day to the subjects.

THIRD TECHNICAL SESSION.

The third and last of the technical sessions was held on Thursday afternoon and the work opened by a presentation of the report of the lamp committee by W. S. Wells of Brooklyn. The developments in the manufacture of tungsten lamps and some of the improvements in standardization of lamp sizes and ratings were taken up, attention being called to two new tungsten units consuming 400 watts and 500 watts that have come into general use during the past year. The principal point brought out in the discussion was that the policy of companies that had given free renewals of carbon lamps was now to reduce the price of tungsten lamp renewals by an amount equal to the cost of an equivalent carbon lamp.

The next subject on the program was the report of the committee on prime movers delivered by I. E. Moultrop of Boston. In this report no newly developed type of apparatus was mentioned, standard apparatus being considered only. Gas engine installations in connection with gas producer plants and the operation of hydraulic units, governors and accessories, were included in the report. The paper was liberally discussed, J. C. Parker of Rochester stating that the central station conditions cannot afford to ignore the possibilities of exhaust steam heating in obtaining isolated plant loads. It was advanced that the bleeder types of turbines are adaptable for this service, the heat being shunted from the turbine at the desired pressure and at a uniform quality. R. D. De Wolfe of Rochester stated that there was a demand for some type of bleeder turbine which would deliver the desired amount of steam for heating independent of the load on the generator. He claimed that small gas engine installations are proving unsatisfactory. Attention was called to the Humphrey gas pump now being built in Europe and recommended that the committee watch developments.

The report of the committee on electrical appliances, L. L. Elden of Boston, Mass., chairman, was read by G. L. Knight. The report took up tests made on 12,000 K. W. turbo-generators under short circuit conditions and gave suggestions based on these tests. Reactance inserted in series with the generator leads was recommended as affording excellent protection to generator and minimizing current to be interrupted by the circuit breaker when opening a short circuit. The auto-transformer to double the voltage of the generator which provides a high voltage unit with sufficient effective series reactance for self protection against destructive short circuit currents, was also mentioned.

In the discussion on this paper, F. D. Newberry of Pittsburg expressed the opinion that the reactance advisable to include in a turbo-generator circuit could easily be provided within the generator itself, thereby avoiding external reactance. E. M. Hewlitt of Schenectady, explained the changes now being introduced in the bellows type relay in order to make it more selective. It was further brought out that the present form of relay is selective for grounds on a system but non-selective for short circuits.

A paper on ventilation of turbo-generators was next presented by R. B. Williamson, of Milwaukee. The weight of air required for proper ventilation and the slight percentage of dust in air used for ventilation was discussed together with the detrimental effect in operation on account of the accumulation of dust in the small air passages of turbo-generators. Methods for filtration of air through cloth were described. In the discussion of the paper H. L. Wallau of Cleveland suggested the use of vacuum cleaning of turbo-alternators instead of the blower method in order to prevent the dust from returning to the generator.

The last subject presented was that of the paper entitled, "Progress and Development of Self Cooled Transformers," by M. O. Troy of Schenectady. The operation of modern self cooling transformers and the increase in style and improvements was dealt with. It was explained that the permissible output of rating of the self-cooled transformer is set by the surface of the case which can be rendered available for cooling purposes. A method was described of cooling involving the use of a boiler iron tank equipped with external tubes. The advantages set forth were effectiveness of the cooling surface obtained and unlimited amount of surface that can be secured and the forced circulation of the cooling oil. A. S. McAllister of New York expressed the opinion that the increase of the effective cooling properties of the tank with external tubes and that with compound corrugation is contributable to increase of surface exposed to air current and not to increased radiating surface.

Power Transmission Sessions.

The first of the power transmission sessions was held on Thursday morning, the meeting being presided over by J. F. Gilchrist. The first business taken up was a presentation of the report of the public conference on water powers and governmental control, called by the transmission section on April 8th. A. S. McAllister of New York, presented the report.

A paper entitled, "Central Station Power and Electricity supply for Trunk Line Railroads," was presented by F. Darlington of East Pittsburg, Pa. The author held that energy generation and railroad should be conducted as separate and independent undertaking. It was his plan to develop the electric railroading by co-operation of central station men with the railroad furnishing them with energy needed. The discussion following the reading of the paper set forth the general opinion that the best and most economical method of handling power was for the power company to operate separate from the railway company.

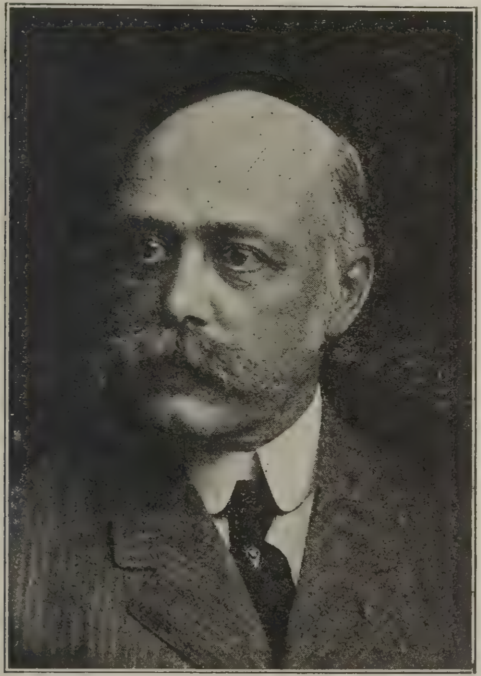
The report of the committee on protection from lightning was next presented by B. E. Morrow of Albany, N. Y. The report was divided into two parts one taking up transmission and the other distribution. The committee recommended the use of electolytic type of arresters on all transmission lines, the multi-gap or horn type. It also advised that a choke coil should be placed on every circuit leaving the generating station, and the improved types of insulations for transformers used where subject to damage from lightning or surges. Overhead ground wires were highly indorsed. The discussion was taken up by prominent engineers including Dr. C. P. Steinmetz of Schenectady. Dr. Steinmetz brought out the fact that almost absolute protection against lightning can now be had if necessary although it may be more economical in some cases to assume some risk of trouble from lightning rathen than expend the money involved in providing perfect protection. He further stated that in some cases it may be best not to protect distributing lines but to protect only the apparatus connected with the system by placing aluminum cells at the sub-station and some cheaper form at the other apparatus to be protected. The matter of cost was the determining factor in his mind as to whether or not protection of various kinds should be placed and where. P. M. Lincoln of Pittsburg mentioned that in addition to arresters there are three means of protecting against lightning, under-hung installation, overhead ground wire and grounded neutral point.

SECOND POWER TRANSMISSION SESSION.

The second and last power transmission session on Friday morning was presided over by President Freeman during a large part of the session, the latter part being in charge of J. R. McKee, vice-chairman. The first paper delivered was entitled, "Increasing the Flexibility and Reducing the Cost of Operation on Steam Boiler Plants by the use of Fuel Oil," by H. A. Wagner of Baltimore, Md. The author took up an arrangement employed for using both oil and coal simultaneously as fuel for steam boilers. He explained actual operation which showed an output increased by 66 2-3 per cent. indicating a saving of about 40 per cent. in cost of boiler equipment for the output. E. B. Rushmore read a written communication from M. C. Kennedy of Syracuse stating that good results have been obtained from the use of oil as fuel in Syracuse.

The next paper took up the determination of steam costs under varying conditions by Messrs Walbridge and Gilbert. Curves were shown based on data taken from engineers note books referring to a certain territory 200 miles in length where energy was produced by steam. The curves showed the relation between weight of steam per K. W. hour and cost of banking per K. W. hour, cost of coal per K. W. hour, cost of labor per K. W. hour, and rating of power plant in K. W.

The next matter taken up at this section was the topical discussion on operation of transmission systems. Three written communications were presented from the following: Max. Hebgen of Butte, Montana; J. P. Jollyman of San Francisco and R. S. Kelsch of Montreal. A number of oral discussions were also presented. Mr. Hebger in his paper advanced the increasing of the factor of safety in installation to the value of three for 100,000 volts, 4 for 50,000 volts, and 5 for 20,000 volts. It was his opinion that for an e. m. f. exceeding 20,000 volts, suspension insulators should be used in preference to pin insulators. Duplicate transmission lines erected along different routes should be carried out when possible. Overhead ground wires, extra insulation and electrolytic lightning arresters should be used to give the best possible continuity of service. Mr. Jollyman stated that the generating plant should be arranged on a unit system and all control apparatus should be located so that one man could handle it in case of accident. It was Mr. Kelsch's opinion that insulation strength should at least be three times as great as it is at present. G. H. Waldbridge explained that most of the troubles encountered on the system of the Central Colorado Power Company's system were mechanical rather than electrical. It was further advanced that interruption of service by birds standing on steel cross arms and touching the transmission wires can be overcome by using suspension insulators.



T. C. Martin, Secretary of N. E. L. A.

Accounting Sessions.

The first accounting session was held on Tuesday afternoon with J. F. Gilchrist presiding as chairman. The first work of this session was the presentation of the report of the commission on uniform accounting by J. N. Bailey of Baltimore, Md. The committee recommended the establishing of a statistical bureau, and that when information is sent to inquiring members the names of companies which have furnished data should not be disclosed.

The next subject considered was a paper on handling customers orders by R. F. Bonsell of Baltimore. On account of the absence of Mr. Bonsell this paper was read by Douglass Burnett of Baltimore. The author advised that orders should be so drawn as to include all of the work of a certain class under one agreement. All forms should be of standard size, and the most efficient forms will permit the necessary carbon copies to be made. Further in cities where a municipal or underwriters certificate of wiring is required, it facilitates the prompt handling of orders to place on file a complete record of certificates.

The collection of bills was the subject of a paper presented by E. J. Bowers of Kansas City, Mo. Mr. Bowers described in detail the practice of the Kansas City Electric Light Company and recommended a discount for prompt payment of bills with penalties strictly observed for noncompliance with rules. Notices of discontinuance of service have been effective in securing prompt payment of accounts past due. This subject was liberally discussed by various members.

The next paper was delivered by Herman Spoehrer on electric vehicles accounts as applied to a department of a central station plant. Mr. Spoehrer in his paper described the electrical vehicle business of the Union Light & Power Company and the methods of accounting, giving the classifications of accounts for the automobile department. The classifications are divided into general headings entitled sales and garaging, showing all expenses pertaining to this feature of the business.

SECOND ACCOUNTING SESSION.

The second accounting session was held Wednesday morning with F. M. Tait presiding. The first paper was presented by J. T. Brady of Denver, Colo., on the subject of tracing store room material. Mr. Brady stated that on account of the nature of the industry it was imperative to store an excessive supply of material and to provide means for carrying and handling it. He advised a complete set of records that should show receipts and disbursements and that no material should be given out without a requisition. He further advised a weekly balance sheet used by each foreman and each month to take a partial inventory of materials in warehouse.

The purchasing department was the subject of the next paper presented by T. W. Buxton of Brooklyn, N. Y. This subject was presented in three divisions taking up the purchasing department of the Edison Electric Illuminating Co. These divisions were orders, invoice, and transportation. The following objects for a purchasing department were advanced: (1) To close the purchase properly. (2) to verify the seat of a purchase. (3) to verify the resulting expenditure with a minimum of dispute and delay. (4) to care for special and miscellaneous matters. (5) to provide particular statistics and information. (6) to handle a sale of certain materials. The discussion following the paper brought out the precautions to prevent payment of a bill twice.

"Advantages of a Job Cost System," was the subject of a paper next presented by A. L. Holme of New York. Mr. Holme took up in his paper, the job order system for construction, and for repair work that is necessary in order that executives may be consulted on expenditures and be assured that expenditures do not pass the amount approved. The method is a very good one to obtain cost data and it makes estimates reliable for future use.

THIRD ACCOUNTING SESSION.

The third and last accounting session was held Thursday morning and called to order by President Freeman. The second session was the longest of the sessions held during the convention and President Freeman expressed his gratification at the large attendance. This attendance was much larger than any other previous annual meeting of the section.

Charles L. Edgar, Member N. E. L. A. Executive Committfe, President of Edison Electric Illuminating Company, Boston.

The first paper was delivered by Franklin Heydecke on general office accounting. The importance of promptness in compilation of monthly statements of operation and of profit and loss were commented upon, it being stated that general facts should be given first, then followed by details in order not to delay the statements. It was advanced as good policy to lean strongly toward charging to operating expenses in case of doubt. Construction accounts for underlying companies should be separated so that if the lease should terminate, the controlling company could receive payment for betterments.

The next paper taken up was on accounting for depreciation by H. M. Edwards of New York. This paper assumed that every company recognizes that its tangible assets are disappearing with use or improvement and that some provision must be made in the accounts to provide for the replacement of worn out or superseded apparatus. The two methods for determination of the depreciation reservation given were the specific method and the general method. With the specific method, if books are properly kept, it would not be difficult to inventory the plant and list costs. The specific tries to treat with exactness what in the very nature of the things is not exact and to the last degree approximate and takes no account of supersessionary depreciation. Under the general method a reserve may be built up by a stated percentage of the inventory value of the property, by a percentage of the gross earnings, by rate applied to the electric energy generated or sold or by a definite amount appropriated from surplus earnings. The New York Edison Company started its depreciation reserve fund on the date of its incorporation, its practice being to set aside 1 cent per k. w. hour off energy sold to general customers. The author of the paper considered this depreciation as a cost that must be recovered from the price of the product sold, and considered that the reserve should be determined by the general rather than the specific method. A lively discussion ensued following the reading of this paper, different opinions being advanced as to the means by which a determination of the amount and the basis on which the reserve should be computed.

The next paper on the program was entitled, "The Extent to which a Tabulating Machine can be Used in Accounting Work," and read by Wm. Schmidt, Jr. of Baltimore. Its general trend was to point out the help to electric companies that the tabulating machine presents explaining that in Baltimore it is used for the tabulation of monthly electrical sales, a daily analysis of lamps used, information as to meters, indicators, transformers, and arc lamps in service, and as to the number of poles in apparatus attached. After the discussion of the Schmidt paper, President Freeman announced that the accounting sessions had been one of the distinct successes of the convention and that the largest number standing at any one meeting was reported by the accounting session which also had the record of beginning its meetings first and ending them last.

Commercial Sessions.

The first commercial session was held Wednesday morning with J. F. Gilchrist presiding. The session was opened by the address of the chairman of the commercial section, George Williams of New York. Mr. Williams called attention to the fact that the commercial section now has a membership as large as the entire association six years ago, and will in all probability double its membership each year for some time. It was his opinion that the commercial section is the best way of developing the commercial side of any association and that the commercial section afforded the best opportunity for commercial men to acquaint manufacturers with customers' wants and for the manufacture to educate the commercial men. The speaker announced that the section will frequently issue special data from expert sources and will furnish individual assistancee if asked for. The next subject on the program was the report of the committee on power presented by the chairman E. W. Lloyd of Chicago. The report presented tabulated data relative to motor development for various industries as well as data on horsepower required to drive various machines. The qualifications of a salesman for soliciting business were commented upon and the advisability of a central bureau established for a collection of data.

The report of the committee on electricity in rural districts was next reported by J. C. Learned of Chicago. This report was divided into several sections, each treated by itself, and in taking up the central station features of rural industries it was pointed out that greater opportunities for load occur than mere farm installations. It is shown from data that the average motor business of a customer in well and firmly established districts is off peak load and very often the lighting is also off peak. It was suggested that business be encouraged by some inducement as installment payments for utensils or motors, cost prices on wiring, etc. The report touched upon in a general way the rural industries which include stone quarries, gravel pits, stone yards, cement mills, brick yards, lumber yards, grist mills, and other small and similar industries. An extensive discussion followed in which S. M. Kennedy of Los Angeles, Calif., gave information on the lines of his company in southern California. He advised the highest standard of line construction and stated that the average cost of extending the line in rural districts depended on the voltage and the territory served ranging from $600 to $1,200 per mile.

Following the report of the committee on electricity in rural districts, W. R. Collier of Atlanta, Ga., presented the report of the committee on Ornamental Street Lighting. This report took up the great advantages and disadvantages of the various systems now in use for lighting streets, paying particular attention to the arc system, the festoon or arch system and the post system of ornamental lighting. The illustrations of the various systems formed a large part of the report. The report advised that the unit of payment should be on the front foot basis and that this should

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also be made the unit of cost of installation. It also advised that the solicitation of street lighting should be done by central stations rather than outside solicitors representing manufacturing companies. The report was generally and thoroughly discussed, V. R. Lansing advancing the statement that whether or not lamps are placed upright or hang pendant is not of great importance since the life of tungsten lamps burning in either position now is about the same. The difference in illumination however, is considerable, lamps hanging pendant showing a gain of 35 per cent. so that the question of light distribution should be considered especially in ornamental lighting schemes where economy of operation is a question of great importance. W. H. Gardner of Lincoln, Nebraska, advanced the idea that street lighting hurts window displays and that more emphasis should be placed on sign lighting and window lighting than on ornamental street lighting, on account of the former yielding greater revenue. A. S. Ives of Poughkeepsie, N. Y., urged companies to get municipalities to pay for the decorative street lighting and said that anything that benefited the communities would benefit the central station.

SECOND COMMERCIAL SESSION.

The second commercial section was held Thursday morning with F. M. Tait presiding. The first subject taken up was the report of the committee on electric vehicles presented by W. H. Peck of Rochester, N. Y., in the absence of J. T. Hutchings. The report advanced the fact that the public is yet unacquainted with the value of the commercial vehicle and that records of the actual cost of operation and service data are of utmost importance. The committee reported the difference of 30 to 70 per cent in tire efficiency between gasoline and electric vehicles and suggested the importance of proper tire selection. The setting of rates was reviewed and stress put upon the absence of fire risk with electric vehicles. The report was discussed from several standpoints including the prospects for future vehicle business, the reports from fields where vehicles are now in operation and the possibilities for the extensive use of electric vehicles.

EXECUTIVE COMMERCIAL SESSION.

The executive session followed the commercial session, the following nominating committee being appointed: H. J. Gille, H. K. Mohr, E. L. Callahan, E. W. Lloyd, Duncan Campbell, and C. W. Lee. The chairman of the membership committee, R. Ownse, announced the membership was now over 1,000. The work of the year was reviewed by N. Boynton of Cleveland. The entire morning session was devoted to the discussion of the electrical vehicle situation and the interest manifested showed its position in central station work.

THIRD COMMERCIAL SESSION.

The third commercial session was held on Thursday afternoon. This session was visited by one of the most prominent and influential minds connected with the electrical industry. At a special invitation Mr. Thomas A. Edison was present, whose appearance on the platform created loud applause and enthusiasm. Mr. Edison does not speak for public praise and therefore does not appear in public as a speaker. What he does speaks for itself and therefore his former associate and friend, Samuel Insull made remarks on his behalf. After this ovation and the election of Charles A. Coffin, President of the General Electric Co., as the 26th honorary member, the work of the session was taken up. The first subject considered was the report of the committee on residence business, this report being presented by Clare N. Stannard of Denver, Colo.

The report was one of general progress and advanced as a means to be adopted for getting residence business, three general methods. The committee stated that the results obtained in securing new residence business are most encouraging, its report indicating that during the past year there was an increase from 20 per cent to 40 per cent in the number of resident customers over the previous year. The revenue varied from $18.00 to $40.00 per year with an average of $25 per customer. The revenue per K. W. connected varied from $18 to $22.

The next subject taken up was the report of the committee on electric heating refrigeration and kindred appliance sales, which report presents the state of the art and the revenue procurable from the electric heating load. The relative importance of the various devices is indicated and the committee encourages the developments in every direction. The report covers the whole range of devices on the market and from it, it appears that electrical refrigeration is confined almost entirely to few large cities.

The report of the committee on improved wiring and equipment standards, was next presented, by M. C. Rypinski of New York. The opinion voiced by the report of the committee, was a need for improvement, standardization and cheapening of wiring practice and equipment for the residence customer. There seems to be a lack of definite knowledge as to the extent to which present cost retards wiring of houses. In old houses it is estimated that the situation is retarded 50 per cent, and it is generally felt that the cost of wiring should be reduced from 25 to 50 per cent., the general feeling being that the cost of wiring new houses does not need as much reduction as the cost of wiring old houses.

Following the report of the committee on improved wiring, M. S. Sloan of Birmingham, Ala., presented the report of the committee on industrial lighting. In this report the committee avoided discussion of merits or weaknesses of lighting systems, and begun its work in a general way owing to the present state of the art. Descriptions of installation formed a large part of the work, it being suggested that work be continued with a view of obtaining the classifications of the various methods of lighting if possible or at any rate the compilations of data which placed in condensed form would be helpful to central station managers.

FOURTH COMMERCIAL SESSION.

The fourth and last of the commercial sessions was held on Friday morning and presided over by J. F. Gilchrist. The report of the committee on electric signs was first taken up and presented by E. L. Callahan of Chicago. It was the opinion of the committee that attention should be paid to the mechanical and artistic features of electric signs, otherwise unreasonable municipal sign ordinances may give trouble. The committee urged the importance of adequate illumination until at least 10 p. m. It also advised the reproduction of animated signs by moving pictures, before the next convention and also suggested that the question of window lighting, life of low voltage lamps and requirements of national advertisers should be investigated and reported.

The next report was that of the committee on competitive illuminants by H. J. Gille of Minneapolis, Minn. A paper was presented giving a list of the chief types of gas lamps, with data on reflectors and gas consumption. The choice of reflectors was stated as small, and considerable information was given in regard to the use and illumination from the gas burner as compared with other illuminants. Tables of operating cost were also given including costs and disadvantages of gasoline lamp illumination. The discussion was spirited and participated in by a number of illuminating engineers. It was the general opinion that the report presents general principles and a compilation of data which is a good combination of laboratory and field data for general use. The report of the committee on advertising was presented by C. W. Lee of New York City and the campaign for various cities was taken up. The committee urged that the character of the copy used in advertising be more important than a medium employed. Street car and bill board publicity were commended and syndicated matter should be given a strong local cast. The discussion brought out schemes of advertising and methods to be used.

The report of the committee on functions of a sales department by T. I. Jones was the last work of the session. Among the topics treated in his report weree the advertising and new installation bureaus, wiring of old houses, installment payments, and fixture rentals. The committee favored the abandoning of the plan of requiring deposits to be made in connection with new business. The partial payment plan of wiring old houses was given high praise. In the discussion which followed the report, the payment of straight salaries to solicitors was favored except in the sale of electrical appliances where a combined salary and commission is desirable. The commission plan however, was thoroughly discussed and opinions expressed that the central station company could not afford to do away with the payment of commissions altogether. Holding of business is the important thing as well as prompt connection of the business.

ARTHUR WILLIAMS, MEMBER N. E. L. A. EXECUTIVE COMMITTEE, NEW YORK EDISON COMPANY, NEW YORK.

F. W. Lloyd presented the following list of nominations for the ensuing year which was accepted. Chairman H. J. Gille, of Minneapolis; vice-chairman S. M. Kennedy of Los Angeles; secretary F. B. Roe of New York; executive committee, George Williams of New York; F. H. Gale of Schenectady; J. Robert Crouse of Cleveland; E. L. Callahan of Chicago; C. Campbell of Scranton; A. B. Rypinski of New York; E. W. Lloyd of Chicago; T. I. Jones of Brooklyn; H. K. Mohr of Philadelphia; C. W. Lee of New York; and J. S. Becker of New York. After the report was accepted the meeting was adjoined.

Executive Session.

After the adjournment of the first commercial session Wednesday morning, President Freeman called to order the executive session at noon. The report of the Public Policy Committee was presented by Arthur Williams of New York in which the co-operation with companies undergoing difficulties was reviewed. Question of municipal ownership, competition and other matters of a serious nature were detailed as the work of the committee.

The report of the committee on proposed constitutional amendments was read by F. W. Frueauff of Denver, which report had to do particular with application for membership, formation of executive committees, and relation with sections, earnings from sale of electrical energy, dues, the organization of geographical sections throughout North America, and the disposition of funds among sections.

The treasurer, G. H. Harries through his report, showed that the association has total assets of $21,548 and no liabilities except current bills. The total receipts during the year were shown as $62,177 and the present cash balance $18,500. The report was accepted.

At the executive committee meeting of the N. E. L. A. held on May 11th at New York, a special committee with Vice President J. F. Gilchrist reported a trip to the Pacific Coast inspecting various cities for facilities in regard to the proposed convention of 1912. After a discussion of the report it was unanimously voted to hold the next convention at Seattle in June, 1912.

Public Policy Session.

A notable session of the convention was held at the New Theatre on Wednesday evening when the report of the Public Policy Committee was preseented. President Freeman opened the session by stating that the report was presented from the view point of the industry and from the larger point of view of national welfare. Mr. Samuel Insull read the report of the committee before a large and enthusiastic audience. Following its reading Mr. Insull made a brief address in which he strongly advised that the suggestions in the report be heeded. President Freeman announced that the report was adopted at the morning executive session and further said that President Taft had been invited to be present at the meeting but that the extra session of congress made it impossible for him to accept. His personal representative, however, Hon. Charles Nagel, Secretary of the Department of Commerce and Labor, was present at considerable personal sacrifice. He stated that he had been very busy at his desk in Washington up

to noon of Wednesday and was compelled to be back early the next morning, a feature which showed the importance attached to this meeting. The presence of Hon. George B. Cortelyou was also an honor to the evening session.

In Secretary Nagel's address he stated that publicity often gives a distorted picture of ourselves, and that we are not half so bad as we appear to be, yet vices are apt to find notoriety and virtue is a poor advertiser. He further said that the report which he had heard read led him to feel that it would be possible to rely upon private enterprise rather than state legislation in grappling with social and economic problems. Voluntary action of the association in betterment work he hailed with satisfaction not wholly on grounds of sentiment but on basis of it being wise and a far-sighted business policy. He advanced the opinion that the boldness and strength of the plan provides an example of what may be and should be done throughout the country under similar conditions.

SOCIAL FEATURES AT NEW YORK.

The opening social event at the New York Convention was the reception to President and Mrs. W. W. Freeman at the Hotel Astor. The receiving party was composed of President and Mrs. W. W. Freeman, vice-president and Mrs. John F. Gilchrist, vice-president and Mrs. F. M. Tait, treasurer Geo. M. Harries and secretary T. Commerford Martin. The reception was held in the ball room where an organ recital was given by Arthur D. Pew of Brooklyn, with selections from noted composers. After the reception a concert was given on the roof garden, music by McKees Band. The concert was followed by dancing in the ball room. The beautiful decorations of the hotel, the electric sign of welcome and the colored lights used in illuminating the flowers, drew forth much admiration. The ladies were entertained on Tuesday morning by a steam boat trip on the Hudson River as far as Tarrytown. The members and ladies were guests on Tuesday evening of the Edison Electric Illuminating Company, and taken for a trip by steamboat down the East River to Coney Island. The ball game scheduled for Wednesday afternoon, a match between Brooklyn and Philadelphia Companies, was called off on account of heavy rains. On Thursday morning the ladies were treated to a costume musicale at the Waldorf Astoria and in the evening members and guests of the association attended the theatre. On Friday the entertainment features took the form of an automobile ride for the ladies through upper New York. In the afternoon a tea at the Hotel Plaza was enjoyed and in the evening a Sons of Jove dinner took place at Coney Island. The closing entertainment event was a boat trip on Saturday, the members and ladies being the guests of the New York Edison Company.

RESOLUTIONS.

Through the report of the committee on resolutions, an expression of thanks and appreciation was extended to the chairman and members of the various committees who contributed to the success of the convention, and a special expression was made for the courtesies and hospitalities received at the hands of several member companies in New York. Resolutions of thanks were passed to President Freeman, Vice Presidents Gilchrist and Tate and Treasurer Harries for faithful work of the year. To Secretary T. C. Martin for his loyal and efficient staff and for the manner in which it has endeavored to place promptly and efficiently at the disposal of every member resources of the association in regard to the furnishing of data and information, prompt handling of correspondence and assistance to all the committees in their work. To the McGraw Publishing Company and to the entire staff of the Electrical World for the Convention Daily issued during the week. To the Technical Press for its loyal and efficient cooperation for the work in publicity which did much to make the convention so successful.

Principles of Illuminating Engineering.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

BY A. G. RAKESTRAW.

From what has been said in the preceding installments of this article in past issues, it is plain that in choosing a light source, there are many things to consider. The ideal source would be one of low first cost, low maintenance expense, high efficiency, easily renewable, non-deteriorating, giving an even distribution of not too great intrinsic brilliancy, and furnishing a steady light of a good color. It is hardly necessary to say that none of the light sources in use at present will fulfill all these requirements. We will therefore consider the characteristics of some of the more common illuminants with a view of determining their adaptability to different kinds of service.

The existence of several typical groups of lamps is to be dealt with according to the character of the light-giving substance and the means employed to bring it to the temperature of incandescence. The radiant substance may be a solid, either in a filament or finely divided as in a flame or arc or it may be a vapor and the heat produced by combustion, either of the substance itself or of a surrounding gas or by the passage of an electric current. We may divide the lamps to be considered into the following groups: open flame, gas incandescent, filament in air, filament in vacuo, carbon arc, flame arc, and vapor lamps. These represent only quite roughly a logical series as to period of development, since new types have been introduced first in one class and then in another. We will therefore vary somewhat from this order in taking up the different lamps. Electric light includes all but the first two of these seven groups, aand will naturally demand the larger part of our consideration, both on account of its great commercial importance and because thus far it expresses the highest development of the illuminating art. Below, the illuminants in use at present are arranged according to this grouping.

OPEN FLAME
Candle
Kerosene lamp
Open gas flame
Acetylene

GAS INCANDESCENT
Calcium light
Welsbach light.

FILAMENT IN AIR
Nernst Lamp

FILAMENT IN VACUO
Carbon filament
Metallized filament
Tantalum
Tungsten or "Mazda"
Osmium, Osram, Helion, Titanium, and others

CARBON ARC
Open
Enclosed
Semi-Enclosed

FLAMING ARC
Bremer and Blondel types
Magnetite
Regenerative

VAPOR LAMPS
Moore tube
Mercury Arc
Quartz lamp.

Taking up the first group, typical examples are the pine knot, the tallow dip, the candle, oil lamp, and the fish tail gas burner. In this one group, the development of centuries are found, and while these lamps are recognized as being inferior to the electric light and gas mantle, and in general used only where these are not obtainable, yet it is a remarkable fact that the candle and the oil lamp are used in increasing numbers each year, the growth of course, being in fields outside the reach of gas or electricity. It seems that each new illuminant introduced, finds a field for itself and while it soon comes into general use, yet the older types also extend their fields of usefulness and are used in larger numbers than ever.

The open flame lamps are faulty in several respects, all being inefficient. The temperature of the flame is low, and consequently they give out a large amount of heat as compared with the light produced. They consume oxygen from the atmosphere, and are affected by air currents, unless carefully protected. They require matches for ignition which introduces an element of danger. Kerosene is accompanied by unpleasant odors, and is moreover dangerous to handle, and the oil lamps are likely to be upset. Gas pipes leak, and the flame is liable to be accidentally extinguished, giving rise to asphyxiations and explosions. The color is decidedly yellowish, which is undesirable for work requiring accurate vision. However in justice, we must admit that the best form of oil lamp is much to be preferred to the cruder forms of electric light. It is much more pleasant to read or study by the mellow light of a student lamp than by a bare electric globe hanging just in front of the eyes.

There is one conspicuous exception to some of the defects mentioned as belonging to this group, and that is acetylene. In efficiency and color it is far in advance of other sources of its class. In color it is said to be the whitest light in existence. While this claim may be disputed there is no doubt that it is very close to sunlight in quality, and this resemblance extends into the invisible spectrum as is proved by its valuable actinic qualities. Experiments have also shown that it resembles sunlight in being rich in those rays which stimulate plant life. The generation of acetylene gas was formerly attended with much danger, but since the apparatus has been improved upon, it may be regarded as comparatively safe if proper precautions are taken. It is used in many country residences, stores and churches, and other buildings, and we even occasionally find it used in competition with gas or electricity.

The next step in the use of gas for illumination was the utilization of a non-luminous flame to heat some other substance to a point of incandescence. This type of illuminant is included in the second group of our classification. Considering for a moment the subject of flame combustion, Figs. 1, 2 and 3, represent open flames, such as a candle, or

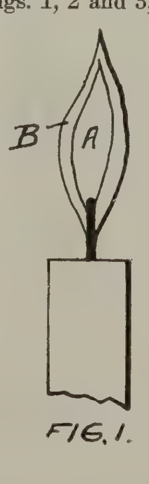


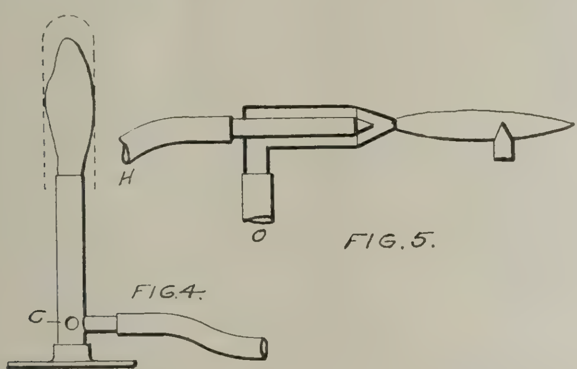
FIG. 1.

FIG. 2.

FIG. 3.

open gas flame. The principle is the same, except that in the gas flame the fuel is already in the form of a gas, while in the candle the volitalization proceeds as required at the point of the wick.

In Fig. 1, A represents unconsumed gas, which is quite cool. B is a thin envelope in the process of combustion. The gas which is a hydrocarbon, is first broken up by a partial combustion and the carbon set free, raised to incandescence in the flame, finally being consumed completely to carbon dioxid. If any cool object is presented to the flame, the heat is abstracted so rapidly that the carbon is deposited as soot. We may note here that since the envelope of the flame only gives light, it is advantageous to spread the flame out as thin as possible which accounts for the flat oil wick, and the shape of the gas flames in Figs. 2 and 3. In Fig. 3 an ingenious arrangement for the acetylene burner, is shown in which two impinging jets are made to flatten



Figs. 4 and 5. The Bunsen Burner and Oxy-Hydrogen Blow Pipe.

out into a very thin and bright flame. In Fig. 4 a representation of a gas flame is shown in which the proper quantity of air is admitted at an opening C. This produces an entirely different condition. The combustion is complete in every part of the flame, which is practically non-luminous, and it is impossible to get any sooty deposit. This is the Bunsen burner. It follows that the non-luminous flame is much hotter than the luminous flame.

The principle of the gas incandescent consists in introducing into this flame some subsance which will become luminous and yet not oxidize. The first lamp of this kind was the calcium or lime light, which was used for search lights and steriopticons, etc., and until the perfecting of the arc search light, it was the most powerful source of light obtainable. For this lamp the heat was produced by the oxy-hydrogen blowpipe, giving the most intense heat possible to produce. It is shown in Fig. 5. The hydrogen enters at H, and is lighted first. Then the oxygen is turned on at O, under pressure and piece of lime introduced into this flame making it attain a dazzling brilliancy.

The same principle is used in the Welsbach light which consists simply in enveloping the flame of a Bunsen burner with a mantle of metallic salts, as shown by the dotted line in Fig. 2. Either artificial illuminating gas or natural gas may be used. Instead of seeking to obtain a high temperature in the flame, as is the case in the oxy-hydrogen flame, search was made for substances having selective radiation, that is, which when heated gave off a greater amount of light than we would expect from the laws governing the radiation from "black bodies." In other words having a greater proportion of luminous to total radiation. The oxides of cerium and thorium and other rare earths are quite remarkable in this respect, and the result is that we get quite an efficient light, in color rather strong in green rays.

The practical operation of gas mantles is familiar to all. The upright and inverted mantles and the gas arcs for the illumination of storerooms and other places of business are used more or less all over the country, especially where natural gas can be obtained. Since we are, of course, particularly interested in electric lighting, we will consider only briefly the characteristics of gas lights to such extent as will enable us to compare them with electric lights. While electric light is much preferable to gas on the score of convenience, safety, cleanliness and coolness, yet it is true that the newer forms of gas burners and reflectors have brought

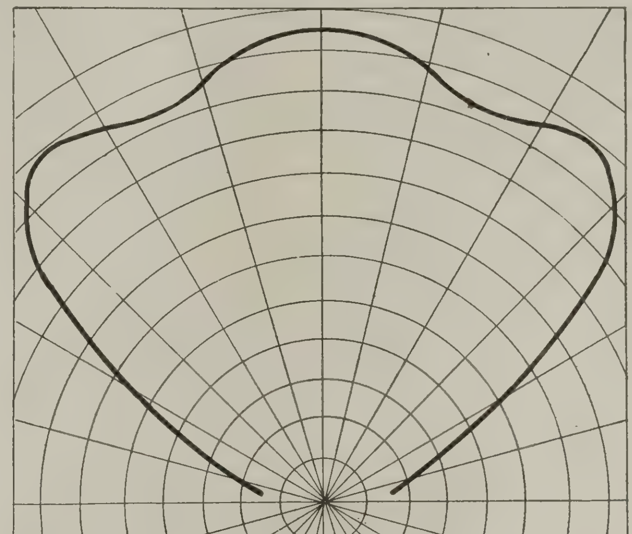


Fig. 6. Typical Light Distribution of Gas Lights With Reflectors and Clear Cylinders.

the gas lamp to a high plane of efficiency. Its competition can no longer be met by the earlier forms of electric lamps, but only by taking advantage of the recent improvements in incandescent and arc lamps. Natural gas at 25 to 30 cents

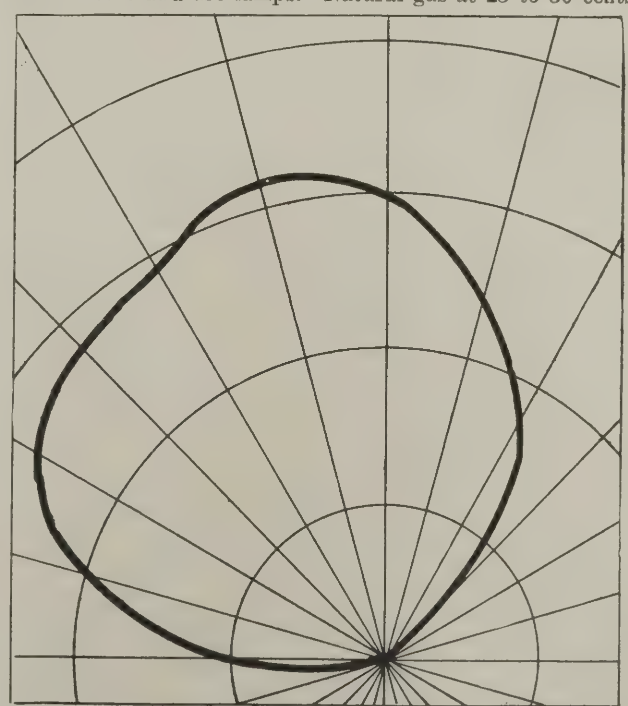


Fig. 7. Light Distribution of Gas Lamps for Window Display.

per 1,000 cubic feet is an undeniably cheap illuminant, and even with artificial gas from 80 cents to $1.25 per 1,000 cubic feet with the newer form of gas lamps, high efficiency is possible. The chief disadvantages of gas for illumination, are the fragility of the mantles which are short lived in the prescience of vibration, and also apt to be broken by accident, or by the inconvenience accompanying their replacement. The mantles moreover deteriorate with age, and must be watched carefully since if not promptly renewed when punctured the escaping jet of gas will break chimney and reflector. Gas is likewise hot in summer, and the upward current of hot air carries dirt and dust with it to be deposited on the ceiling. The danger from matches and the consumption of oxygen has been already mentioned.

I give below a table furnished by the Welsbach Company showing the consumption in feet of gas per hour and the effective lumens per cubic feet of gas consumed.

	Cu. ft. per hr.	Lumens per cu. ft. with Light ceiling and Light Walls.	Lumens per cu. ft. with Light ceiling and Dark Walls.
Reflex lamps, frosted tip cylinders			
Holophane concentrating reflectors	3.5	125	114
Same with distributing reflectors	3.5	110	100
Same with French roughed ball globe	3.5	95	70
Reflex cluster lamp, four mantle, with alabaster globe	13	85	64
Inverted 5-mantle arc with alabaster globe	16.6	87	65
Upright 4-mantle arc with same globe	20	66	48

Fig. 6 shows a typical distribution of 2-light, 3-light and 4-light Reflexoliers with Holophane reflectors and clear cylinders. The consumption and candlepower of these units are as follows:

	Gas per hr.	M. S. C. P.	M. Lower H. S C. P.
2-light	6.27	88.6	154
3-light	9.55	140	242
4-light	12.6	171	302

These are typical of the most efficient form of gas lights for interior use and with given values for gas, they may readily be compared with electric lights.

The distribution shown in Fig. 7 is around a gas lamp used for window display and consuming 3.12 cubic feet per hour. The question of the cost of gas versus electric light will be taken up more fully in a later number of this article in which the cost of illumination will be taken up in detail for each kind of light.

The proper quantity of light for the lighting of any space is that quantity which will properly and adequately light it under all the varying conditions of its use. And it should be so distributed, and so arranged, and so controlled at each outlet, at the will of the user, as to get the most results from it that he desires at any particular moment. Single unit high wattage lamps will not permit of this. The quantity of light at each outlet should be broken up into small wattage lamps to permit of such variation in quantity as the requirements demand.

Alternating Current Engineering.

(Contributed Exclusively to SOUTHERN ELECTRICIAN.)

BY WILLIAM R. BOWKER.

In the last issue transmission and distribution problems were discussed. In this article, the subject of application of alternating current motors is taken up. In the alternating current system where energy is transmitted over a distance for practical utilization of motors for power purpose, both synchronous and induction (asynchronous) motors may be used. The choice is largely determined by service requirements in combination with the effect upon power factor and electrical condition of the system in general.

Types of alternating current motors will now be taken up and their use explained. The single-phase alternating current motor is called a synchronous motor because it works in synchronism with the generator. It possesses two great disadvantages. (1) It is not self-starting and must be brought up to the proper speed before being connected in circuit, and (2) its field magnets must be separately excited.

With two-phase and three-phase motors (each polyphase motors) the principle of action depends upon a rotating or rotatory magnetic field. They are self-starting and called asynchronous motors being more generally known however as induction motors. In this type there are two chief parts composing the apparatus, one part at rest called the stator and analagous to the primary receiving circuit of a stationary transformer, the other part rotating called the rotor and analagous to the transformer secondary circuits, only it delivers mechanical power through the inductive action between the stationary stator and movable rotor instead of secondary currents as in the case of a transformer.

Both single-phase and poly-phase motors may be divided into two distinct classes, namely: synchronous and asynchronous, these names already being referred to above. The synchronous motor is one which runs perfectly in step or phase with the alternating current supplied and consequently runs at constant speed. The asynchronous or induction motor does not run in synchronism with the alternating current supplied and does not necessarily run at constant speed.

Any alternating current generator can be run as a synchronous motor. The single-phase synchronous motor is simply a single-phase alternator reversed. When its armature is supplied with an alternating current, and once brought up to a constant speed so as to be in synchronism with its generator, its field magnetism being separately excited with a direct current, it may be fully loaded and do work without being thrown out of synchronism.

For long distance transmission of power, constant speed and steady running with variable torque, the single-phase motor is perfectly adapted. There is, however, a limit to its usefulness. (a) It is not suitable under conditions when the power has to be divided into separate and small units. (b) It is not self-starting, without special devices, as it possesses practically no initial torque. (c) There is a limit to the load that it will take, and it is liable to a sudden stoppage by a temporary overload throwing it out of synchronism.

The necessity of separate field excitation by a direct current is also a disadvantage. Many devices, however, have been introduced to render this type of motor self-starting, and in this way its sphere of usefulness has been considerably enlarged. On the other hand it offers certain advantages. (a) The speed of the motor is very constant and uniform, a property desirable and essential in certain service requirements. (b) The synchronous single-phase motor has a great advantage over all other alternating current apparatus in the fact that no phase difference between voltage and current is caused by its practical use.

Owing to the above mentioned disadvantages, two-phase and three-phase motors have become generally used. The distinguishing features of the poly-phase motors are: (1) The rotating magnetic field and (2) the initial torque due to the inductive action which results between the stationary primary stator circuit, and the closed rotor secondary circuit which is practically a closed or short circuited armature. These are known as induction motors, and require no commutator. Unless a special starting resistance is used in connection with the rotor circuit, no slip rings or brushes are required, as there is no electrical connection between the external circuit and the secondary rotor circuit.

Without the starting resistance these induction motors have sufficient starting torque to enable them to start under load and for general purposes they have a fairly high efficiency. Motors of this type are called asynchronous, because their working principle depends on the fact that they do not run synchronously, their speed being less than the speed of synchronism. The difference in amount between the rotor speed of an induction (asynchronous) motor, and the speed of rotation of the revolving magnetic field is called the slip. The asynchronous motor is self-starting under load, and the slip increases as the load increases. If the slip at half load, that is, at half normal full load, is one and one-half per cent., it will be about three per cent. at full load. In practice a slip of from two to five per cent. is allowed in large motors, but may run as high as 30 or 40 per cent. in small sizes. A variation of speed and variable starting torque may be obtained by inserting adjustable resistance in the rotor circuit through the intermediary of slip rings and brushes.

The synchronous motor is liable to develop a hunting action, due to variation of load and the resulting reaction on the electrical system. When the load on a synchronous motor is suddenly increased, the resulting action is for the motor to momentarily slow down, which by its reaction lags behind the generator in phase. When the motor has fallen behind sufficiently to absorb additional power to carry its load, it is still somewhat below synchronism, making it liable to fall still further behind. It thus demands an excess of power from the generator with a resulting quickening in speed above synchronism, finally gaining on the generator in phase until it is using less power than is required for its load, with a resulting slowing down and so on. This oscillation of speed above and below synchronism called hunting, is accompanied with fluctuating changes of the current between the generator and motor, resulting in a rapid rise and fall of the voltage or E. M. F. across the terminals of the motor. It is frequently a source of great practical inconvenience, especially where several synchronous motor or rotary converters, are run in parallel from the same electrical system. Hunting may also be caused by the periodic changes in speed of the engine or prime mover that drives the generating alternator, and the practical remedy is by use of heavy copper frames or dampers partly covering the edges of the pole pieces of the field magnets both in the generator and synchronous motor.

The synchronous motor is in most respects identical with the poly-phase generator, and its speed is independent of loads and impressed voltage, only within certain practical limits of the latter, the speed being determined by the periodicity. One of the chief reasons for the use of the synchronous motor is that at proper excitation, they have a power factor nearly unity, and a little more can be obtained from them than with a non-synchronous equipment, other conditions being equal.

A valuable feature in connection with synchronous motors is that by a variation of excitation, they can be employed to compensate for lagging currents or phase difference, resulting from the use of induction apparatus. It is thus possible to get rid of undesirable practical disadvantages which adversely effect the desirable and essential requirement of high efficiency of the system in general. This is done by neutralizing the detrimental influence of the wattless component upon the pressure or voltage regulation of the generator, the line drop, and the overload capacity of the motors working on the system. Since the output of alternating current motors varies as the square of the impressed voltage, a serious trouble must be provided against, due to any resulting excessive voltage when subjected to an overload.

While single-phase synchronous motors possess no torque except when running in synchronism and can not start themselves, that is, possess no starting torque, poly-phase synchronous motors for multi-phase circuits will come up to synchronism, if subjected to only a very light load, giving about 25 per cent. starting torque. Starting as induction motors with the direct current field open after synchronism is attained they may then be loaded. In every day practice they are most suitable for powers of large magnitude, being freqenutly so arranged that it is unnecessary to start under load. They are mostly used in sub-stations of large electrical supply companies, where skilled attendance and operation is available.

The power factor of a synchronous motor may be controlled by varying the field excitation and over-excited motors of this type are frequently utilized for the purpose of compensating the lagging currents due to a number of induction motors on the system. One large sized motor is often efficient to compensate for the effects due to a number of induction motors on the circuit, thus improving the power factor. When used in this way it is called a synchronous condenser. Considerable care must be exercised in the practical employment of synchronous motors, their best working conditions being when the load is approximately steady, otherwise they are liable to cause inductive effects that are undesirable in practice.

The exciting field of this type of motor can be adjusted for a particular load, so that there will exist no phase difference between voltage and current, that is, neither lag or lead, but unity power factor. Further, it is possible by adjustment to produce a leading current, thereby compensating for, or neutralizing any inductive drop or phase difference on the line or service.

If a synchronous motor is inserted in the line circuit of an electrical system, and not subjected to load conditions, the control and raising of the power factor is very efficient and when employed under conditions that require the compensating of induction effects, which cause a lowering of power factor and general efficiency, the condenser effect comes in and thus the reason for the motor being called in such cases a synchronous condenser.

If the load fluctuates on a synchronous motor, there is likewise a change in the value of the power factor, and a readjustment of field excitation becomes necessary. With a variable load the current will lead with a decreased load, and lag with an increased load. A synchronous motor with a steady load and over-excited field so as to produce a leading current, can, however, be adjusted to exactly compensate or neutralize the effect of one or more induction motors which induce lagging currents.

The practical working conditions under which it would be advisable to use either a synchronous or an induction motor are as follows: If the requirement is to start under full load torque, an induction motor would be employed, if the circumstances are such that the motor starts light, with no load and is subjected to a load after having attained full speed, then either type of motor could be used. The synchronous motor possesses the advantage of high power factor but the disadvantage of separate direct current excitation, whereas the induction motor has a definite and lower power factor that is constant for a given load. The synchronous motor possesses the advantage that its power factor is adjustable by variation of field excitation, and can be made to suit the requirements of a power transmission system.

Synchronous motors commonly start with a reactance in their armature circuit of sufficient magnitude to keep the starting current down to a value not greater than 50 per cent. of normal full load current. Induction motors starting under light load and employing a short circuited rotor, are generally started by devices for decreasing the line voltage, these being inserted in the main line primary stator circuit for decreasing the impressed voltage and keeping the starting current to a value of little more than full load current. If overloaded beyond a certain practical limit, either motor will come to a standstill. While the induction motor can recover and restart under load, the synchronous motor will have to be restarted under light load, and again run up to synchronism, after which it can be loaded.

The next section of this article will take up the generation of poly-phase current and a discussion of the rotating magnetic field.

Testing Transformers and Locating Troubles.

(*Contributed Exclusively to* Southern Electrician.)

BY S. H. BROWN.

WHEN it was first discovered that the cutting of a magnetic field by a wire produced an electric current in the wire, the foundation was laid for the betterment of existing industrial conditions. These conditions have been attained through many intermediate steps. The direct current generator was developed, changing the alternating current set up in the revolving wires to a continuous current flowing in one direction. This type of generator was sufficient to operate the apparatus then employed, however if a voltage differing from that generated was desired, complications naturally were met with. With the introduction of alternating current apparatus, conditions were greatly changed and phenomena made use of which had been known but not applied.

The transformer is among the important inventions brought out in this way. This device is now generally familiar and known as an electrical appliance for changing the voltage in an alternating current circuit. It is made up of two separate and distinct coils of electrical conductors wound around or through an iron core, one of these coils being termed the primary, the other secondary. The primary receives the alternating current from the generator, being connected to the generator side of the system, so-called.

As alternating current travels in a wave form and fluctuates from a maximum positive value through a zero value to a negative maximum, this rapid change sets up a magnetic field in the core of the transformer which changes in value as the alternating voltage. The secondary winding while stationary, is influenced by this changing magnetic field and gives the same results as if moving wires were cutting a stationary field. An alternating voltage is therefore set up in this secondary winding which is proportional to the number of turns in the primary and secondary coils.

Theoretically this result would be represented by the formula:

$$\frac{\text{Secondary turns}}{\text{Primary turns}} = \frac{\text{Secondary volts}}{\text{Primary volts}}$$

However in practice this is not exactly the case. When the transformer is loaded, the theoretical conditions vary somewhat, the variation being known as the regulation. This means that when full load is thrown off, the secondary voltage will rise a certain per cent., usually not exceeding 1 per cent. This voltage drop in the transformer is chiefly caused by the inductance of the windings, also to some extent by the ohmic resistance. When the secondary is on open circuit an e. m. f. is generated in each turn equal to the counter e. m. f. per turn in the primary. When the secondary circuit is closed however through a resistance as when load is thrown on, the current flowing tends to decrease the core flux demanding an increased current in the primary to restore the core flux to its former value. The power factor of the systems has an effect, as regulation of a transformer on inductive loads is worse than on non-inductive loads.

The characteristics of the transformer have made possible the transmission of electrical energy economically over long distances at a high voltage. Transformers are being built for commercial service at 110,000 volts, and it now seems that the greatest distance to which electric power can be transmitted is only limited by the amount of revenue to be obtained.

A constant potential transformer is referred to as step-up transformer if the delivered voltage is greater than the supplied voltage, or with the delivered voltage less than the supplied as a step-down transformer. They are usually of the shell type or core type, both being manufactured and arguments given by the manufacturers as to the advantages of each type. The question as to particular merits of each type is generally determined by the space-factor of the windings, which is the total amount of space occupied by copper. As the remaining space is required for insulation and ventilating ducts, it is evident that small high voltage transformers should have a large percentage of insulation, and large low voltage designs a large percentage of copper. As the shell type offers the greater winding space factor, and the core type the better insulating factor in small sizes, we can readily see that small high voltage transformers should be of the core type, and large low voltage designs of the shell type.

The transformer in practical operation is a much abused piece of electrical apparatus. All kinds of service is expected from it under any and all kinds of conditions. Since the maximum load exists for only a few hours daily, the tendency is to increase this load beyond safe limits, the transformer being fused to such an extent that it would require several times normal load to blow the fuse. The smallest fuse is 18 per cent. German silver, which requires one ampere to melt, which means a load at 2200 volts of 2.2 K. V. A. It must be admitted that less than a 7½ ampere fuse is seldom used, which means a load of about 16 K. V. A. at 2200 volts. This explains the reason why manufacturers' reports show that about 75 per cent. of burned out transformers returned to them are below 5 K. W.

The term burned out is used here in connection with transformers which become damaged and must be removed from service. The transformer may be burned out by developing a short circuit or by being overloaded. When a transformer develops a short circuit and is properly fused the chances are it will not be greatly damaged. When burned out from overload however the coils are generally charred and brittle and the transformer is practically destroyed. A short circuit in the primary winding does not necessarily damage the secondary winding, and also a short circuit in the secondary does not necessarily damage the primary winding. In damp localities water sometimes gets into transformers, which is due to a so-called breathing effect, caused by the continual changes in load. Manufacturers are endeavoring to eliminate this trouble by using impregnated gaskets placed between the case and the cover and by sealing up the outlets for the leads with an insulating compound.

With the rapid development of water powers, there is a constantly increasing demand for transformers of large size and higher voltages. The first transformers for this service were of the air-cooled type, but as it is not practical to build these for use on circuits of over 30,000 volts, they are being replaced by the oil insulated type. These can be built of nearly any size and voltage. The most common type of the larger high voltage transformers at present are oil insulated and water cooled, although transformers have been built as high as 1,000 K. W., 100,000 volts, oil insulated and self cooling. This latter type requires an enormous amount of heat radiating capacity, and the transformer case must be of special design. Due to the fact that it will require considerable space and time to discuss the merits and demerits of the different designs of transformers such will not be included in this article. The main idea in the foregoing remarks has been to give a brief idea of transformer principles and lead up to the subject of testing and locating the various troubles which may arise.

Transformer testing has already received a great deal of attention, and considering the number and variety of articles on the subject the ground may seem to be covered. However the writer has found through his own experience that such is not the case. Through the changes that have taken place and the rapid advance in transformer design, it has been found that what is suitable for small transformers is entirely unsuited for large sizes, and methods which applied very well to low voltage must be modified or entirely abandoned for high voltage apparatus. I shall therefore give a few simple but important tests for the central station man.

CONVERSION.

This test, while a simple one to make, is extremely important, especially where the transformers under test are intended for parallel operation or for delta connection to three-phase lines. The best method is to use a standard multi-ratio transformer and a single voltmeter. Then by applying a suitable common voltage to the high tension side of the transformer under test and the standard, the two low tensions can be compared and the true ratio obtained. It is extremely important that the transformers should be connected just as they are intended to operate in service, as for instance single-phase transformers which are required to operate in parallel on single-phase circuits, or delta on three-phase circuits, also delta-connected phases in three-phase transformers. This will allow a test to be made for circulating current and will serve as a check on conversion measurements.

POLARITY.

This test can be performed either by direct comparison with a standard transformer, or applying direct current to the high tension winding. Then take a direct current voltmeter and note the position of positive and negative connections, then shift the voltmeter to the low tension winding and note the deflection on breaking the direct current circuit. This is the best method to use for testing large power transformers with differing voltages. However when testing a large number of small transformers with the same ratio, the first method is sufficient. The polarity test is not necessary when using transformers of the same type or design. It is necessary, however, when transformers are to be used in panalled and of different manufacture. The test avoids the possibility of connecting them in such a way as to short circuit the one on the other.

RESISTANCE AND COPPER LOSSES.

An attempt to discuss this test will not be made, as it involves considerable discussion and is not necessary for the average central station. The losses in a transformer consist of copper and iron losses. The copper losses vary with the load while the iron or core losses remain about the same for all loads. It is necessary therefore in order to obtain good efficiency at light loads to reduce the core losses to a minimum.

REGULATION.

Regulation in a transformer is the percentage drop of secondary voltage from no load to full load, the primary voltage remaining constant. Good regulation is of much importance in a transformer as there is no way of compounding it for voltage drops as with a generator. However the best types of transformers will now regulate within 1 per cent. unless it be in very small units.

A rough test for regulation can be made by placing a full load on the transformer and connecting a voltmeter across the secondary, apply a constant primary voltage, note secondary reading on voltmeter, throw load off and again note secondary reading of voltmeter. The regulation will be the percentage difference between the full load and no load readings.

OVER-POTENTIAL TEST.

This test is important, especially on transformers that blow fuses on no load but operate all right when loaded. This trouble is generally known among the manufacturers as a high-resistance short circuit and is sometimes very confusing and difficult to locate. This kind of short circuit will generally clear itself after the transformer is loaded, on account of expansion of the coil which separates the wires that were nearly in contact. This trouble can generally be located in the following way, provided low tension transformers are dealt with. Take two standard transformers 2200 to 110 volts and connect their secondary coils in multiple through a few lamps, and the primaries in series. This will give 4,400 volts as shown in Fig. 1. On low voltage transformers this test is not difficult, but where the voltage is high it is an entirely different question, chiefly on account of the absence of a suitable means of measuring high potential.

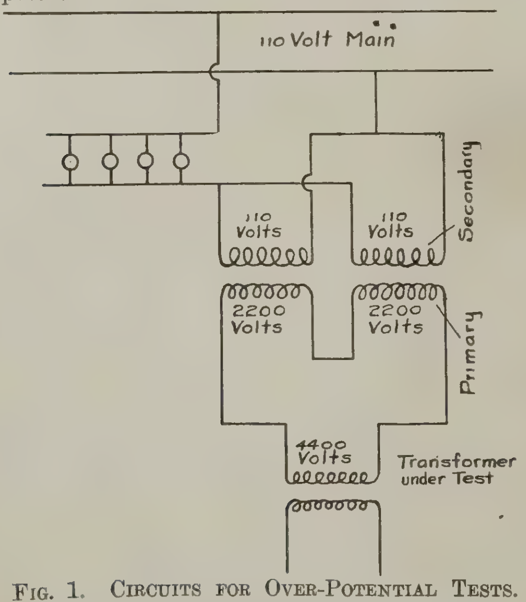


FIG. 1. CIRCUITS FOR OVER-POTENTIAL TESTS.

Care must be exercised in making the high potential test, as insulation resistance decreases at a rapid rate as the length of time double potential on transformer increases. About one minute is long enough to keep the insulation under this strain.

HIGH-VOLTAGE INSULATION TEST.

This test is just as important as the high potential test referred to, as it determines the insulation strength between turns, between layers, and between leads. If the transformer withstands double voltage, internal conditions are assumed to be in first-class condition. We have on the system with which the writer is connected several 50 K. W. transformers installed on an overhead circuit and also underground, and when we have an occasion to bring in one of these transformers it is put through the following test which may prove of interest. The coils and core are taken out of the casing and given a thorough drying out, which is done in the following manner as shown in Fig. 2. Short circuit the secondary windings and connect the primary to 110 volt circuit through a suitable resistance to give the transformer full load current determined by the ammeter. Place a thermometer in the winding and heat transformer up to about 50 degrees C., by which time it will be pretty thoroughly dry. Empty the oil out of the case and after giving the case a thorough cleaning, replace the oil in the case. Get a few coils of ordinary iron wire and connect them in series with 110 volt and place the coils in the case keeping them submerged by the oil, taking care to have enough iron wire coils to allow about 100 amperes to flow for heating the oil. Place a thermometer in the oil and gradually bring the temperature up to about 240 degrees F., which will evaporate all the moisture from the oil. Allow the oil to cool down to about 140 degrees F. and then with the core and coils heated to about 45 degrees C., and after making a high voltage test between layers, between turns, between leads and between core and coils, again replace the coils and core in the case, the transformer is then ready for service. In applying this voltage test the same connections as shown in Fig. 1 can be used, by taking the two 4400-volt leads and touching them between turns, between layers, between leads and also from leads to transformer core. This will put the transformer through a very good test as to grounds and short circuits.

Transformers should be inspected for height of oil every spring before the storm season begins, and at the same time

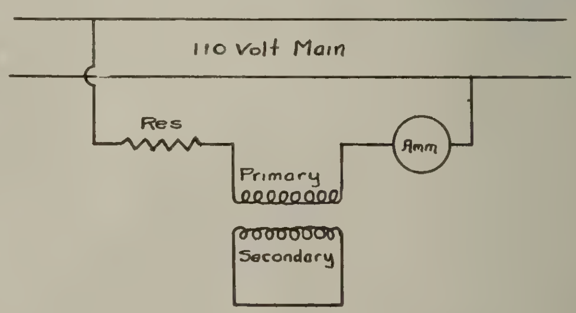


FIG. 2. DIAGRAM FOR DRYING OUT COILS.

note if there is any water in the bottom. A very convenient way to do this is for the inspector to be supplied with a glass tube with which he can take a sample of the oil from the bottom of the case. It is only necessary to close one end of the tube with the finger, lower the other end to the bottom of case, remove the finger and give the oil a chance to rise in the tube, then close end with the finger again and raise the tube.

If there is any water in the oil it will have collected at the bottom, the proposed method affording a ready means of taking a sample of the bottom oil and indicating this. Testing as a whole requires painstaking and constant study and the changing conditions of design and construction must be carefully followed.

Technical Features of Telephone Work.

BY R. M. FERRIS AND DR. JEWETT.

THE problems which the technical men in the telephone field are constantly working on, present interesting material to those interested not only in the telephone business but in engineering problems in general. In a lecture at Cornell University, Mr. Ferris and Dr. Jewett took up this subject in an interesting manner. We publish it as reported by the Sibley Journal of Engineering as follows: The very rapid advances which are now being made in many directions in the telephone art and the very large additions which all of the companies are making to their plants necessarily impose very serious responsibilities on the technical men in the business who are responsible for preparing the plans for the proper expenditure of very large sums of money and then seeing that the money is properly expended in accordance with the plans. Looked at from a purely scientific point of view, the importance of a given class of work would be independent of the amount of money, the expenditure of which was dependent upon it. From an engineering point of view, however, the amount of money to be expended has a great deal to do with the importance of the work. No matter how interesting from a scientific point of view a given question may be, from an engineering point of view it is of little or no importance if only the expenditure of a small amount of money is dependent upon it. On the other hand, if a method of expending large amounts of money is dependent upon the decision obtained on a certain physical question, then this question becomes one of great engineering importance. In the telephone business it is the combination of the large amount of money expended and the interesting scientific nature of the questions which must be solved in connection with its proper expenditure that make this work so absorbing to those engaged in it. The following I think will be sufficient to illustrate the nature of some of this work.

In order to establish telephone service in any large city, such as New York, or Brooklyn, or Buffalo, it is necessary of course to have one or more large central offices containing the telephone switchboards. The telephone lines throughout most of the city must be carried underground in telephone cables, which must be placed in telephone subways. Before any actual construction of the plant can be intelligently done, it is necessary to know whether there should be one central office in the city or whether there should be more than one; where the office or offices should be located; how large the various switch boards should be; and of what type they should be. With reference to the subways and cables, it is necessary to know in what streets they shall be run; how large the subway system should be built; the types of cables that should be used; and many other points.

The solution of a problem such as this for any large city is a very complex engineering question, and it is to the solution of this problem as a whole or to the solution of various parts of it, that we have given the name of "Fundamental Plan." The method of making a fundamental plan is briefly as follows: It has been determined that plans should be made for a period of about fifteen years, and estimates of the number of subscribers' lines which we will have in a city at the end of that period are made and a distribution of these lines laid out in the various sections of the city, the distribution being based on the character of the various sections and their possibilities of development as can be best foreseen. After this has been done, various arrangements of central offices are laid out—say an arrangement of five, ten, and fifteen offices. The total annual costs of each of these arrangements is determined, and the most economical arrangement selected.

The fundamental plan indicates what arrangement of offices it will be most economical to have at the end of the period in question; it does not indicate when or in what order the offices should be established, and there is a great deal of engineering required in the proper application of this plan in order that we may not only have a proper arrangement of offices at the end of the period in question, but that from year to year, as the plant grows, the number and arrangement of offices should be proper for the conditions existing at that time. For example, in case a central office building is becoming congested, we have to consider whether it would be more economical: 1. To enlarge that building; 2. To take care of the growth by transferring a portion of the district to another district; or 3. To put up a new building and switchboard. Besides these alternatives, there are often other alternatives which can be followed.

If we find that it is economical to establish a new central office building, the amount of space required for central office purposes and for other purposes is determined, and the most economical floor plan for such a building and the size and shape of lot necessary for its accommodation are next studied and determined. This information having been given to the business management, a search for real estate is made in the vicinity of the telephonic center as determined by the fundamental plan, and prices obtained on a number of sites located in the vicinity. After excluding those sites which are not of suitable size or shape, the remaining sites are considered and the asking price of the property weighed up against the costs for subways and cables, which costs are of course different for each site and which becomes greater and greater as the sites are located more distant from the telephonic centers, this center being by definition the point at which the subway and cable costs are a minimum.

Having determined the most economical site and this site having been purchased, the next point to be settled is to prepare the preliminary floor plans of the building which are to serve the architect as the basis for his work. The preparation of these preliminary plans involves working out in detail the design of the telephone switchboard in order to determine the amount of equipment of various classes to be provided. It involves a careful consideration of the matter of bringing the underground cables into the building and the arrangements through the building in order that such cables should be brought up to the terminal room, and a careful consideration of the matter of bringing the underground cables into the building and the arrangements through the building in order that such cables should be brought up to the terminal room, and a careful consideration of the location of the various parts of the telephone apparatus in order that such arrangements might be the most economical and convenient.

Having completed these preliminary plans and indicated not only the central office arrangements but also the arrangements for other purposes, the plans are placed in the hands of the architect who prepares the detailed plans and specifications. The architect's plans and specifications are of course checked and then the contract for the building is let. Soon after the building is started the detailed plans and specifications for the telephone switchboard must be written and sent to the contractor who manufactures these switchboards. In connection with the design of the switchboard, much study of an engineering nature is required to determine what constitute desirable and economical operating methods. Our methods of handling business are not determined by the types of apparatus which we build, but the converse is true. The proper methods are first determined and then, as far as physical conditions will permit, apparatus is designed to meet those methods.

In addition to the work described above, the study and development of new methods of construction in what we call the "outside plant," which consists of underground conduits, underground and over-head cables, pole lines, etc., involves many engineering problems, in order to ascertain the most economical types of construction to meet various conditions. Much interesting work has been done recently with reference to timber preservation, design of concrete poles and other fixtures, design of submarine cables to meet peculiar telephone conditions, etc.

The efficiency of transmission of lines and apparatus is most important, and underlies the design of almost every part of the telephone plant. In power transmission work, it is necessary that considerable amounts of power be transmitted over lines with a small loss of power in the lines themselves. In telephone work it is necessary to transmit small amounts of power much greater distances, and it is necessary that there shall be, not only a small loss in the amplitude of the wave, but that the wave form itself shall not be distorted. Important studies are made to see that a proper grade of transmission is obtained in the most economical manner.

EXTENSION OF THE COMMERCIAL RANGE OF TRANSMISSION.

With the growth of the Western sections of the country there has come an increasing demand for the transmission of speech to distances greater than 1000 miles and a problem has arisen quite as difficult as that confronting the engineer who transmits large quantities of electrical power over long distances. In certain ways the problem is even more complicated since the transmission must be affected without serious loss in intensity and also without appreciable change in the form of electrical wave transmitted. At present the telephone companies are preparing to meet the problem of extending the limits of satisfactory commercial operation from the Atlantic coast cities to points beyond the Mississippi Valley, which is now the Western limit.

To effect this improvement involves the whole telephone plant in the region affected. This is evident from a consideration of the system of connections involved when a subscriber in New York City is talking with one in Chicago. The scheme of connections is indicated systematically in Fig. I.

The connections are as follows: New York. a. From subscriber's instrument to the local exchange board; b. From local exchange to outgoing toll board, over toll lines; c. Over long distance toll lines to switching board in Pittsburg; d. From Pittsburg over toll lines to Chicago toll board; e. From Chicago toll board to local exchange; f. From local exchange to subscriber in Chicago.

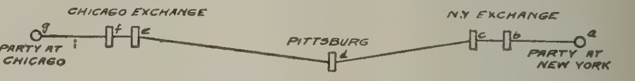


FIG. 1. SCHEME OF CONNECTIONS FOR A CALL BETWEEN NEW YORK CITY AND CHICAGO.

Thus, there are five switching points between the two subscribers, and at every switching point the resistance of the switching apparatus adds to that of the long connecting lines and lowers the efficiency of transmission of the talking currents.

Another feature which is rendering long distance transmission more difficult is the growing necessity of putting the telephone lines under ground, for greater and greater distances as the municipalities passed through extend their borders. As the capacity of under ground cables is far greater than that of aerial lines the difficulties of transmission are increased by this change, or the effective distance of transmission is increased.

While there has been a steady advance in the quality of instruments used, this growth has not kept pace with the substitution of cables for overhead wires, so that other means must be relied upon for improvement and extension of service. The greatest aid thus far discovered is the "loading" system devised by Prof. Puppin, who discovered that if induction coils be placed at intervals along the telephone cables, the capacity of the lines may be compensated for and the distance of possible transmission greatly extended. Thus the efficiency of transmission is increased as much as two to three times that of the same cables without loading.

An added effect can of course be obtained by lowering the resistance of the lines by increase in area of wires used. By this means the transmission losses, due to the switching apparatus interposed in long distance work, may be made up by the use of more copper in the lines joining switching points. It becomes an interesting problem in finance to figure what changes will affect the desired

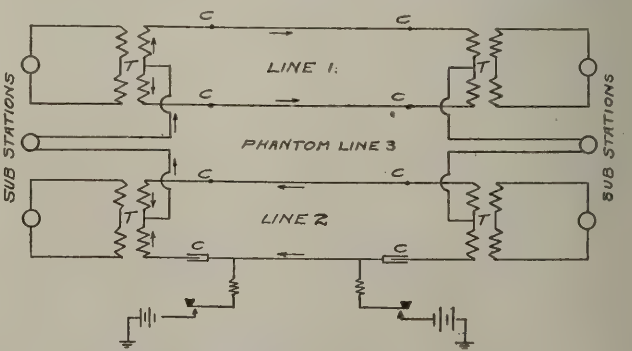


FIG. 2. DIAGRAM OF PHANTOM CIRCUITS.

increase in commercial range of speech transmission with the greatest returns for the money invested. This problem becomes of especial interest when it is desired to add the necessary apparatus so that the lines may be used for the greatest possible number of messages in a given time.

BY-PRODUCTS OF THE TELEPHONE BUSINESS.

It is common practice to arrange lines to transmit simultaneously telegraph and telephone messages. More than this, by properly combining the lines, more than one telegraph message may be sent at the same time, and it is even possible for the wires to transmit more than one telephone message at one time. Thus, in addition to loading the lines, the telephone engineer plans to increase its efficiency by arranging the line to accommodate both kinds of service. With two pairs of wires between, say, New York and Pittsburg, it is possible to transmit, at the same time, three telephone messages and eight telegraph messages.

The method by which this is accomplished is shown in Fig. 2. At the mid-points of the transformers, *T*, taps are taken off at each end of the system and carried to receiving apparatus. As indicated by the arrows, talking currents which come equally on both wires of, say, line 2, pass in opposite directions through the upper and lower halves of the transformer and so neutralize one another so far as their effect in the secondary of this transformer is concerned, so that they do not affect the receiving apparatus of line 2. They are, however, received in the apparatus of line 3, whence they pass through the transformer on line 1 without being there detected, and return to the sending station along both wires of line 1. Thus it is possible to send telephonic messages along line 1, line 2 and this "phantom" line.

If now, condensers be inserted at *C*, in each of the four wires, it is possible to take off to telegraphic apparatus using one wire of the telephone system and the ground for return. The condenser allows the high frequency talking currents (as high as 2000 cycles per sec.) to pass unimpaired, but prevent the passage of the telegraph currents. The telegraph apparatus tapped in beyond *C* has an inductance coil *L*, which prevents the passage of the high frequency talking currents but does not affect the telegraphic impulse. By the well known system of "duplexing" a line two telegraphic messages can be sent over each of the four wires at the same time so that we have the three telephone and eight telegraph messages at one time.

Remarks on Description of Harmonic Instrument.

The following letters have been received referring to the description of the Harmonic Instrument for determining alternating flux weaves, as published in the June issue of SOUTHERN ELECTRICIAN:

EDITOR SOUTHERN ELECTRICIAN:

The June number of the SOUTHERN ELECTRICIAN has been received and I have read the article on the "Harmonic Instrument." Judging from the cut in the article, the instrument is carefully worked out as regards mechanical construction, and I should judge would work satisfactorily. The theory of the instrument is based, of course, upon the article by Lloyd and Fisher published in the *Bulletin of the Bureau of Standards*, May, '08. The designer of the Harmonic Instrument has evidently broadened its scope so that it is applicable to alternators having any number of poles, while Lloyd and Fisher designed their instrument for a 4-pole alternator. It is to be regretted that the article does not go into the construction which broadens the scope of the instrument, the part in the design really new.

The Harmonic Instrument can be used to obtain E. M. F. and current waves as well as flux waves, as pointed out both by the author of the article in the SOUTHERN ELECTRICIAN and by Lloyd and Fisher, but it is my belief that the use of one of the many "point by point" contact-makers designed especially for E. M. F. waves will give better satisfaction than the use of a flux instrument converted into an E. M. F. contact-maker by means of auxillary apparatus.

The determination of flux curves by a machine instead of indirectly from the E. M. F. curves by laborious computations or graphical constructions is certainly a step which conserves time and energy and makes for accuracy.

C. A. PIERCE.

Cornell University, Ithaca, N. Y.

Sign. Montford Morrison,
Care of Editor SOUTHERN ELECTRICIAN,
Atlanta, Georgia.

Egreggio amico:—

Nel numero di Giugno del "SOUTHERN ELECTRICIAN" mentre leggevo circa la vostra invenzione del "Harmonic Instrument" mi passo sotto l'occhio il nome d'un libro italiano "Teorica delle Froze Newtoniane," il quale dovrebe essere "Teoria delle broze Newtoniane," il quale dovrebe gere il resto mi fermai a la parola "Froze" e incominciai ad investigare in dizionari di parecchie lingue e con mia gran sorpresa trovai nel dizionario inglese che la parola "froze" e il passato di "freeze," che tradotto in italiano significa "gelato," ma ritornando al nome del libro, non me potevo persuadere chi era lo gelato, Newton, la teoria o il compositore. Ma riflettendo un po' sul soggetto mi immaginai che lo gelato doveva essere il compositore, perche ne sono sicuro che la teoria di Newton non gela essendo manipolata troppo da suoi studenti e Newton se anche avesse gelato, adesso e un po' troppo tardi di parlarne, percio ripeto che lo gelato deve essere il compositore.

Questa non e la prima ne l'ultima volta che io osservo questi errori nei giornali americani, percio questa volta ho creduto di farvene a voi noto come un stretto amico e uomo d'influenze. Fo questo non con intenzione di criticare, perche stimo l'intelletto americano troppo alto da esser criticato per cose cosi piccine, ma anzi cerco da voi un consiglio per poter mettere un riparo a questi errori che quantunque sembrino di poca importanza pur potrebero riuscire considerevolmente dannosi ai lettori.

In attesa d'un vostro favorevole riscontro e gentile cooperazione, credeteme vostro amico,

GIOVANNI CASACCIO.

Indirizzo futuro
Monterotondo, Provincia di Roma,
Italia.

Translating the above letter, it reads as follows:

June 10, 1911.

Mr. Montford Morrison,
Care Editor Southern Electrician,
Atlanta, Georgia.

Dear Friend:—

In the June number of the SOUTHERN ELECTRICIAN, while reading about your invention of the Harmonic Instrument, my eye passed over the name of an Italian book

"Theoretic of the Newtonian Frozen," which should be "Theory of the Newtonian Potential Function," but before reading the rest I stopped at the word "frozen" and began to investigate in dictionaries of several languages and to my great surprise I found in the English dictionary that the word "frozen" is the past participle of "freeze," which translated into Italian also signifies "frozen," but returning to the name of the book I could not decide for myself which was frozen, Newton, the theory or the compositor. But reflecting a little on the subject I imagine that the frozen one must be the compositor, because I am sure that the theory did not freeze, being manipulated too much by his students and too, if Newton had been frozen it is now a little too late to talk about it, therefore I must say again that the frozen one must be the compositor.

This is not the first nor the last time that I have seen these errors in the American journals, though this time I thought of sending you notice as a staunch friend and man of influence. I do this not with the intention of criticising, because I esteem the American intellect too highly to be critical on things so very small, but I do seek advice from you to be able to put a stop to these errors which may seem of little importance but yet able to do considerable harm to readers.

In awaiting a favorable reply from you and with your kind co-operation, believe me your friend,

Giovanni Casaccio.

Future address.

Monterotondo, Province of Rome, Italy.

The above letter is indeed a most tactful reference to an error of transposed letters. As we are not accustomed to courtesy of this nature in other similar cases, the letter contains something of a moral to other critical readers. We are thankful for calling attention to errors and like the spirit of our friend and author of the letter.—Ed.

Southern N. E. L. A. News.

The third annual convention of the Mississippi Electrical Association will be held in Gulfport, Miss., June 20th, 21st and 22d, 1911, and it is expected, judging from present reports, that the attendance will be more than double that of last year. The program for the convention meeting has been published and distributed, giving the proposed order of proceedings. The opening session will be held on Tuesday morning, followed in the afternoon by an executive session and papers on following subjects: "Relation to Employees to Company and Public," by A. B. Patterson; "Modern Street Lighting," by J. N. Eley; and "Electrically Heated Appliances," by L. Callender. On Wednesday morning papers will be read as folllows: "Economy of a 750-K. W. Engine," by D. R. Tomlinson; "Steam Turbines," by Edmond Dreyus; "Necessity of Commercial Departments," by A. H. Jones. In the afternoon on Wednesday, Jack Abbott will deliver a paper on "Economical Care and Maintenance of Street Cars." The Question Box will also be discussed and an executive session held.

The entertainment features have been liberally provided for, and something interesting will take place during each day of the convention. On Tuesday afternoon there will be a sight-seeing trip for the ladies, and in the evening a reception dance. On Wednesday afternoon an interurban trip will be made to Beauvoir and Biloxi, and in the evening a banquet held. On Thursday morning a trip is planned to Ship Island by boat. With these features well planned, all those attending will receive considerable benefit, both practically and socially.

In order to facilitate the registration of representatives, members and guests, a system of advanced registration has been adopted, and something special in the way of badges is being prepared. In order to carry out this plan, therefore, the secretary requests that all those planning to attend who have not received registration cards should do so, so that prompt attention can be given to the matter. The Great Southern Hotel at Gulfport will be the headquarters of the convention, and applications for accommodation should be made direct. A report of the convention proceedings will appear in the next issue of Southern Electrician.

Annual Convention of the A. I. E. E.

At the time this issue goes to press the American Institute of Electrical Engineers is holding its annual convention at Chicago. The headquarters will be at the Hotel Sherman, corner of Clark & Randolph streets and here most of the sessions, especially the technical sessions will be held. While the names of papers were published in the last issue of Southern Electrician, the completed program as it now stands is as follows:

On Monday evening June 26th, the convention will be opened by a reception and dance at the grand ball room of the Hotel Sherman. On Tuesday morning, the power station session will be held at 10 o'clock. This session will be opened by the address of president Dugald C. Jackson, followed by an address by the president-elect, Gano Dunn. The following papers will be delivered, "Development of the Modern Central Station," by C. P. Steinmetz; "Tests of oil Circuit Breakers," by E. D. Merriam; "The Use of Reactance Coils in Large Central Stations Systems," by R. F. Schuchardt and E. O. Schweitzer. At 8:30 p. m. on Tuesday, the electric lighting session will be held. The following papers will then be read; "Depreciation as Related to Electrical Properties," by Henry Floy of New York and "Important Features Entering Into the Making of Appraisals," by H. M. Byllesby of Chicago.

On Wednesday the railway session will be held at 10 o'clock. At this session the following papers will be read and discussed. "Some Data From the Operation of the Electrified Portion of the West Jersey & Seashore Railroads," by B. F. Wood of the Pennsylvania Railroad; "Analysis of Electrification," by W. S. Murray of the New York, New Haven & Hartford Railroad; and "Induction Machines for Heavy Single-Phase Motor Service," by E. F. W. Alexanderson of the General Electric Company. On Wednesday afternoon at 2:30 the industrial power session will be held and the following papers on industrial application of motors presented: "Automatic Motor Control for Direct Current Motors," by Arthur C. Eastwood of the Electric Controller & Supply Co.; "Some Limitations of Rheostat Control," by T. E. Barnum, of the Cutler-Hammer Co.; "Electrically Driven Reversing Rolling Mills," by Wilfred Sykes of the Westinghouse Electric & Mfg. Co.

In parallel with the industrial power session will be held the Telegraph and Telephone Session at which the following papers will be read: "Multiplex Telephony and Telegraphy by Means of Electric Waves Guided by Wires," by G. O. Squires, U. S. A.; "Telegraph Transmission," by F. F. Fowle, of Chicago; "Commercial Loading of Telephone Circuits in the Bell System," by Bancroft Gherardi, of the American Telephone & Telegraph Company.

On Thursday the high tension transmission session will be held at 10 o'clock, the following papers being taken up: "The Law of Corona and the Dielectric Strength of Air," by F. W. Peak, Jr., of the General Electric Company; "Dielectric Strength of Air," by Prof. J. B. Whitehead of The Johns Hopkins University; "Transmission System of The Great Western Power Company," by J. P. Jollyman, of San Francisco; "Transmission System of the Southern Power Company," by W. S. Lee, Charlotte, N. C.; "Transmission System of The Great Falls Power Company," by Max Hibgen of Butte, Mont.; and "Electric Line Oscillations," by G. Facciolo of the General Electric Company.

On Friday the general session will be held at 10 o'clock. The papers at this session will be on general engineering topics and as follows: "The Economical Design of Direct Current Electro-Magnets," by R. Wikander of Pittsburg; "Electrolytic Corrosion in Reinforced Concrete," by Prof. C. E. Magnusson and G. H. Smith of University of Washington; "Wave Shape of Current in Individual Rotor Conductor," by Hans Wsichsel of the Wagner Electric Company; "The Choice of Rotor Diameters and Performance of Polyphase Induction Motors," by Theodore Hoock of the Westinghouse Electric & Mfg. Co.; "The Application of Current Transformers in Three-Phase Circuits," by J. R. Craighead of the General Electric Co.; and "The Cost of Transformer Losses," by Messrs. R. W. Atkinson and E. C. Stone of the Standard Underground Cable Company.

On Friday morning a parallel meeting of the high tension transmission session will be held at which these papers will be read: "Solution of Problems in Sags and Spans," by W. L. R. Robertson of Philadelphia Electric Co.; "Sag Calculations for Suspended Wires," by P. H. Thomas of New York; "Mechanical and Electrical Characteristics of Transmission Lines," by Harold Pender and H. F. Thomson of Mass. Inst. of Technology; "The High Efficiency Suspension Insulation," by A. O. Austin of Ohio Insulator Company.

On Friday afternoon at 2 o'clock an educational session will be held at which the following papers will be taken up; "Tentative Scheme of Organization and Administration of a State University," by Ralph D. Marshon of New York.

The usual entertainment features have been cared for and arrangements have been made by the convention committee whereby this end of convention work will not be neglected.

The Electric City Club, Columbus, Ga.

This club was organized on March 22, 1910, for the purpose of bringing into closer relationship officers and employes of the Columbus Railroad Company and the Columbus Power Co., sociability and educational matters being given careful attention.

The club meets the first and third Friday night of each month at temporary headquarters in the offices of the Columbus Railroad Co., every meeting night bringing a large and enthusiastic attendance. Discussions on any electrical subject are always in order. The writer had the honor of attending a recent meeting and can report an enjoyable and helpful evening, as there were a number of interesting subjects discussed that brought out some very valuable pointers to all.

The club plans to give a number of outings during the summer months, one outing planned for an early date is a trip by automobile, a truck ride to Goat Rock, 15 miles north of the city to view the new impounding dam, which is about completed.

The officers of the club are A. A. Wilbur, president; H. M. Corse, vice-president, and Emmett Crook, secretary and treasurer. The membership numbers about 40 and is made up from the various departments of the two companies referred to above. The following is a list of members: J. S. Bleecher, T. W. Peters, C. M. Young, G. K. Hutchins, A. A. Wilbur, W. R. Clark, J. W. Bazemore, W. R. Duncan, H. O. Burnside, L. D. Bazemore, T. D. Ector, C. J. Brooks, T. L. Moss, S. D. Higgins, H. L. Averill, J. C. Cook, W. H. Speer, B. M. Lentje, D. H. Howell, Fred Tibbs, J. M. Flournoy, J. C. Fox, H. M. Corse, B. B. Hamby, J. N. Nollner, R. W. Smith, J. A. Cameron, Emmett Crook, S. L. Burney, C. Trull, J. O. Brown, B. M. McCullough, Harry Worley, Jeff Henderson, C. J. Snowden. It is the purpose of the club to soon affiliate with the Georgia section of the National Electric Light Association.

JNO. A. CULVER.

The Electrical Industry in Panama.

The only electric light company in the city of Panama is the Colon Electric & Ice Supply Co., which has one central station and charges the following prices: For installation, \$3; for connection, \$1; for one 40-watt tungsten lamp, \$1; for one 16-candlepower carbon-filament lamp, \$0.50; for one 32-candlepower carbon-filament lamp, \$1; and in addition a charge of \$1.75 a month is made for each light.

The company has a five-year contract with the National Government, dating from February 18, 1909, for the electric lighting of public offices, buildings, and the streets of Colon, under which it received for service during the month of January (1911) alone \$1,733. This would aggregate nearly \$20,800 a year; and if to this amount is added the \$15,000 paid by private consumers for current, some idea of the company's annual income may be obtained. The company has a monopoly of supplying Colon with ice, which it retails at 2½ cents a pound; and in conjunction with the ice plant there are cold-storage facilities from which a neat sum is realized.

While, of course, the Isthmian Canal Commission and the Panama Railroad Co. maintain electric light and ice plants, they supply only their own needs and those of their employees, and do not enter into competition with the Colon Electric & Ice Supply Co.

The only competitor of the electric light here is the incandescent kerosene lamp; but it is noticeable that those who find fault with the high price of electric illumination, or its service, generally go back to it even though the kerosene lamp is much the cheaper. An American incandescent kerosene lamp of 1,000 candlepower is a favorite in this market; placed in position, with tank, wire tubing, and pump, it costs \$89. There are, however, two German lamps which, by reason of cheapness, may develop into serious competitors. One of them requires neither tubing nor pump, only a tank, and is sold for \$48; the other, requiring pump and tank, costs \$40. Both of these lamps are 900 candlepower. Kerosene is sold here for 20 cents a gallon.

Two other kinds of incandescent lamps have been tried in Colon—the gasoline and the acetylene—but have not proved satisfactory. The former is considered dangerous, and gasoline is 40 cents a gallon here; the carbide necessary for the latter is very expensive, but an outfit of three lamps is priced at only \$40.—Consular Report.

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.

STARTING INDUCTION MOTORS.

Editor Southern Electrician:

(226) Please ask your readers to explain the methods which they considered standard practice for starting induction motors of 5 to 15 H. P., and from 25 to 50 H. P. Also furnish diagrams of the devices used. C. T. A.

A. C. WIRING SYSTEM.

Editor Southern Electrician:

(227) I would like to get from your readers information as to the system of wiring best adapted to a combination factory and office building for lighting and power. Our new factory will be about 200 by 60, two-story, with a 40 by 60 two-story annex which will be used as an office building. 10-5 H. P., 3-10 H. P., 2-25 H. P. and 4-50 H. P. induction motors will probably be used, besides lighting. Kindly furnish drawings showing scheme of connections for operating motors on 440-4 wire system if such is suitable and also give suggestions as to other systems which could be used. Would an isolated plant be profitable for this plant and if so kindly give data to show it. Suggestions on a lighting system would be appreciated, giving types and sizes of units. H. A. P.

IS WATTLESS CURRENT A WASTE?

Editor Southern Electrician:

(228) Kindly advise through your information columns as to whether or not a low power factor and considerable wattless energy means a loss or waste of the energy generated at the station. To what point is it advisable to raise the power factor on a system which, say, has now a 75 per cent power factor. That is at what point will the increased size of synchronous condenser be such that the expense is not justifiable if such a case is possible?

G. W.B.

SERVICE TRANSFORMER DIAGRAM.

Editor Southern Electrician:

(229) I would like to obtain an explanation of the connections and internal scheme of windings for a service transformer to be used with a balanced three-wire system, and providing arrangements for different voltages.

C. A. K.

CALL BELL WIRING DIAGRAM.

Editor Southern Electrician:

(230) Please publish a diagram for a residence door bell system which is considered most economical of wiring and high efficiency as to battery life and number of batteries needed. Two bells are to be operated at once, one at door and one in kitchen. The arrangement should be such as to enable the kitchen bell to be operated by a floor button in the dining room. I believe a system using three wires is most used. Kindly explain such by showing connections.

T. A. N.

CHOICE AND USE OF A STORAGE BATTERY.

Editor Southern Electrician:

(231) I would like to see a discussion in your paper as to the advisability of purchasing, installing and operating a storage battery in connection with the necessary generating equipment of a central electric lighting and power or railway station of four or five thousand kilowatt capacity or greater. (1) What conditions would make a storage battery desirable? (2) What would be the advantages to be gained by its installation and use? (3) Would not its high first cost more than counterbalance the advantages gained by its use? (4) Will not its first cost prohibit the installation of a battery whose ampere hour capacity is greater than the stations largest generating unit? Thus say in a station of 4,000 kilowatt capacity whose generating units were of the following sizes, three 500 kilowatt, two 750 kilowatt and one 1,000 kilowatt, would it be advisable to install a storage battery of a greater ampere hour capacity than the full load ampere capacity of the 1,000 kilowatt unit? (5) Assuming the battery to have been installed, what if anything besides assistance in the regulation of the voltage is to be gained by allowing the battery to float upon the station bus-bars during times of non-use or during times when it is neither charged nor discharged? (6) Would the regulation of the voltage afforded by floating the battery on the station bus-bars be equivalent to the regulation afforded by the installation of automatic field regulators or rheostats on the generators? (7) What can be said in favor of the installation of a storage battery at a remote point, say 5 or 6 miles from the central station on a railway feeder which is supplying a short suburban or interurban railway line. J. C. K.

OPERATION OF METERS.

Editor Southern Electrician:

(232) The writer will greatly appreciate descriptions and diagrams of the principles upon which the following switchboard instruments operate: Frequency meter; Synchronizing meter; Oscillograph; Power factor indicator.

E. W. T.

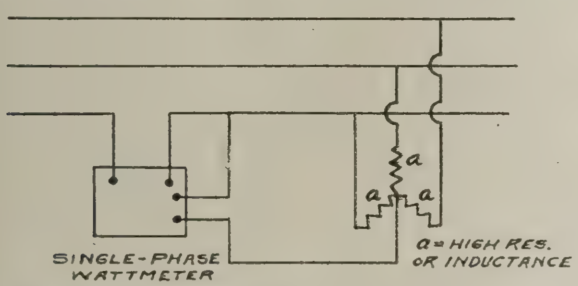
Measuring Power of 3-Phase System, Ans. Ques. No. 205.

Editor Southern Electrician:

I note in your June issue two comments on my answer to question No. 205. While I believe the method is clear to anyone who has carefully read my answer, I will go into further details for the benefit of Mr. McCoy and Mr. Hayward and furnish here a diagram of connections. If I have interpreted the original question correctly, G. W. B. desires to know if an approximate power reading can be taken by a single-phase wattmeter on a system containing only induction motors. If this assumption is true I believe my answer correct and the easiest method to employ. It must be understood that I do not consider it an accurate method, for if such is desired the two wattmeter method should be used, as the system is balanced, and something as described by Mr. Hayward.

Evidently the point objected to both by Mr. McCoy and Mr. Hayward is that the total power equals the meter reading in our phase times 3. In answer to Mr. McCoy I will say that wattmeters are effected by the power factor of the circuit if such power factor is low enough, however, if the instrument has been tested and properly adjusted and lagged so that the flux from the pole of the potential coil is 90 degrees behind the impressed E. M. F., it will read correctly on any power factor. All makes of meters are provided with this adjustment which is familiar to all who have had experience with wattmeters.

In answer to Mr. Hayward, I can see no excuse for his objection to the method except that he can not account for the addition of the reading of the two wattmeters in the two-wattmeter method and three times the single wattmeter reading in my answer. To use his own words I fail to see how anyone who pretends to know as much about poly-phase currents as he, should question the method. Evidently Mr. Hayward has never heard of the 3-watt meter method for measuring three-phase power and does not know that this is one of the most accurate methods, whether the load is balanced or not. However, this may be, when the three wattmeters are used the total power is equal to the sum of the three meter readings. It will be seen, therefore, that the meter reading in one phase as shown in the diagram, times 3 is based upon this method. It can only be depended upon for accuracy when a perfectly balanced load exists.



MEASURING 3-PHASE POWER BY A SINGLE-PHASE WATT METER.

It can now be asked if the system referred to by G. W. B. was balanced and the use of the single reading times 3 correct for the case. As stated before, if only approximate data is sought, yes. Unless an induction motor is poorly designed a balanced system will result, as the uniform winding and equal number of turns per coil will give balanced phases.

It may be well to state here that Mr. Hayward's two-wattmeter method should never be used on systems with grounded neutrals or when the load is badly unbalanced. In the first case we have a 4-wire system, the ground serving as a common return conductor for the three other conductors. Three wattmeters are necessary to measure the total power in both cases.

RAISING P. F. BY SYNCHRONOUS MOTOR, REMARKS ON ANSWER TO QUESTION 214.

I desire to ask Mr. Hayward how he arrived at his conclusion that only 30 per cent. of the rated capacity of rotary condensers are available for power factor correction and 70 per cent. for power. True 70 and 30 add up to 100 per cent., but this is a case where mathematics and geometry show that the synchronous condenser operates at highest efficiency and 100 per cent. load when delivering 70.7 per cent. of its rated capacity as wattless leading current and also 70.7 per cent. of its rated capacity as mechanical load. A good explanation of this is given by H. L. Williamson on page 256 of the June issue.

In regard to measurement of power I would be glad to refer my critics to the following works, "The watt hour meter," by Shepard and Jones, and "Alternating Current Motors," by McAllister. After a perusal of these works I will be glad to talk this matter over further.

W. A. BATES.

3-Phase Power by Single Phase Meter, Ans. Ques. No. 208.

Editor Southern Electrician:

I submit herewith a sketch which explains itself as to connections. I would like to have you insert it in your

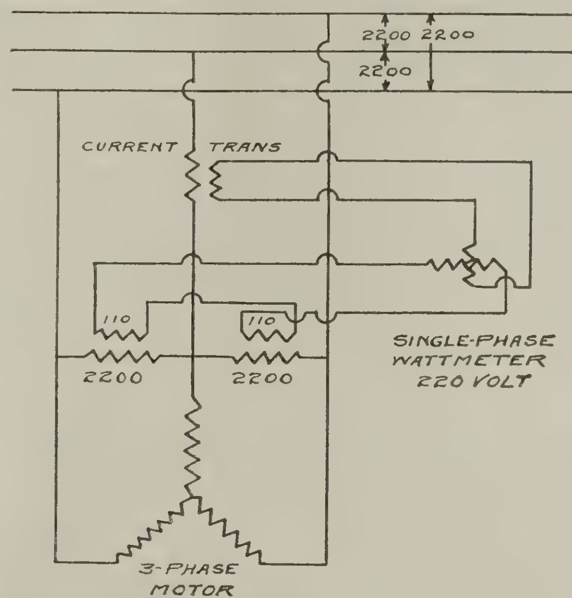


DIAGRAM FOR METER CONNECTIONS ON 3-PHASE CIRCUIT.

question and answer department, asking your readers for comments on using the scheme as a meter for a 3-phase motor.

L. McCOY.

H. P. of Motor Equipment, Answering Question No. 203.

Editor Southern Electrician:

For the benefit of H. A. B. asking question No. 203 in the March issue, I will state that it is impossible to give any intelligent method of determining the horsepower of motors for driving any equipment unless data is given on such equipment. Extensive tests have shown that the horsepower required to drive tools of any sort varies considerably and nothing further than general data on existing systems and practice can be given. For the lumber equipment referred to it is quite possible to determine the size of motors knowing the make, size and use of machine. If H. A. B. will furnish this data I shall be pleased to work out these sizes. It will be necessary to know the source of power whether from central station or private plant, and if central station the voltage of distribution system. The system wiring will depend upon the voltage adopted. For wiring in a lumber mill it is advisable to run all wiring in conduit and for a neat system where the ceilings are not finished, conduit may be run on ceiling under floor where motor is located. The connections to motor can then be run through the floor properly insulated and brought to motor with few exposed connections about the working floor.

H. F. BOYLE.

Fuses For Induction Motors, Ans. Ques. 209.

Editor Southern Electrician:

Question 209 of the April issue has come to my attention and permit me to offer a few suggestions in regard to it. The formula given by Mr. Williamson in the May issue is correct for determining sizes of fuses, however no precautions have been given as to their use. The writer has found it advisable for motors of 50 H. P. and in some cases of smaller size, to protect by means of circuit breakers. One of the frequent causes of the burning out of induction motors under normal load is the ability of the motor to run single-phase, when once brought to speed on polyphase. Thus when a large motor is fused and one of the fuses in the 3-phase circuit blows, the motor continues to carry practically full load on one phase only. The result is that this one phase which is overloaded burns out even though the mechanical load on the motor is no greater than usual. As abnormal conditions frequently arise in alternating current work in which the rise in current may be from three to six times normal, depending upon what these abnormal conditions are, it is always best to provide sufficient protection to motors of considerable size.

W. A. BATES.

Station Equipment, Ans. to Ques. No. 211.

Editor Southern Electrician:

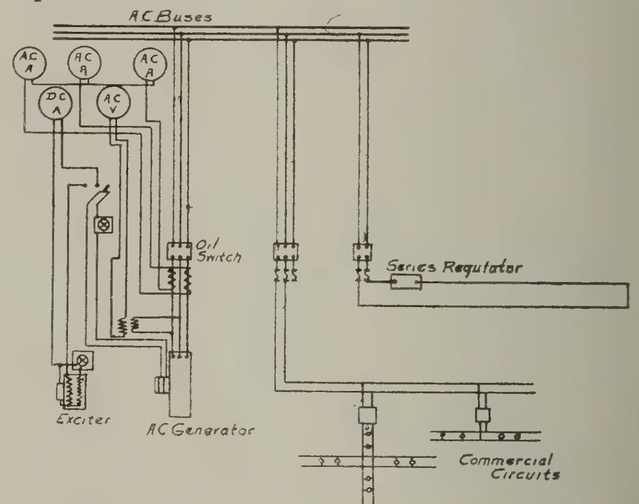
In laying out a generating station and distribution system, it is always best policy to adhere as closely as possible to accepted standards, as this tends to keep the first cost down to a reasonable figure per unit of capacity and greatly facilitates getting material and appliances as needed. In buying the generator I would specify a 2300-volt, 60-cycle, 3-phase, revolving field type of machine, rated at 50 K. W. upon an allowable temperature rise of 35 per cent. after 24 hours run at full load with a power factor of 80 per cent.

This machine could be run single phase until such time as the business grew to demand full output or it is desired to take on power business. As a single phase machine it would develop 70 per cent. of rating and would cost no more than a single phase machine giving equal output. For the commercial circuit, two No. 6 wires may be used and when the business demands changing the system to three phase, it will only be necessary to string one additional wire and, other conditions being the same, this third wire will almost double the capacity of the line.

For the street lighting, series tungsten lamps should be used on a series circuit of No. 8 wire controlled by an automatic series regulator. If a current of 6.6 amperes is selected for this circuit it will be possible at any time it is desired, to insert arc lamps in the same circuit. The size of tungsten lamps to be used depends altogether on the amount the city wants to spend for street lighting. Lamps of 60 candlepower placed at each intersection gives excellent service for a small town. The flat radial reflector is probably the best thing on the market to put over them. The height at which these lamps are hung will depend entirely upon the trees. If there are no trees they should be between 20 and 25 feet from the street, but if the foliage is dense it may be necessary to bring them down to 16 or even 12 feet. These lamps, of course, should be used in the large series cut-out type of socket.

The poles for the line should be at least 30 feet, 6-inch top, and for the transmission line and main lead into town, should be 35 feet, 7-inch top, spaced 35 to the mile. As cross-arms decay very rapidly and this decay always starts in the pin holes, I should recommend arms bored for through-bolt only, and use for pins the clamp type of pin which has recently been placed on the market.

For a distributing voltage 105, 107 or 113 should be selected. Lamps, meters, fans, etc., are cheaper for these voltages than for 220, and it is possible to get a much closer selection of lamps than if 110 is ordered for the reason that the demand for 110-volt lamps exceeds the supply. In other words, much greater latitude is given the lamps labeled 110 than for those of odd voltages.



LAYOUT OF CIRCUITS.

The size of transformers can only be determined by local conditions. In all growing systems, it is necessary to be continually shifting transformers to keep them where they are in proper proportion to the demand. For the business district they should have about 120 per cent. of their rating, whereas in residence districts it is common practice to connect to them 300 to 400 per cent. of their rating.

On a small waterpower proposition, where the town is small and the possible revenue limited, I should consider tungsten lamps in residences on flat rate as very good business. It would be possible in this way to have at least one or two lights in nearly every house in town. On a meter basis this wouldn't pay on account of investment necessary in meters.

If the lighting company does wiring it will, of course, be necessary to carry a stock of material, although it need not be a large one. As there are now good jobbers in every large town and city, it is possible to get nearly any standard article in one day. The only advantage in buying in larger quantities being price, the usual discounts being for less than 1/5 of a standard package 30 per cent, 1/5 and over 40 or 45 per cent., and for full standard package 50 or 50 and 10 per cent.

A rough sketch of circuits recommended herein, is shown. It will be noted that standard switchboard panels for 3-phase systems is indicated. By using a standard panel the board may be enlarged at will by placing additional generator panels at one end and additional feeder panels at the other. C. L. CLARY.

Station Equipment, Ans. Ques. No. 211.

Editor Southern Electrician:

In question 211 there are a number of indefinite things expressed and consequently the solution of it will be more or less arbitrary. Assuming that 50 K. W. only, is to be transmitted over a distance of 2 miles, a potential of 2,200 volts should be economical and the transmission should be 3 phase. With this potential the question of insulation would not be so great as with higher voltages, either for line or transformers and transformers would cost less, due to this fact.

If incandescent lamps only are to form the load the question of induction and power-factor would be practically negligible as it will depend only upon the induction of the line and transformers. The data given is hardly explicit enough to determine size of wire for transmission, number of poles, etc., as the first is dependent upon the character of the load and the second upon the character of the country through which the transmission is to be made. A central transformer feeding a three wire network is good, economical practice for small installations, connected to give 110-220 volts, and then small power units can be used on 220 volts. Power units up to five horse-power could be used on lighting circuits without creating much disturbance, especially as most of it would be in use when lights were least needed, providing too much of it is not intermittent. The size of transformers will depend of course on the size and character of the load, also the mode of distribution. Again the size of lamps, type of reflector and spacing of poles depends upon the character of streets, whether thickly bordered by trees, etc., an arbitrary example could be taken and figured out, but it would probably be of little value. The street lighting should be by series transformers, constant current. Not knowing size or character of load it would be quite a job to determine character or quantity of supplies to carry.

GEORGE I. MORGAN.

50 K. W. Station Equipment, Ans. Ques. No. 211.

Editor Southern Electrician:

I present herewith sketches showing the switchboard design, the plant connections and the distribution system of a small central station of about 50 K. W. capacity such as referred to in question 211. It is not stated whether it is designed to operate single or polyphase. If there is any likelihood of securing any power load in the vicinity, it might be well to consider two or three phase, but if the prospective load is entirely lighting, single phase would be the simpler to install and would give about as good results. In drawing up the diagrams the full lines show the circuits for single phase and the dotted lines the additional wires which would be required if three phase were chosen.

For the load and distance mentioned, 2,200 volts will be the most suitable standard voltage. Fig. 1 shows the switchboard with one generator panel. In case another generator is added, the panel for same is shown dotted. Each machine will have of course, its ammeter and voltmeter with current and potential transformers. The synchronising lamp will not be needed unless another generator is added. The ground detector lamp with multiple plug is so arranged as to show on which circuit any ground may exist, and the plug may be arranged for single, two or three phase. The same arrangement applies with the voltmeter. For polyphase circuits it is provided with a plug so that the voltage across any phase may be read but if single phase, it is permanently connected, and the plug omitted. Fuses may be used for generator protection, but circuit breakers are much better, and they also take the place of a main switch. Two rheostats may be used, one for the generator field and one for the exciter field, but it makes a better job to use a combination rheostat with concentric handwheels as shown. The generator panel also contains a field switch which may be of the knife or plug type.

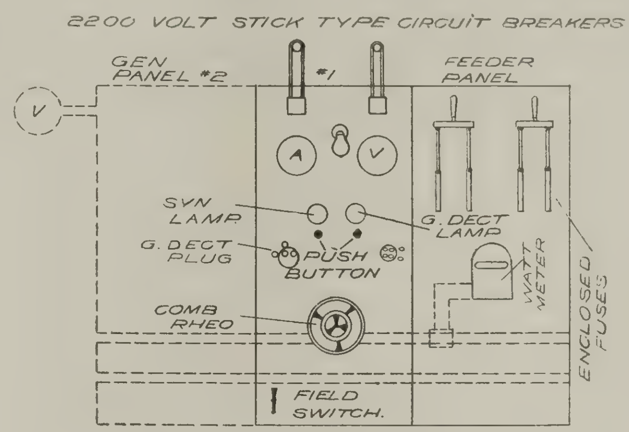


FIG. 1. CIRCUITS AND SWITCHBOARD ARRANGEMENT.

From the generator panel, or panels, the current passes to the combined load and feeder panel, on which is mounted an integrating wattmeter which takes account of all current generated, and serves as a check upon the metered consumption. Then the current is distributed by the feeder switches. For this layout there will likely be but one feeder circuit for the present, but it will be well to provide for two as it will undoubtedly be needed as the territory is developed. Switches and enclosed fuses may be used for the feeder circuits as shown, but here again, I would recommend circuit breakers, as being more reliable and cheaper in the end. Fig. 2 shows the circuits and is self explanatory. V′ shown dotted gives the voltmeter connections for more than one phase. Fig. 3, shows the distribution layout. I consider it better to carry the 2,200 volt

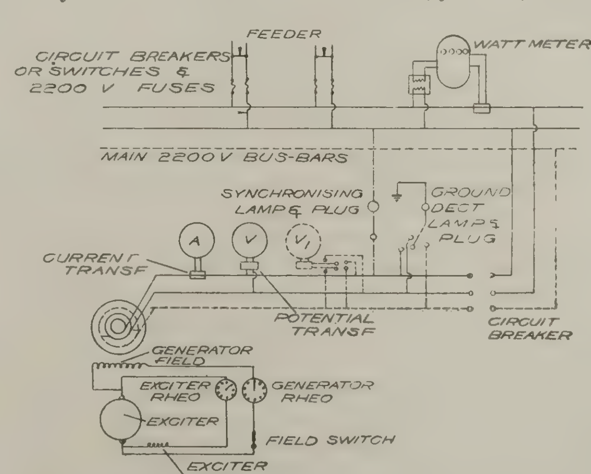


FIG. 2. FEEDER CIRCUITS.

line right up to the consumers' premises and not to distribute for any distance at 110 or 220 volts. I would use transformers with 110-220 volt secondaries and run 220 volts on the outers and ground the neutral. Several houses should be fed from one transformer adjacent to buildings on alternate sides of the circuit as shown. If this plan is followed, it will mean that the transformers will be from 2 to 5 K. W. in size, although there will be scattered locations where smaller ones will be necessary. Good central station practice is favoring the banking of transformers wherever possible.

The best system for the street lights would be a series arrangement with a constant current transformer, as shown. This piece of apparatus may either be located at the station, the series circuit run the two miles and the entire installation controlled from the station, or the transformer may be located at the town and will require no attention except for some one to light and extinguish the lamps daily. As to the size for the street lamps, I would suggest the 50 or 75 watt size, giving from 42 to 63 candle power, and provided with a street hood and fluted reflector such as are manufactured by several concerns. One lamp at each corner and one in the middle of each block should give good results, if the lamps are not hidden by foliage. With blocks of ordinary length this will give a spacing of 150 to 200 feet, and works out with a moderate wattage per foot front. These lamps are made in several different amperages but the 4 ampere will likely prove to be the more satisfactory. If arc lamps are desired on some of the business corners they can be put on the circuit without the slightest trouble.

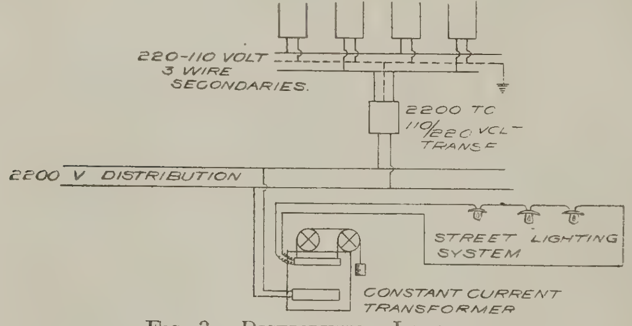


FIG. 3. DISTRIBUTION LAYOUTS.

The entire load as laid out at present will be about 12 amperes to 13 amperes on the 2,200 volt side. The proper size of wire to use is that size where, according to Kelvins law, the interest on the copper and other accessories which vary with the size of the wire equals the annual money value of the lost power. If the line is smaller there will be too great a loss in voltage and consequently in power and if larger, the investment in copper will be out of proportion. From the above rule we find the most economical size of wire to be No. 2 B. & S. Whether or not it would pay to use about No. 0 wire to provide for future needs or to run another feeder as the need occurs, is largely a matter of opinion and depends upon the prospect for rapid growth in business.

As regards rates, you will find in a community of this size that unless your proposition is made especially attractive, while you may get a good number of customers, you will also have to run considerable wire to reach them. In other words the proportion of the total population who use electricity for lights will be small. I believe that the use of a controlled flat rate with tungsten lamps is a great help towards getting a number of small consumers on the lines who would otherwise not use service at all. Of course, there should be an optional meter rate, and the flat rate proposition reserved entirely for the residence trade.

As to supplies, you could probably carry knife switches, panel cut-outs, panel boards, main fuse blocks, etc., by the dozen; plugs, sockets, rosettes, branch cut-outs, etc., by the hundred; lamps, knobs, tubes, and other small articles by the thousand. Lamp cord and wire will probably be needed by the thousand feet. Experience will soon show what stock is the most needed. As regards cooking and heating utensils, irons, etc., it will be well to carry a few samples sufficient to keep them before the public. I would not recommend stocking up with a large quantity of this kind of apparatus in advance of more or less call for it.

A. G. RAKESTRAW.

Station Equipment, Ans. to Ques. No. 211.

Editor Southern Electrician:

In reply to question 211 in the May issue I respectfully submit the following: The average kilowatt rating of central stations supplying light and power to towns of 800 inhabitants is about 70 kilowatts or 87.5 watts per capita and the average load during operation is 12 kilowatts. For towns of 1,600 inhabitants the average central station rating is about 120 kilowatts or 75 watts per capita and the average load during operation is 20 kilowatts.

In view of the above and keeping also the first costs in mind, the following equipment, for a town of 1,600 inhabitants, is consistent with good practice. The station to consist of two 3-phase, 2,300 volt units of 50 and 70 kilowatt rating respectfully. Transmission to be 3-phase, 2,300 volts, wire to be Brown and Sharpe gauge No. 4 or 5, preferably No. 4. Poles for transmission to be about 35 to the mile, for city distribution to average 45 per mile. Standard 2,300 volt distribution transformers to be used giving 220 volt taps for power service and 110 volt taps for lighting on the secondary side. Sizes of transformers cannot be satisfactorily determined without more data as to the loads to be carried at points of installation.

It is advisable to urge the use of the tungsten lamp as it represents the latest advance in modern residence lighting and also is growing in favor for general street lighting. Reports from central stations show that the total energy consumed has not been lessened perceptibly by the use of tungsten units. The tendency has been toward increased illumination rather than decreased consumption. The advent of the tungsten lamp has also had a tendency to further the feeling of good will between public and central stations which in itself is no small item.

By careful manuagement and the use of some reliable type of flat rate controller or excess indicator the flat-rate scheme in the opinion of the writer can be employed to good advantage. Several central stations using the flat-rate method report increased earnings and less complaints of poor service, high bills, disputed bills, etc.

The spacing of poles for street lights depends altogether on conditions. For small towns a lamp at each street intersection in the business district and one about every other street intersection in the residence districts seems to be the most frequent arrangement. Sizes of lamps vary from the 25-watt to the 250-watt and larger. In some localities reflectors are not used, the use of an enclosing opalescent globe being very popular. The radial and holoplane type of reflectors are used to some extent.

HIGH TENSION TRANSMISSION TOWERS, ANS. QUES. No. 216.

In reply to question No. 216 in the May issue regarding high tension transmission towers, I would say that experience has proven tower construction employing the suspension type of insulators to be far superior to the ordinary pin-type construction. In fact it is a matter of doubt as to whether the pin-type insulator can be successfully employed at all in the use of extreme high voltages. The suspension type is also superior as a mechanical element of line design in that it permits cross-arm stresses to be applied more as a direct pull, whereas in the case of high-voltage pin-type insulator a load applied at its top causes a greater amount of twisting stress on the cross-arms. Another point in favor of the suspension type of construction is that in case of line breakage the insulators swing out, increasing the sag in neighboring spans and thereby resulting in reduced stresses on cross-arms and towers in the near vicinity of the break.

It is believed that the suspension type of construction will often be employed for voltages well within the efficient range of the pin-type insulator, in fact, in the latest high-tension systems, such as those of the Southern Power Company, Hydro-electric Power Commission of Ontario, Great Western Power Company and others, it is reported that less line trouble has been experienced even under the most adverse conditions, than at previous lower voltages. This is generally attributed to the use of the suspension type of insulator. As to the general problem of tower construction, however, it is not effected except in detail by the type of insulator employed.

A. H. Mitchell.

Raising P. F. by Syn. Motor, Ans. Ques. No. 214.

Editor Southern Electrician:

My May copy of Southern Electrician came to hand only a day or so ago, being delayed by the revolutionary troubles in this country. In reply to question 214 relating to the calculation of the rating of a synchronous motor to raise the power factor of the power system referred to, I beg to offer the following consideration:

Total net load on system at present = 400 kilowatts.

Apparent load = $2300 \times 140 \times 1.73/1000 = 557$ kilovolt-amperes. Hence power factor at present load is 400/557, or 71.8 per cent.

Assume future power factor with synchronous motor on system to be 85 per cent. The method of procedure is then to calculate the wattless components of the system at 71.8 per cent. power factor and at 85 per cent. power factor, and thus arrive at the value of the wattless component to be considered in raising the power factor to the latter value. This component is evidently the difference between the two components to be calculated. Now since the apparent power on the system is the geometrical resultant of the wattless and the energy components, these being at right angles to one another, we have the following:

K. V. A. (apparent power) without synchronous motor on the line $= \sqrt{(KW^2 + WC^2)}$ where WC denotes the wattless component.

Substituting values for 71.8 per cent. power factor we have, $557\ (KVA) = \sqrt{(400^2 + WC^2)}$, or $310{,}249 = 160{,}000 + WC^2$

Therefore, the wattless component $= \sqrt{310{,}249 - 160{,}000} = 387$ KVA.

With the synchronous motor on line we have an apparent output of 400/.85, or 471 KVA, and solving for the wattless component as above we get the following:

$471 = \sqrt{400^2 + WC^2}$, or the wattless component = 249 KVA.

Hence the wattless component to be considered in calculating the rating of the motor required will be 387-249, or 138 KVA. This would be the rating of motor required if run light at 100 per cent. efficiency. But we must consider the motor losses, and in addition the mechanical load to be carried by same, which in this case is 38 horsepower or 28 kilowatt. The losses in the motor of the size required and carrying the above load may be taken at 20 kilowatts, giving a total energy component of the synchronous motor of 48 kilowatt. Now solving for the resultant of this energy component combined at right angles with the wattless component of 138 KVA required for power factor correction, we have:

Actual rating of motor required $= \sqrt{(48^2 + 138^2)}$, or 146 KVA. Or say, use a motor of 150 KVA rating.

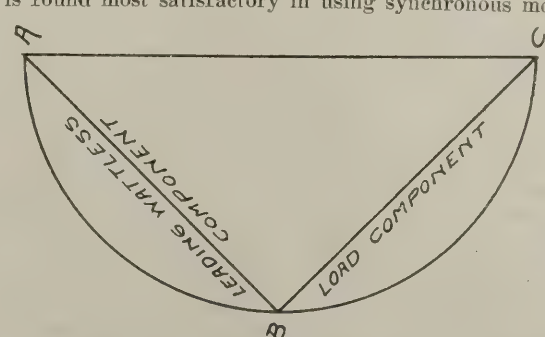
In case it is desired to make the above calculations for size of motor required to raise the power factor from 71.8 per cent. to 90 per cent. instead of to 85 per cent., it is evidently only necessary to calculate the apparent (KVA) output at 90 per cent. power factor and to substitute the quantity thus obtained in place of that obtained at 85 per cent. power factor. The above calculations are not carried out to a fraction, but are quite sufficient for commercial purposes. In case the inquirer should desire additional information along same lines I would refer him to the article on page 477 of the October, 1910, copy of the General Electric Review, which treats the problem along somewhat different lines, although arriving at the same results in the end.

C. C. Hoke.

Raising P. F. by Synchronous Motor, Remarks on Ans. Ques. No. 214.

Editor Southern Electrician:

I wish to offer a correction to the statement made by Mr. Haywood on page 255 of the June issue. He says, "It is found most satisfactory in using synchronous motors



Load and Leading Wattless Components of a Synchronous Motor.

as rotary condensers to install them of such capacity that they will deliver 70 per cent of their rated capacity in power, the other 30 per cent being leading wattless currents."

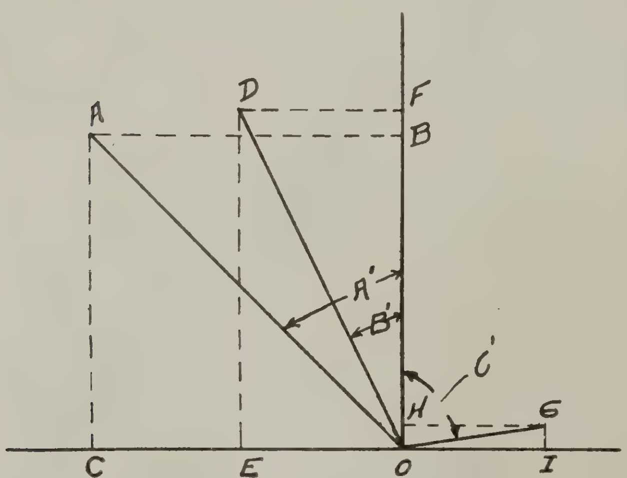
In view of the fact that the wattless leading component of the machine is 90 degrees to the energy component, we have a condition as expressed in the diagram. It will be seen that to maintain 100 per cent load on the machine the point B travels on the are of a circle and when the value of leading current demanded is small the mechanical load can be increased and vice versa. The maximum efficiency will be observed when angles D and E are 45 degrees and the values of A B and B C 70.7 per cent of A C the rated input.

H. L. WILLIAMSON.

Raising P. F. by Syn. Motor, Ans. Ques. 214.

Editor Southern Electrician:

I beg to submit the following solution to Question 214, in the May issue, in regard to the size of synchronous motor required to raise the power factor to 85 or 90 per cent. I have evolved a solution to this problem and have worked it through, assuming that the power factor was to be raised to 90 per cent. The same method could of course be used to find the size of motor to raise the power factor to only 85 per cent., by substituting .85 for the value of Cos. B′ for the value of .9 which I have used. For the problem, I have assumed the voltage at 2,300 at all times. Of course, when the voltage is stepped up or down, the current will vary according to the same ratio, and it is therefore possible to deal with just this one voltage. Having assumed this, the problem can be solved by use of the victor diagram of currents which is shown herewith. If the current were in phase with the voltage, it would be shown along the line OF; if lagging 90°, along the line OC; and if leading 90°, along the line OI. Referring to the diagram, OA represents the apparent load which lags in accordance with the present power factor, OG represents the leading load to be



ELECTRICAL RELATIONS FOR SYNCHRONOUS MOTOR.

furnished by the over-exacted synchronous motor; and OD represents the victor sum of the two, or the total apparent load of 400/.9 KVA at 90 per cent. power factor. Now the present power factor of the system is KW $\times$ 1000 / A $\times$ V $\times$ $\sqrt{3}$ = 400,000 / (140 $\times$ 2,300 $\times$ $\sqrt{3}$) = .718. The value of OA will be the total inductive load in amperes. But as the 38 H. P. load taken by the 50 H. P. induction motor mentioned is to be carried by the synchronous motor, the inductive load will be only 400 K. W. minus 38 H. P. equals 371,752 watts.

Therefore OA = 371,752 / (.718 $\times$ 2,300 $\times$ $\sqrt{3}$) = 130.1 Amps. OD = 400,000 / (.9 $\times$ 2,300 $\times$ $\sqrt{3}$) = 111.7 Amps.

Now in order to add victor quantities, it is necessary to reduce them to their vertical and horizontal components. In this case, we have OA and OD, and wish to find OG.

It is evident from the diagram that

$$OH = OF - OB$$
$$\text{and} \quad OI = OC - OE$$

Now Cos A′ = Power actor = .78

Therefore (from tables) A′ = 44° .7′ and sin A′ = .696

$$OB = OA \text{ Cos } A' = 140.0 \times .718 = 93.4$$
$$OB = OA \text{ sin } A' = 140.0 \times .696 = 90.55$$

Now Cos B′ = power factor = .9

Therefore B′ = 25°50′ and sin B = .436

$$OE = OD \text{ Cos } B' = 111.7 \times .9 = 100.53$$
$$OE = OD \text{ sin } B' = 111.7 \times .436 = 48.7$$

From formulas obtained above,

$$OH = OF - OB = 100.53 - 93.4 = 7.13$$
$$OI = OC - OE = 97.50 - 48.7 = 41.85$$
$$OG = \sqrt{(OH^2 + OI^2)} = \sqrt{(7.13^2 + 41.85^2)} = 42.4 \text{ Amps.}$$

Now, while only 38 H. P. load is to be put on this synchronous motor, it would of course be necessary to produce a motor which could stand the high current taken on account of the low leading power factor, and the H. P. of the motor required would be: (42.4 $\times$ 2300 $\times$ $\sqrt{3}$) / 746 = 263 H. P. To find the power factor of the motor, we find that tan C′ = 41.85 / 7.13 = 5.8695. Therefore C′ = 80° 2°′ and power factor = Cos ’C′ = .168 or 16.8 per cent.

3-PHASE POWER BY 2-WATTMETERS, ANS. QUES. No. 223.

In answer to question 223, I would say that two wattmeters on a three phase circuit will give unequal readings due both to changes in power factor and to changes in load balance. There might be such a combination of unbalancing and low power factor as to give equal readings on the two wattmeters, and therefore it cannot be assumed that equal readings mean 100 per cent power factor unless the load is absolutely balanced.

C. E. CHATFIELD.

60 Cycle Motor on 133 Cycle Circuit, Ans. Ques. No. 215.

Editor Southern Electrician:

Replying to question 215 would say that it is possible but not advisable to operate an induction motor on a circuit of different frequency from that for which it is designed. A 60-cycle motor of a given speed will have just half the number of poles that one built for 120 cycles and the same speed would have and consequently would run twice as fast as it should if operated on 120 cycles, and of course somewhat faster still on 133 cycles. Also on the other hand a 133-cycle motor would run slow on 60 cycles. This however is not the greatest objection to such use. In the design of induction motors, as well as transformers, the number of turns of wire is made such that the magnetic density will have the proper value whe operated at the correct frequency and voltage, and any increase of voltage or decrease of frequency will result in increased magnetic density without a consequent large increase of hysterisis loss and heating. The writer has operated small 125-cycle motors or 60-cycle circuits but they invariably run hot with a rather heavy torque due to the high magnetic density and of course the speed was just about half normal. If we operate a 60-cycle motor on 125 or 133 circuit the case will be just the reverse, that is it will run at high speed and the torque will be weak because of the low magnetic density and consequently it will not carry as much load as it should at that speed.

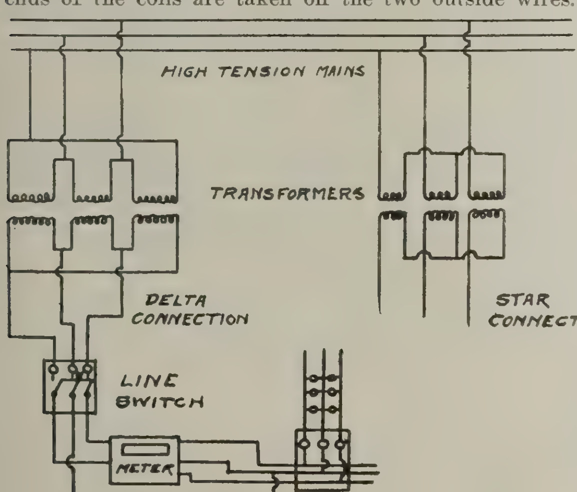
When a motor or transformer is in operation it must generate a back pressure of counter electromotive force that is nearly equal to the line voltage, the difference between them being that necessary to send the working current through. If the magnetic density be insufficient to do this because of the low frequency, the wattless current will increase until the magnetism has reached the proper value and as the magnetic reluctance is much greater at high densities the power factor will also be poor. It is possible to operate a motor on different frequency very well if we compensate the change of frequency with a change of voltage. To illustrate, if we have a 110-volt, 125-cycle machine it will work very well on a 50 or 55-volt, 60-cycle circuit and also we may use a 110-volt, 60-cycle machine on a 220-volt, 125-cycle circuit. This would not give the correct speed, however, the only way to do that is to wind the machine over with the right number of poles.

T. G. Seidell.

3-wire Meter, Ans. Ques. No. 220.

Editor Southern Electrician:

In the meter referred to in Question No. 220, there are two current coils in series with the two outside wires of the line that enter the meter, there are also two shunt coils connected in series, a tap being taken from the middle of the two and brought out to the neutral or middle wire of the circuit on the load side of the meter. The other two ends of the coils are taken off the two outside wires.



Circuits for House Wiring Sysjem.

The cut-out in the sketch is known as a triple pole, double branch. Four circuits can be taken from the cut-out, placing the lamps across lines numbered 4 and 5, 5 and 6, 7 and 8, and 8 and 9.

HOUSE WIRING, ANS. QUES. No. 221.

The usual practice at the present day is to use a three-phase transformer, which is virtually three transformer windings in a single case. The winding may be connected either in star or delta, but the primary and secondary should be connected the same. The connections for the meter, however, would be the same on the star connected transformer as it would on the delta, as shown in the accompany diagram.

G. I. Morgan.

House Wiring, Ans. Ques. Nos. 220 and 221.

Editor Southern Electrician:

In answer to questions 220 and 221, I note that the author refers to a Thompson high torque, 220-volt meter and 10-ampere fuses using 110-volt lamps but does not mention the ampere capacity of the meter. It is possible that he has enough 110-volt load on his 220-volt meter to blow the fuse, for if he has a simple three-wire alternating current supply of current and not three-phase, he should have a three-wire, 110-volt meter instead of a 220-volt.

As to only two series wires entering the meter and three leaving it he is mistaken, for referring to the drawing he will see that the upper wire is only the shunt top from the neutral lead which is correct. The special branch block referred to it seems to me is only a three-wire double

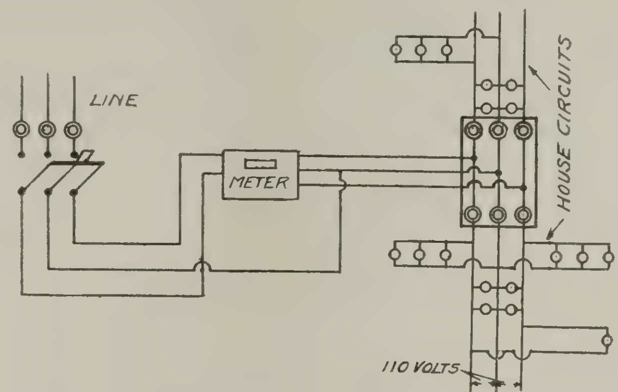


Diagram of House Wiring Circuits.

branch and if so, four different 110-volt circuits may be taken from the block, two on a side, as from neutral to either side wire. As far as the meter internal circuits are concerned it has two series coils and one shunt with a tap from each series coil. A drawing of connections should be on the back or inside of the cover giving directions for installation. The accompanying drawings show connections, when a Thompson high torque Type I, three to twenty-five ampere meter is used.

E. D. Dumas.

Heating and Cooking, Ans. Ques. No. 212.

Editor Southern Electrician:

The amount of heating and cooking load necessary to justify the installation of a separate meter, is not so much a question of percentage that load should bear to the lighting load but rather of the total consumption of heating and cooking operation. The writer is in favor of installing a separate meter for this class of service when requested and furnishing current at the rate of five cents per K. W. H. with a minimum of one dollar per month. The meter is to be installed without charge to the consumer. The heating rate on the writer's system is 10.8 cents per K. W. H.

REASON FOR WATTMETER READING, ANS. QUES. No. 218.

When two generators, either A. C. or D. C., are operated in parallel, and the fields are so adjusted that the two machines give exactly the same voltage, each one will take an equal amount of load. If however the voltage of one should be higher, it would take more than its share and the other less, the sum of the two, of course, remaining the same. Therefore the fact that the watt meter readings varied shows that the voltage was not equally adjusted. The character of the load has nothing at all to do with it.

3-PHASE POWER BY 2 WATTMETERS, ANS. QUES. No. 223.

Equal readings on the two wattmeters of a three phase circuit is proof that the circuit is balanced, but is no proof that the power factor is unity. The nature of the load determines the power factor, but the amount of the load on each side determines the relative amount of registration on the wattmeters. A. G. RAKESTRAW.

Lamp Renewals, Ans. Ques. No. 204.

Editor Southern Electrician:

Presumably G. W. H. refers to the policy of issuing free lamp renewals to householders, offices and similar consumers. The advisability of this procedure has been much discussed in England and the chief arguments for and against seem to be as follows:

For free lamp renewals where such renewals are granted: (1) The consumer pays a certain fixed price per kw. hr. or per lamp per quarter (in which, of course, allowance is made by the station for the probable average renewals cost) and then knows that he has discharged all his lighting liabilities. This avoidance of periodical indeterminate charges of greater or less amount is more important than is generally allowed. (2) The consumer has always good lamps in service and is thus in a fair way to become that most desirable of beings a satisfied consumer. (3) The supply station can purchase a good class of lamp in bulk and by the favorable terms it secures and the expert knowledge of its purchasing agent is actually able to furnish the best lamps at much below their open-market price. (4) Standardization of equipment at a high level is facilitated. (5) The station keeps in close touch with its consumers and small consumers undoubtedly extend their installations more freely when relieved from all immediate outlay required by the latter, ultimately of course, their share of the total renewals and extensions charges of the district comes back to them. (6) The station loses nothing by the scheme, indeed it secures an excellent investment for the capital laid out in extensions and renewals and gains considerably in revenue by its apparent generosity.

Against free lamp renewals where free renewals are allowed: (1) Some consumers will be deliberately wasteful of lamps, but such persons are exceptional and can generally be individually tackled in an appropriate manner. (2) Consumers naturally clamour for the best available types of lamps regardless of the burden they thus throw upon the station, which further suffers by reduced revenue per consumer consequent upon the higher efficiency of modern lamps. As regards the cost to the station, this is only apparent and is ultimately recovered from the consumer by a higher tariff or by a higher minimum levy. No central station is a philanthropic institution and strictly free lamp renewals is, of course, unthinkable. Again, the reduced demand referred to is purely transitory. The demand on the station will ultimately rise the higher for its temporary depression by this cause and has actually done so in many cases. It has occasionally been suggested that a station having the supply of lamps in its own hands should suit its own convenience as to the type fitted. This, in the long run, must prove a mistaken policy. (3) The central station may be said to exceed its functions and submit local contractors and supply agents to unfair competition. To what extent this is true in individual instances depends upon circumstances and the past behavior and terms of the alleged injured parties, as also upon the conditions under which the station commenced and has carried on business.

Quoting from my recent article on Central Station Developments in England, published in SOUTHERN ELECTRICIAN: "Though the consumer has, in some form or another, to repay his actual cost to the station plus an adequate clear profit, the various bonus systems of installation and supply—(this including free lamp renewals)—have done much to extend the use of electrical energy in this country and are much appreciated by consumers."

From England by CEC. TOONE.

Paralleling 2-Phase Generators With a 3-Phase.

Editor Southern Electrician:

In looking over the May issue of SOUTHERN ELECTRICIAN, I notice an article dealing with alternating current engineering, in which the subject of transformers is taken up and dealt with at some length, giving a most interesting and informative discussion on the best methods of transformer connections to different phase circuits. In connection with the above named article, I would like to cite an example of a satisfactory method for paralleling two 2,200 volt, 2-phase generators, with a 3-phase, 6,600 volt generator direct-connected to a low-pressure turbine. Before the turbo-generator was installed the two machines were connected to two 150 K.W. transformers wired to take 2,200 volt 2-phase current and produce 6,600 volt 3-phase current for the high tension line. The method adopted to run the machines in parallel was as follows: The 6,600 volt 3-phase generator was connected behind the transformers on the 6,600 volt 3-phase side and run in parallel with the 2,200 volt 2-phase machines through the transformers, the transformers acting as a step-up or a step-down transformer according to which side was loaded heaviest in proportion to the generators running.

LE ROY SCOTT.

Utilizing Old Arc Lamps.

Editor Southern Electrician:

"The passing of the arc lamp for street lighting to the incandescent is fast becoming a fact rather than fiction. We can not all ride in automobiles or carriages, some of us must walk. It is the same with street lighting, we can not get all we need, not mentioning what we would like to have to give our cities an up-to-date street lighting system, so many of us have to utilize what we have on hand. The lamps on the writers system were designed several years ago for 133 cycle current, later changed to 60 cycle, so they are at the best out of date and a makeshift, fit only for the scrap heap.

"Another reason for changing to incandescent lamps is the much better distribution obtained with the same amount of energy, especially where there is shade trees. Since we have no appropriation for brackets and hangers, we have accomplished results in our system by changing several of the arc lamps into supports for incandescent lamps. We removed the base plate and all its attachments, screwed the lock nut half way off the upper carbon holder tube, and into this nut screwed the fork that the base for the socket fits into and made a neat substantial support with a reflector. It is a very good way to make use of the old lamps. We have had one in use on a prominent corner with an 80-watt Tungsten lamp for six weeks and only a few people noticed that it was not an arc lamp.

G. W. HUBBARD.

New Apparatus and Appliances.

New Indicating Instruments—12 pt.

The Weston Electrical Instrument Company of Newark, N. J., has recently placed on the market a complete line of alternating-current switchboard indicating instruments, including single-phase and polyphase wattmeters, power-factor meters, synchroscopes, frequency meters, voltmeters and ammeters. The wattmeters, power-factor meters and snychroscopes are of the Weston electrodynameter type, while the rest are of the so-called soft iron type.

The operative characteristics of these instruments are quite unique and the mechanical construction is distinctly novel. They all have an accuracy guaranteed correct within 1 per cent throughout the entire range of variable conditions, such as frequency, power-factor, voltage, load, etc., met with in general commercial work.

WATTMETERS.

The wattmeters have the distinction of being the only switchboard wattmeters of this type that have a uniform or proportional scale. This characteristic is especially valuable in switchboard instruments, since it permits the operator to make a reading from a distance based on the general position of the pointer with reference to the scale as a whole. The instruments are equally accurate on alternating-current and direct-current circuits without change of calibration or reversal of leads. The damping is practically perfect, and this combined with an extremely great sensitiveness to sudden changes in load enables these instruments to indicate violently fluctuating loads with great accuracy, and reading of fluctuating loads can be made with practically the same ease as those of steady loads. The scales are flat and thus facilitate reading from points at one side or the other of the instrument with scarcely any parallax errors. The accuracy is correct within 1 per cent for variations in frequency between 15 and 900 cycles per second; for changes in power-factor from 0.50 lag to 0.50 lead; for fluctuations in temperature from 50 deg. fahr. below to 50 deg. above normal temperature, and for wave distortion within the limits of general commercial practice. An important advantage of these instruments is the ability to adjust the zero position of the pointer from the outside without removing the instrument from the board or breaking the seals, and without the slightest danger of damaging the instrument.

FIG. 1. WESTON POLYPHASE WATTMETER.

SYNCHROSCOPES.

The synchroscope is of an entirely new type. It behaves exactly like an ideally perfect rotating synchroscope, but does not actually rotate. In mechanical construction the instrument is almost exactly like a Weston type single-phase wattmeter, except that the field coil is wound with fine wire. The pointer stands normally in the middle of the scale and is hidden from view by a translucent glass. Behind the pointer is mounted a small synchronizing lamp.

The movable coil is connected in series with a condenser across the incoming machine, and the fixed coil is connected in series with a resistor across the line. The lamp is connected through a special three-legged transformer to synchronize light. The connections are shown in Fig. 4.

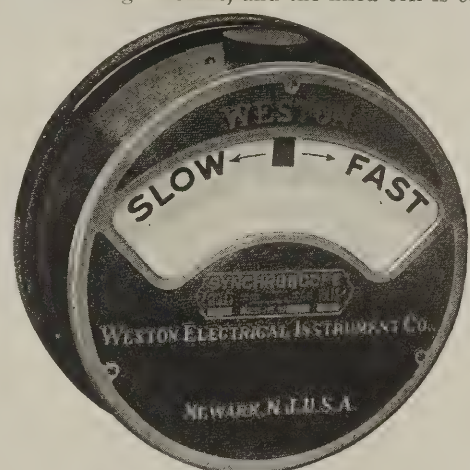


FIG. 2. WESTON SYNCHROSCOPE.

When the e m fs. of the two sources have the same frequency and are exactly in phase coincidence or in phase opposition, the currents in the two coil circuits will be in time quadrature and no torque will be produced. Therefore, under these conditions the pointer stands in the middle of the scale, but is only visible when the e m fs. are in phase coincidence. When the e m fs. are out of phase a torque will be produced by the currents in the windings and the pointer will take up a position at one end or the other,

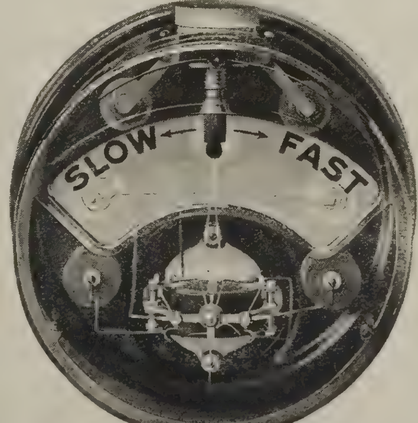


FIG. 3. PHANTON VIEW OF SYNCHRONSCOPE.

depending upon the magnitude and sign of the phase difference.

Finally, when the e m fs. have different frequencies the phase will shift continuously through complete cycles of 360 time degrees and the torque will vary continuously from zero to plus maximum back through zero to a negative maximum, etc., and thus the pointer will be caused to swing back and forth over the scale. At the same time the light will alternately become light and dark and the periods of light and darkness will coincide with the swings in such a way that the pointer will be visible only during every other swing and will thus appear to rotate continuously in one direction. The direction of apparent rotation will indicate whether the machine is fast or slow, and the speed of rotation will be a measure o fthe magnitude of the difference in speed.

The diagram in Fig. 5 shows what actually takes place in the instrument and why the instrument can be relied upon to indicate correctly whether a machine is fast or slow. The diagram is constructed by drawing in at the top two waves of different frequencies. These also represent the currents in the primaries of the lamp transformer, and their resultant shown dotted is the current active in the lamp. This current lights the lamp to incandescence only when the maximum falls outside the shaded band, and thus the period of light and darkness is determined.

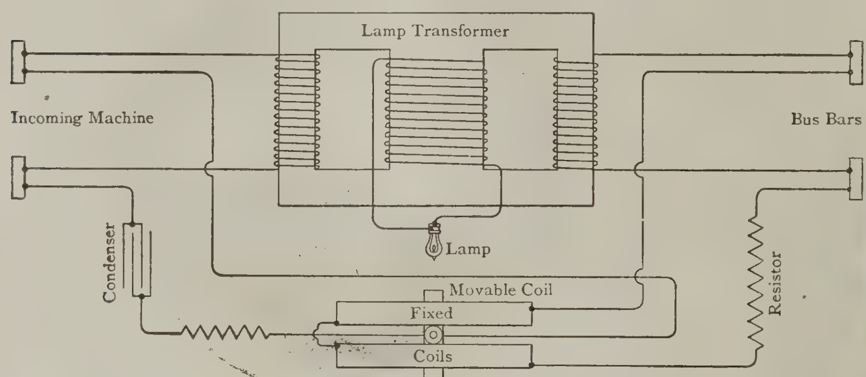


FIG. 4. CIRCUIT CONNECTIONS.

The other waves which show the currents and torques in the instrument coils are constructed by taking first one and then the other of the top waves as belonging to the incoming machine and advancing that wave 90 deg. or a quarter period due to the condenser in the circuit. The torque is taken as the product of these two current curves. A superficial examination of this diagram shows the periodic alternation of the torque and its reversal with respect to the light and dark period when the machine changes from fast to slow.

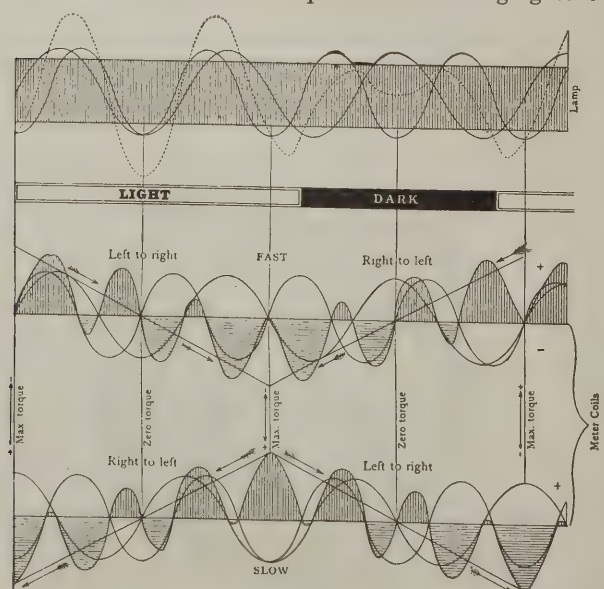


FIG. 5. PERFORMANCE DIAGRAM OF SYNCHRONSCOPE.

POWER-FACTOR METER.

The Weston power-factor meter is noteworthy principally on account of its novel mechanical construction and its unique operative characteristics which result from the new type of design As was said above, it belongs to the electrodynamometer class. The construction of the movable coils is the most interesting feature of the design. In an instrument of this type the theory calls for two absolutely equal coils placed concentric and in quadrature; that is, at the two diametral points where the coils intersect each must pass bodily through each other and both should occupy the same space. In the Weston power-factor meter this seemingly impossible condition is met by interlacing the coils layer by layer at crossing points. Otherwise the coils are quite the same as those used in the Weston wattmeters.

FIG. 6. WESTON FREQUENCY METER.

Another difficulty encountered in the construction of the movable coils to the external circuit without interfering with the free motion of the system. Another distinctive characteristic of this new power-factor meter is the ability to use it on single-phase circuits without sacrifice of accuracy.

FREQUENCY METER.

The Weston frequency meter is based upon a new principle of operation. It consists of a Wheatstone bridge arrangement of resistors and reactors, and a differential meter to indicate the unbalance of the bridge. The arrangement of the circuits is shown in Fig. 7. When the frequency is normal the same current will be carried by each coil and none across the lead A. For any other value of frequency the change in reactance will upset the balance causing more current to be carried by one coil and less by the other.

The instrument itself is of the moving iron type. It consists of an iron needle hung in the magnetic field produced by the two field coils connected in the bridge. These field coils are flat and rectangular in form. They are placed at right angles to each other and closely surround the iron needle.

The needle is without spring control and is perfectly free to take up a position where it coincides with the resultant magnetic field of the two coils. As was pointed out above, the relative value of the currents varies with the frequency, and since the components of the field are proportional to these currents, the space position of the resultant field indicates the frequency. By properly choosing the constants of the circuit and proportioning the parts, the scale has been rendered uniform and open, and therefore can be readily read from a distance.

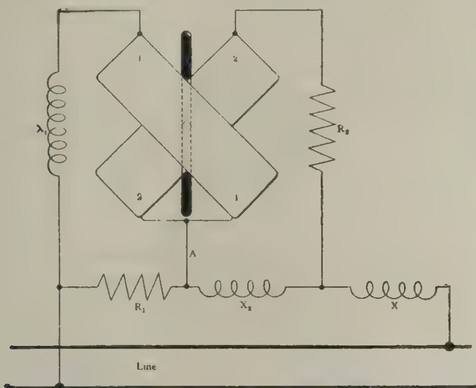


FIG. 7. CONNECTION DIAGRAM FOR FREQUENCY METER.

The great accuracy of these meters is largely due to the careful design and construction of the reactors. The reactors resemble in general appearance a coretype transformer. The core is built up of extremely thin laminations firmly bolted together and thoroughly insulated. It is provided with two accurately adjustable air gaps, one in each leg. By thus locating the air gaps they are effectively shielded by the conductor turns so as to prevent the formation of stray or leakage fields, such as are present when the gaps are located outside the coils. By thus reducing the leakage field to a minimum, the errors due to variations in line e m f. are rendered negligible; for instance, a variation of e m f, from 75 to 150 volts will produce a maximum error of only 1½ per cent.

Excel Electric Iron.

The illustration below shows a type of electric iron, designed and manufactured by the Lowe Electric Co., 54 Vesey St., New York City. A feature of construction in connection with this iron, is that most of the weight is below the heater next to the goods, so that the heat is where it is needed. Nearly three-quarter inches of solid casting is provided to store the heat. The iron is not only hot on the point but is hot over its entire surface. The heating element contains important features, it is self contained, simple, compact and quickly removed or replaced in the iron. The two element parts are sheet mica and resistance metal.

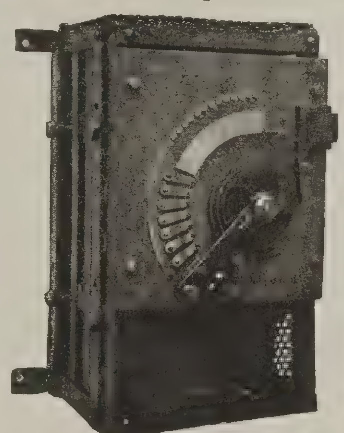
EXCEL ELECTRIC IRON.

The zig zag resistance, of which the element is composed, is arranged in one plane between sheets of mica and the completed element is of such design that the heat giving element directly applied all over the iron bottom, gives the greatest heat delivery with the lowest possible difference in temperature between element and body of iron.

The cord consists of standard copper conductor six feet in length covered with asbestos insulation and worsted covering. The two conductors under one braid, ends properly finished and all braids tied back the proper distance. Both ends of the flexible cord have a special design of plug. The iron is of shapely design and of three sizes. The three pound is suitable for all light purposes and takes 200 watts approximately, the six pound domestic size is popular for household use and takes 400 watts, the most popular size, however, is the 8 pound heavy duty iron used in laundries, hotels and offices, where the heaviest work is required and takes 560 watts. All of these irons can be directly attached to any standard electric light fixture and will work on either direct or alternating current.

New Cutler Hamme Products.

The Cutler-Hammer Manufacturing Company of Milwaukee has recently put on the market a compound speed regulator which gives speed changes in a number of steps, providing 100 per cent. variation by field control, and 50 per cent. by armature resistance. This apparatus by the operation of a single lever starts the motor, varies the speed up to normal and increases the speed above normal. Where



SPEED REGULATORS FOR WIDE RANGE VARIATION.

large speed variations are desired and only one voltage available, this device provides a most economical and convenient means. The automatic release operates from any point, and is always in circuit. Two separate types of this regulator are made, a fan type and a machine type, each made in sizes from ¼ H.P. to 50 H.P. for 115, 230 and 500 volt circuits.

A FEED THROUGH SWITCH.

Many heating devices and small portable motor-driven devices, such as drills and vacuum cleaners, are used with long portable cords and are operated at a distance from the attachment plug or switch. For such cases a feed-through switch, which can be installed directly on the cord near the apparatus, permits of turning the current on or off wherever the device is being operated.

The new Cutler-Hammer switch, shown two-thirds size in the accompanying illustration, has an enclosing casing made of a black insulating material, which is the result of years of experimental work. This composition is remarkably tough, has a handsome finish and can be mouled with extreme accuracy, so that perfect alignment of the operating mechanism is possible. The rating of this switch is 6 amperes at 125 volts, and has been approved by the Underwriters Laboratories.

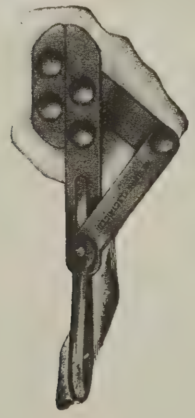
NEW SELF STARTER.

The Cutler-Hammer Manufacturing Company of Milwaukee has put on the market a new type of motor self starter for use with small direct current motors. These devices, a universal type of which is shown in the illustration below, are made in capacities from ¼ horsepower to 3 horsepower and are particularly adapted for the automatic or remote control of motor-driven pumps and similar machinery.

The new Z type starter is operated by means of a solenoid which revolves a horizontal shaft on which four short contact arms, making butt carbon to copper contacts, are mounted. The arrangement is such that the time of short-circuiting the rheostatic armature resistance and the acceleration can be varied. This self starter canbe employed for control by float switch, push button or pressure regulator. An important feature where used in compression tank systems and with air or gas compressors is the direct operation of the solenoid circuit by the pressure regulator. No relay circuit is required. These starters are also particularly useful with vacuum cleaner systems. The vacuum pumps can be started or stopped from different floors by means of push buttons connected in the solenoid circuit. These self starters are made in 110, 220 and 550 volt types, for two and three-wire control, with and without knife switch and fuses.

The Improved Buffalo Grip.

The Western Electric Company has recently placed on the market a new improved Buffalo Grip with a special locking feature. In Fig. 1 the new grip is shown with the jaw held open by the locking device. A turn of the handle locks the jaw in any position and enables the lineman to easily and quickly insert the wire in the grip. When the



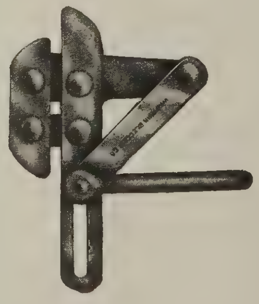


FIG. 1. BUFFALO GRIPS WITH JAW OPEN AND CLOSED.

handle is pushed down as shown in Fig. 2, the wire is held in a tight grip. The improved Buffalo Grip is made in various sizes for both bare and insulated wire, and can be supplied both with and without pulleys.

Perfex Portable Cleaner.

The Suction Cleaner illustrated herewith, contains a feature which makes its appeal to persons who desire a suction cleaner, in which the motor can be detached and used for various purposes. The pump is mounted above a small electric motor to which it is belted and by simply removing this belt, the motor can be used for running washing machines, sewing machines or for any other purpose for which electric motors are desired. The bag of screening material is placed above the pump, and the whole

PERFEX CLEANER WITH CASE REMOVED.

is placed in a cylindrical case. The air drawn into the machine leaves its dust in the bag, and on its passage out is used to ventilate the motor. If desired, the action may be reversed, the machine being used as a blower for hair drying, renovating pillows, blowing out pianos, etc. The motor in the portable machine is rated at ⅙ horsepower and the machine complete weighs 50 pounds. This cleaner is manufactured by the Perfex Cleaner Co., of Waukegan, Illinois.

A New Solder

A new kind of solder has recently been placed on the market by the H. W. Johns-Manville Co. It is in the form of a paste in a collapsible tube, and all that is necessary for its effective use is to scrape off the surface of the part a little with a knife, squeeze some of the soldering paste on and apply a match, candle or torch. When the paste becomes hot it fuses and solders in the same manner as the old style soldering stick. While this article has been in use only a short time its convenience, cleanliness, economy and many other advantages have naturally made a wide appeal to householders as well as to plumbers, tinsmiths, electricians, hardware and supply stores and others. The name of this new product is Solderall.

Detroit Switches.

The Detroit Fuse and Manufacturing Co. has placed on the market a new type of Detroit switches, known as the "Severe Service Junction Box Switch." In addition to being an Ironclad fused switch, this device provides for the branching out of circuits in all directions and for the main lines passing entirely through the box and under the porcelain base. The switch is of quick make and break type, positive in its action and controlled instantly from the outside of a cast iron box. All working parts are of phosphor bronze, making a rust proof design and the switch is equipped with gaskets, giving a water tight construction.

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. It is understood that plans are being considered by the Board of Commissioners to supply the city with elictricity from North Birmingham and to light the municipal buildings in Birmingham. The plans call for the enlargement of the original plant so as to take care of this service. The cost will be about $9,000.

CENTERVILLE. The Centerville Light & Power Co., of Bibb county filed its certificate of incorporation Monday with the Secretary of State. The capital is $15,000 and the incorporators are J. P. Kennedy, H. E. Reynolds, J. N. Lightsey and O. G. Oakley.

COLUMBIA. Plans for the construction of a hydro-electric plant are being considered by F. S. Twitty and others. The cost of the plant will be about $8,000.

DECATUR. It is understood that plans are being prepared for a municipal electric light plant to cost $40,000. The J. B. McCrary Co., of Atlanta, Ga., are engineers.

DOTHAN. It is understood that bids are out for the construction of the Dothan Light & Water Works plant. The plant will cost approximately $60,000.

GADSDEN. The Alabama Power & Light Company has incorporated. The object of the company is to furnish light and power in a number of counties in North Alabama and the incorporators are R. A. Mitchell, E. T. Hollingsworth, T. S. Kyle, O. R. Goldsman and E. C. Allen.

GADSDEN. Reports state that E. R. LeSeber of Gadsden is interested in the construction of a water power development sufficient to produce 20,-ooo horsepower.

GANTTS QUARRY. An electric power plant will be installed by the Alabama Marble Company with a capacity of 500 k. w. Electric drive will be used throughout. The vice-president and general manager is J. S. Sewell.

HEADLAND. The citizens have voted $7,500 in bonds for the purpose of improving the electric light plant and water works.

IRON CITY. It is understood that the city is planning to vote on $10,000 in vonds for the installation of an electric light plant and water works system.

MONTEVALLO. The installation of an electric power plant for the mines at Aldrich and also a plant sufficient to furnish Montevallo with light and power is the plan of Peter Thomas of Aldrich, Ala.

JASPER. It is understood that the Jasper Water Light & Power Company contemplates the enlarging of its electric equipment.

MARION. The Marion Electric Company has been incorporated with a capital of $10,000 by T. J. Krouse and others.

ONEONTA. An electric light plant to cosr $6,000 is now being considered. D. M Farson & Co. of Chicago, Ill., are interested.

ARKANSAS.

FAYETTEVILLE. Plans have been announced by which the plant of the Fayetteville Electric Light & Power Co. will be considerably enlarged, the expenditure for such being placed at $20.000.

MANSFIELD. The Modern Electric Light and Power Company has been incorporated with a capital stock of $100,000. The president is C. E. Brice, vice-president, M. Hudson, and secretary G. E. Gilmore.

LITTLE ROCK. The Little Rock Railway & Electric Co. s planning to install a new intake and condensing system in its power plant. G. A. Hegarty is general manager.

FLORIDA.

FORT PIERCE. The installation of an electric light plant water works and sewerage system is under consideration. A bond issue of $85,000 is also being considered.

HASTINGS. Plans are under way for the construction of an electric light plant by the city.

HAVANA. A company has recently been organized to install an electric and ice plant at Havana. James Cheatham is interested.

JACKSONVILLE. The Jacksonville Traction Co, as successors to the Jacksonville Electric Company is to erect a power plant equipped with three water tube boilers, two 1200 K. W. generators and auxiliary apparatus at a total cost of approximately $500,000.

JACKSONVILLE. The Lofield Engineering Company of Philadelphia, Pa., are the engineers for the electric power plant to be installed at Jacksonville.

TALLAHASSEE. Bids are open by the city of Tallahassee for $15,000 in bonds for extension to the electric and gas plant. A. H. Williams is the city clerk.

GEORGIA.

ALBANY. The city council has granted a franchise to local capitalists for the construction of a street railroad.

AUGUSTA. The Augusta & Aiken Railway Company are making arrangements to place all wire underground on the principal streets of the city.

BAXLEY. Considerable agitation is now going on in this place in regard to the construction of an electric light plant.

BLACKSHEAR. The installation of an electric light plant is under consideration

CLAXTON. The mayor and city council are considering the installation of an electric light and water works system.

LEARY. An electric light plant, a cotton gin, and a grist mill will be erected by the Leary Gin & Light Company.

PERRY. The city will vote on the issue of $6,000 in bonds July 1st. The proceeds to be used for the construction of an electric light plant.

SYLVANIA. J. B. McCrary & Co., of Atlanta have been engaged as engineers for the construction of a water, electric light and sewer system. A. B. Lovett is Mayor.

STILLMORE. It is understood that plans are reaching a definite state for the installation of a power plant and a distribution system to furnish light to tSillmore. About 350 lights have been subscribed besides 50 arc lights for the town.

WASHINGTON. Plans are underway by the city for the improvement of the electric light plant including expenditures on the power plant to the amount of $10,700, outside wiring, $8,000, pumping station and transmission line $6,500. Bonds to the extent of $30,000 will be issued.

MARIETTA. It is understood that J. J. Black is in the market for electric supplies, building materials and plumbing and heating supplies.

ROBERTA. Plans are being discussed for building an interurban line from Roberta connecting with Atlanta and Albany lines at Byron, Fort Valley and Macon, Ga.

VIDALIA. It is understood that the Vidalia Coffin & Casket Co., desire prices on 100 light electric plant.

KENTUCKY.

LOUISVILLE. The Lanham Hardwood Flooring Co. is planning to erect a power plant. Its equipment is at present operated by electrical drive, the power being furnished by a central station.

LOUISVILLE. It is understood that the Louisville and Nashville Railroad will double the power installation at its shops at New Decatur Ala. Alectrical apparatus of considerable capacity will be installed. Further information can be obtained from W. H. Courtney, chief engineer.

LOUISVILLE. Brinton B. Davis, 609 Atherton Bldg., Louisville, is the engineer in charge of an office building for the Inter-Southern Life Insurance Co., to cost $750,000. The equipment will be steam heat, electric lights and elevators.

LOUISIANA.

LAFAYETTE. Prices are desired by the LaFayette Water & Light Co., on three phase generators and a switch board, W. L. Eyres is superintendent.

LAFAYETTE. Reports state that plans are under way for the changing of the electric light plant from direct current to alternating. This development will entail a cost of $40,000. W. L. Eryes is superintendent and can give other information.

NEW IBERIA. The Southwestern Traction & Power Co. is to erect a power house. F. W. Crosby of New Orleans is president.

MORGAN CITY. Plans are under consideration for the installation of a water works plant at Morgan City.

NEW ORLEANS. It is understood that the merger of American City Railway & Light Company with the New Orleans Railway & Light Co., is practically assured and will become effective very soon. The deal will include the street railway light and power companies in Birmingham, Knoxville, Memphis, Little Rock, Husotin and New Orleans, and the capital stock of the merged company will be the same as to the total capitalization of the company's interested of about $48,000,000. The new company will be operated by Messrs. Ford, Bacon and Davis of New York and it is expected that the improvements planned in the Birmingham district will be accomplished.

ROSELAND. Plans are under way for the construction of an electric light plant. The mayor can give other information.

SHREVEPORT. The Caddo Window Glass Co., desires prices on a 50 K. W. dynamo. A. B. Boulenger is president.

MISSISSIPPI.

ELLISVILLE. The Jones County Rural Telephone Company has been incorporated with a capital stock of $10,000 by W. N. Montgomery J. O. Freeman and others.

RELIANCE. An electric light plant sufficient to supply energy to 200 lights is planned by W. R. Cline, president of the Old Dominion Academy.

TUPELO. Bids are out for the equipment necessary for the electric plant in this city. R. C. Huston is the engineer whose address is 1634 Exchange Bldg., Memphis, Tenn.

NORTH CAROLINA.

ASHEVILLE. J. R. Lignon desires to communicate with the manufacturer of electric elevators for a residence. Address care of C. A. Rayson Drug Store, Asheville, N. C.

CONCORD. Prices are desired on a 300 K. W. generator, 40 cycles, and several 40 cycles motors by J. W. Cannon.

GIBSON. It is the plans of Z. P. Pate to install a hydro-electric plant and transmit electrical energy two miles to a cotton gin, guano factory, and desires therefore prices on equipment for these plants.

RALEIGH. According to reports the Carolina Power & Light Co. has secured the controlling interest of the Standard Gas & Electric Co. of Raleigh. C. E. Johnson, of Raleigh, is president of the Carolina Power & Light Co.

RALEIGH. The North State Hydro-Electric Company has been incorporated with a capital stock of $300,000 by A. C. Wykoff, H. L. Parker, and F. H. Briggs. A hydro-electric plant is proposed ,and a transmission system.

TOWNSVILLE. The Northwestern Telephone & Telegraph Company has been incorporated with a capital stock of $10,000 by G. W. Morrel, J. J. White, W. P. Chapin.

WELDON. According to reports the work on plans for developing the Roanoke River Water Power near Weldon, N. C., has begun. It is expected that this development will furnish 25,000 porsepower for transmission to Petersburg and Norfolk and to operate the southern link of the Frank J Gould electric system from Norfolk to Baltimore by way of Richmond and Washington. Ir is understood that the development resulting from the Norfolk and Portsmouth Traction Co., with the Virginia Railway and Power Co., of Richmond.

SOUTH CAROLINA.

COLUMBIA. The capital stock of the Columbia Railway Light & Power Company has been increased from $1,600,000 to $3,000,000. Extensive improvements are said to be under consideration fro the system. The name is also to be changed to the Columbia Railway, Gas & Electric Co'

EDGEFIELD. The city will receive bids for the construction of an electric light plant at once. W. H. Harlins is city clerk and can give other information.

GREENVILLE. The plans for the installation of a Great White Way are under consideration. The system is to cost $2.00 per front foot of property to cover cost of installation and the city council is called to expend $2,600 per year to cover cost of electric current for maintenance of the system.

GREENWOOD. It is reported that the Southern Power Company has applied for a franchise to construct a power line in Greenwood. If the franchise is given several mills will be connected to the lines.

HONEAPATH. At a recent election an issue of $11,000 in bonds was voted for the construction of an electric light plant. The superintendent is P. W. Sullivan.

WOODFORD. The Woodford Ginning & Lighting Company has been incorporated with a capital stock of $40,000. H. B. Knotts, G. W. Wattstone, J. S. Ulmer, and W. E. Ulmer are interested.

TENNESSEE.

DYERSBURG. The citizens have voted an issue of $30,000 in bonds for improvements at the electric light plant.

GREENEVILLE. The city has voted $55,000 in bonds for the purpose of establishing a water and electric light plant.

KNOXVILLE. Plans are under way for the development of water power sites by the Knight, Weller Co., Knoxville, Tenn. A company has been formed with a capital stock of $2,000,000, to establish plants for smelting iron ore by electricity.

LIVINGSTON. The Livinsgton Light & Power Co., are considering the installation of additional electric equipment. W. W. Hendrix of Crookville is interested.

MANCHESTER. The recently incorporated company, known as the Duck River Power Co., is planning the development of a water power near Manchester for the purpose of furnishing lighting to that town.

McKENZIE. Bids will be open until July 1st for the construction of an electric light plant for McKenzie. The engineer in charge is D. K. Jenks, St. Louis, Mo.

MEMPHIS. Prices on electric generators are desired by H. E. Houston.

MEMPHIS. Prices are desired by R. C. Houston on a cross-compounding and gasoline engine, also on an electric generator and pumps of various classes.

PETERSBURG. The Petersburg Electric Light & Power Company and G. McAdams are among the incorporators. A lighting plant will be erected at once according to reports.

PULASKI. It is understood that plans are now taking shape for the establishment of an electric lighting plant at Pulaski. H. M. Grigsky can give information.

TEXAS.

BASTROP. The Electric Light Plant at this place will be considerably enlarged and an ice plant installed. The owner is F. C. Bishop.

BROWNSVILLE. Improvements are being made at the electric light plant including the installation of a water filter plant to cost approximately $20,000. Other improvements are said to be proposed.

FRANCIS. The Francis Light & Power Company has been incorporated with a capital stock of $10,000. The Incorporators are A. L. Mullergren and W. J. Donathan of Poteau, and W. P. Chism, Albert Goetter and W. L. Shaffer, of Francis.

HONDO. The Hondo Light ,Power & Ice Company has been formed with a capital stock of $24,000. The incorporators are J. H. Horn, L. Schlentz and Jacob Sohn.

LULING. The Luling Electric Light & Power Plant will be enlarged and otherwise improved.

NEW BRAUNSELS. Reports state that the preliminary plans of W. J. Farmer Co., Kansas City, Mo., are taking definite form. The proposition now is to construct a concrete dam across the Guadalupe River nera New Braunsels, and the installing of hydro-electroic equipment by the city.

VIRGINIA.

DANVILLE. A vote will be taken July 11, on a bond issue of $150,000 for the improvement of the electric light plant.

EVINGTON. Prices are desired on plumbing, electric wiring, and other material for mill work, by C. H. Turner & Co.

GREAT GATE. The Gap Falls Power & Electric Co., is reported as the name of a company now under organization to construct a hydro-electric plant at this place. Walter Graham is interested.

RADFORD. The Dominion Power Company of Radford proposes to construct a nhydro-electric plant on the New River, to supply electrical energy to Worth, Carol, Palache, Montgomery and Grayson counties. The officers of the company are J. E. Walters, of Radford, setc., and J. J. Mar of Stateville, N. C.

ROANOKE. J. S. Barbour & Co., desire prices on electrical wiring

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BOOK REVIEW.

MOTION STUDY. By Frank B. Gilbreth. Published by D. Van Nostrand Co., New York. 135 pages and 44 illustrations. Price $2.00.

In this work the principles of motion economy have been carefuly worked out in connection with a business such as a building contractor. The study has been directed toward increasing efficiency of the output of workmen. In the elimination of unnecessary motion, the methods to be adopted are dependent upon the conditions governing the state of being of the workmen. His own individual characteristics, the nature of the surroundings, quality of tools and appliances, and the property of the motions necessary to accomplish the work are points involved. The illustrations given show details and the principles of motion study and how they can be applied. The field is a broad one and all those who are interested in it can find much of interest in this work.

MATHEMATICS FOR THE PRACTICAL MAN. By George Howe. Published by D. Van Nostrand Co., New York. 143 pages. Price $1.25.

This work takes up in brief the fundamental principles of algebra, geometry, trigonometry, co-ordinate geometry and calculus. The work is written in such a way as to be of use and interest to the practical engineer, who may desire a grounding in mathematics sufficient to read intelligently other works on engineering. The treatment is such that the various principles can be clearly understood by anyone who has never taken up the subject of mathematics in its higher branches. It is clearly written and well arranged and should serve a useful purpose.

New Orleans drainage system and those that supply the water for the city of Duluth. He is an active member of the A. S. M. E. and is well known to members of the engineering profession.

DIRECT AND ALTERNATING CURRENT TESTING. By Frederick Bedell. Published by D. Van Nostrand Company, New York. 275 pages. Price, $2.00.

The work covers tests on alternating and direct current apparatus, referring to the practical use of such apparatus and indicating the particular features of interest both from an operating standpoint and from an instructive standpoint. The work has been the outgrowth of many years of instruction, personally directed by Professor Bedell and it therefore presents material of particular interest to students. However, so well is it planned and so practical are the lines along which suggestions and tests are given that it will be found of considerable value to every engineer having to do with the operation of electrical machinery. The contents of the book cover tests on direct current generators, direct current motors, synchronous alternators, single phase currents, transformers, polyphase currents, phase changes, potential regulations. Under each of these headings complete informátion is given as to the operation of various apparatus making the volume more than a testing manual in that it is a reference text as well.

HYDRO-ELECTRIC DEVELOPMENT AND ENGINEERING. By Frank Koester. Published by D. Van Nostrand Company, New York. 472 pages and 500 illustrations. Price $5.00.

In view of the increasing interest in hydro-electric development and the increasing number of such plants in this country, a complete and exhaustive work on this subject is most acceptable. The above work can be said to fulfill these conditions, as it has been carefuly laid out and well developed covering the entire field of hydro-electric engineering. It is divided into three parts, part one covering the transformation of water powers into electrical energy, part two, the transmission of high tension electrical current, and part three, the modern American and European hydro-electric developments. In part one, the folowing subjects are presented and discussed: The hydro-electric proposition, dams, headrace, penstocks, power plant, mechanical equipment and electrical equipment. Part two, electrical transmission, substations and line protection. Part three is devoted to a description together with illustration of nine developments and their transmission systems which fulfill the various conditions and embody the varying design of hydro-electric plants. The work is of such a nature that it applies to general designs of hydro-electric power plants in various sections of the country and presents the information in such a clear and simple manner that it is readily understood even by those who have little grounding in the technicalities of the work. The author is a consulting aand practical engineer with experience both abroad and in this country and the information on the features of hydro-electric engineering are therefore up to date and the best of current practice.

PERSONALS.

G. K. HEYER, railway sales engineer of the Western Electric Company, recently read a paper on telephone train dispatching before the Telephone Society of Boston in which he traced the early history of train dispatching from the time that running ahead of the train with a flag was the method employed, up to the present day. As early as 1883 the telephone was employed for dispatching trains on a few small railroads, but it was not until 1907 that the improvements in telephonic apparatus made possible the widespread of this method, supplanting the telegraph for this important service. In the course of his address, Mr. Heyer said: "The extent to which the telephone has been adopted by these roads is best shown by the following lines of roads each having telephone circuits covering 1,000 miles of line. These figures include in most cases equipment installed and under construction both on train and message circuits: Atchison, Topeka & Santa Fe 7,000 miles, Lake Shore & Michigan Southern 2,300, Pennsylvania Railroad (east of Pittsburg) 1,700, New York Central (including Boston & Albany) 1,225, Big Four 2,500, Illinois Central 2,259, Canadian Pacific 3,782, Great Northern 3,000, Chicago, Milwaukee & St. Paul System 1,800, Louisville & Nashville 2,200, Northern Pacific 1,153, Chicago, Burlington & Quincy 2,700, and the Seaboard Air Line with 1,161, making the total 32,810 miles. In aaddition to the above roads, there are 60 which have one or more telephone train dispatching circuits in operation, the total number of roads being 73 and the mileage covered approximately 48,000 out of a total of 285,000 of railroads in United States and Canada. Of the railroads that have installed telephone and selector equipment over practically their entire systems, the Lackawanna is the largest. This road, out of a total of 957 miles, has equipped 933, on which there are 271 stations. There are several other railroads, however, which will be fully equipped and plans already worked out are carried to completion. In fact, it is only a matter of a few years when the telephone will entirely replace the telegraph for the dispatching of trains as well as for the transaction of all local, commercial message and routine business."

The Pennsylvania is to extend its system of train dispatching, and the Chicago, Milwaukee and Puget Sound will equip 755 miles of track in the near future.

WALTER R. ARMSTRONG, who has recently been elected president and general manager of the Federal Miniature Lamp Company, is a wellknown figure in the miniature incandescent lamp business. Mr. Armstrong's experience in lamp manufacture dates back to 1886, and for the past 20 years he has made a special study of odd and novel types of lamps. Personally one of the most expert lamp makers in this country, he has a rare ability in teaching the art efficiently to others, and has thus developed a corps of specialists thoroughly skilled in the delicate, exacting operations of miniature lamp manufacture. During the past four years Mr. Armstrong has given much attention to the perfecting of high-efficiency and incandescent lamp for automobile head-light service, and has worked on the automobile lighting problem in co-operation with the engineers of a large number of storage battery, generator and automobile manufacturing concerns.

Mr. Armstrong's chief assistants in the operation of the Federal Miniature Lamp Company are O. V. Maurer, formerly factory expert of the Fostoria Incandescent Lamp Company, and now on a tour of investigation in Europe; R. O. Poag, formerly of the Engineering Department of the National Electric

W. R. ARMSTRONG.

Lamp Association, and B. F. Whelan, formerly of the Buckeye Electric Company. The federal factory is of very recent aand thoroughly modern construction, and carries a stock of over half a million lamps, said to be the largest single stock of miniature lamps in the world.

INDUSTRIAL ITEMS.

THE CUTLER-HAMMER MFG. CO. announces the establishment of a new department to be devoted exclusively to the design and manufacture of electrical appliances for industrial heating. The resources of the company's large and thoroughly equipped New York factories at 144th street and Southern Boulevard, will be principally devoted to the manufacture of this class of appliances, under the direct supervision of W. S Hadaway, Jr., who for many years has specialized on applications of electric heat to industrial purposes. An opportunity to aid in the solution of any problem of this nature is solicited.

SCREW-GLASS INSULATORS. Catalog No. 50 describing Brookfield standard screw glass insulators and knobs has been received. This catalogue contains 52 pages of descriptive and illustrations, taking up the various types of Brookfield glass insulators. These insulators are manufactured by the Brookfield Glass Company of New York.

A CORRECTION. On page 259 of the June issue appeared an article entitled Murdock Safety Cabinet. In the third line of this article appeared the name Murdock Electric Manufacturing Company. The heading for the article should have been "Wurdack Safety Cabinet," and the name of the company should have been Wm. Wurdack Electric Mfg. Co.

TRANSFORMERS. The Crocker-Wheeler Company, of Ampere, N. J., has issued a small folder taking up construction on features of Crocker-Wheeler Transformers.

ORNAMENTAL ILLUMINATION. The Four City Ornamental Iron Works has recently issued a catalogue devoted to modern municipal illumination. The catalogue is beautifully arranged and contains photographs of installation of decorative lighting installations now in operation throughout the country.

THE ECLIPSE ELECTRIC ARC LIGHT CO. has been awarded the contract for the complete electrical equipment of the Cohen Brothers Department stores at Jacksonville, Fla. The work consists of the electric light wiring for 6000 electric lights, power wiring for six elevators, vacuum cleaning systems, pumps, ventilating systems, etc. There will be about 100,000 feet of piping, all of which will be concealed and imbedded in the concrete. Mr. Geo. H. Schuman, president of the Eclipse Electric Arc Light Co., advises that the company is prepared to furnish electrical supplies and do electrical construction work of all kinds.

Alphabetical Index to Advertisers.

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CONTENTS.

The Public Policy Activity.

In another section of this issue is a report of the convention of the Mississippi State Section of the N. E. L. A. Running throughout all the discussions and occupying a prominent place in the papers of the most important session, was the theme of how a closer and more cordial relation can be established with the public. Here at this meeting as at every other meeting of public utility men, there was a clear demonstration of how closely the interests of the people and the utility corporation as well as the private company are interlaced. At the most successful convention of the American Institute of Electrical Engineers, recently held at Chicago, the attention given to this subject was especially noticeable. We quote as follows from the discussion of the topic to which a session was devoted: "The electrical engineer can perform no higher service than by becoming interested in the problems affecting the relations of public service corporations with their customers. It is highly necessary that the mind of the public be made clear, or that the public be helped to make up its own mind, as to what is fair and reasonable in its attitude toward the service companies supplying so universally needed a commodity as electrical energy. Distrust of some of the methods which had been practiced by corporations in the past was warranted in many instances, but the public had not been fair in all cases. When the public did realize that it had a weapon with which to attack the corporations it went to the other extreme, but fortunately there were elements at work which speedily sought to educate the public to a better appreciation of the great benefits conferred upon the community by these corporations, and the situation now appears to be possible of a happy and satisfactory solution."

That the operation and extension of central station properties is a distinct social service no one in these days will doubt when carefully considering all of the features. The increase in financial worth in business and property by the placing of transportation, electric, gas and telephone service within the reach of all is evident. If there is a certain prejudice and dissatisfied feeling among those served by the public service corporation and a general tendency to criticise at the least provocation, then there is one remedy only. Regain absolute confidence of the community as a whole, the corporation's sole field for its business, by conducting affairs above board and in such a way that the interests of the public are plainly evident. The conditions and complications which have developed with the growth of most public service corporations have already brought out these distinct features and compelled action in order that a just return on investment be placed upon a substantial basis and the profits distributed to factors, such as legal adjustment of differences, be turned not only into cash but the most substantial of all assets, "good will." That a majority of electrical companies recognize these facts, the records of expression from all sections of the country given before recent conventions of the N. E. L. A. stand as evidence. Further the formulating of ways and means of co-operation between public and the operating company is pointed out by the extensive scope and rapid growth of the above named organization during the past year. While much can be done through a large organization of interests of this nature, there remains more for each company and its individuals by themselves. It is in this field that the wise policy of the N. E. L. A. has shown up and here again it is that the greatest good can be accomplished, for each company has its own problems and in general each requires an individual method of solution.

In the Southern States there are several organized public utility associations, organized to bring about results in a particular section, and while these organizations are yet young, they are unquestionably doing considerable good. Through publicity methods and the practices adopted, there has been a decidedly better understanding of the purposes and aims in extending service and dealing with immediate customers. While these district associations, so to speak, have their own field and the local company has its field, there is yet a gap between the organization covering the restricted territory and the organization of the entire central station industry.

Co-operation is now offered as a modern invention and a substitute in a way for the older pracpractices and destructive methods. The meeting from time to time of various bodies having common interests, at which occasions there may be a free exchange of information as to business affairs, is a particularly good arrangement by which a frank and full exchange of opinions current in different districts can be effected. It would seem therefore that the joining hands of all public service associations in a particular territorial division of the country could extend the good work which may result from efforts in the territory of each without detriment to any, but with benefit to the industry in general. Organizations representing territorial divisions of this character, ready to combine their resulting features of investigation are needed in our Southern States, and will make a National body, if followed elsewhere, one of its intended importance. The South is a large central station field and a new one, the work to be accomplished is all before. At the September convention of the Georgia State Section is the time for all associations in the South to have representatives present to take up this matter. May there at that time be a unanimous opinion that there shall be a Southern Geographical Section of the National Electric Light Association or an organization of equally broad scope brought into being.

Convention of the Georgia Section of the N. E. L. A.

The date set for the convention of the Georgia Section of the N. E. L. A. is September 26th and 27th, and the meeting will be held at Columbus, Ga. This is the first convention of the Georgia Section, organized at Atlanta, October 20th, 1910. The organization has enjoyed a lively existence so far and it is expected that the convention will number 100 members and representatives of central stations in the territory. An extensive program is being arranged by the program committee, the details of which, however, are not ready for publication. There will be many important matters discussed at this first meeting and the program will interest every central station man in the State. There will be social features arranged for also which will add pleasure as well as benefit to the meeting.

Mr. H. M. Corse, who has acted as secretary and treasurer of the Georgia Section has resigned his position as assistant to the manager of the Columbus Railway & Power Company to take up business of a private nature at his home in Jacksonville, Fla. On account of this fact Mr. Thomas W. Peters, of the Columbus Railroad Co., has been appointed secretary and treasurer to complete Mr. Corse's term. Further arrangements in regard to the convention will be published in these columns as soon as the details are definitely outlined.

In commenting upon the coming convention in a recent letter, President Bleecker has the following to say: "I hope to see at the September convention of the Georgia Section of the National Electric Light Association not only a large number of representatives from the member companies, but a number of invited guests, who, through their connection with kindred electrical matters or as prospective members of the Georgia Section, will be invited to the convention and whose presence I am sure, will be beneficial not only to the existing members but to the visitors themselves. The rapid increase in membership of the Georgia Section during its first year of existence is an indication that before a great while all those interested in central station matters will be numbered in its membership. Through the extensive exchange of ideas the central station industry of Georgia will thus be brought up to, and perhaps surpass, the standard of excellence existing in other localities. Don't forget the time, the place and the name. September 26th-27th, Columbus, Georgia Section N. E. L. A."

John S. Bleecker,
President Georgia Section, N. E. L. A.

To Investigate Electrical Vehicles.

The electrical engineering department of the Massachusetts Institute of Technology has received an appropriation of $3,000 from the Edison Electric illuminating Co., of Boston, to be used in an investigation of the relative operating reliability and costs of electric trucks, gasoline trucks and horse trucking, for the purpose of determining to what degree electric trucks are adapted to compete with gas and horse trucks in the city of Boston. This investigation will cover the cost of delivery of goods in the different ways. It will include all questions which concern electric trucks, including the influence of the different kinds of city pavements on cost of delivering goods, and the effects of different routings of the vehicles. The investigation will be partly theoretical but it will be planned to determine practically what it ordinarily costs to deliver goods under city conditions. This part of the investigation will be accompanied by actual observations extended over a period of many months. At least a year will be occupied in this work, and Mr. H. F. Thomson has been appointed Research Associate to carry on the work under the direction of Professor Pender.

The Application of Electric Power to Southern Industries.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

BY F. B. DAVENPORT, B. S. IN E. E., ADJUNCT PROFESSOR ELECTRICAL ENGINEERING, GEORGIA SCHOOL OF TECHNOLOGY.

IN THIS article the writer will attempt in a general way to discuss the question of the application of electricity to some of the industries of the South. An effort will be made to show approximately the power required by a number of industries, and it is hoped that the information given will prove useful and of some value to the manufacturer contemplating the use of electricity as well as the central station manager in search of an increased power load. The data given is taken from authentic sources and may be considered as representing fairly average conditions.

The question of using central station power or obtaining power from a plant built in connection with the manufactory is one of some importance and should be taken up carefully in those cases where the user of power is operating a plant of medium or large size. It might be said that in the majority of cases, the small manufacturer will obtain his power more cheaply and more satisfactorily by buying it from the central station. Of course there are cases where it would be advisable for the small factory to use electrical power and be isolated from a central station to such an extent that it would be necessary to manufacture its power on the spot. As an example: In a location remote from a central station or transmission line, a small manufacturer has two developed water powers located on the same stream and several hundred feet apart. One of these drives a grist mill and the other a small woodworking plant. In addition there is a steam driven cotton gin. At certain times when water is low, sufficient power is not available to satisfactorily drive the mill. By installing a generator at the lower water power (which drives the woodworking plant) electric power could be utilized to aid the mill and electric drive could be applied to the gin during the ginning season. An additional industry at this point is the pumping of sand, which at present is done by a gasoline engine. An electric installation would also simplify matters here. In addition to the above, the electrical energy could be used for lighting, to drive a pump for house service water, and numerous other small necessities and conveniences.

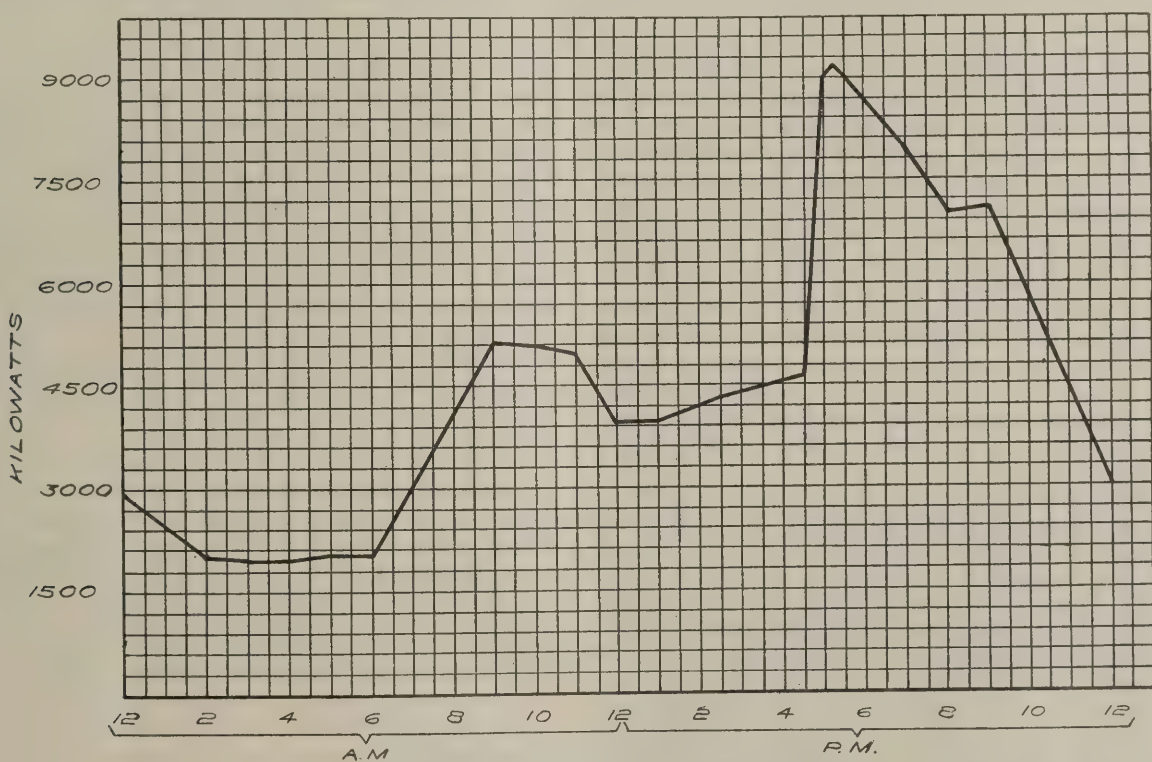


FIG. 1. A TYPICAL STATION LOAD CURVE.

If an industry is large and uses a large amount of power, it is in general advisable to manufacture its own power. In general it must be said that the question of central station or isolated plant power is one that should be worked out on its merits for each case, and where a large expenditure for power is to be made the case should be put in the hands of a reputable engineer who can be relied upon to give both sides of the question a thorough and unbiased investigation. Some of the points to be taken into consideration are as follows: Location of plant as regards fuel and water facilities; the possibility of making profitable use of the exhaust steam for heating, ice making, etc.; extra labor required; interest, depreciation, etc., on the power plant; and in cities especially, the cost of additional land for the plant is of great importance.

As a good example of a large industry generating its own power, may be cited the *Woodward Iron Company, near Birmingham, Ala. This company has built a power house near its blast furnaces and the boilers are fired with the blast furnace gas. This centrally located power plant generates 25-cycle energy at 3,500 volts and distributes it by means of four feeders as follows: One extends to a point one mile west, where the entire water supply is pumped by two centrifugal pumps driven by 3,500-volt induction motors; a second feeder is run three miles southwest to the opening of the ore mines, where electrically driven crushers and hoists are supplied; two other feeders run from the power house to the coal mines are located about two miles northwest. Here the feeders enter switch houses containing lightning arresters, choke coils, etc. From the switch houses the feeders pass into the mine entries in lead covered, steel armored cables and down to sub-stations in the mines, where the high-tension current is converted by means of transformers and rotary converters to 250-volt direct current for operating locomotives, coal cutting machinery and lighting.

An important consideration to the central station manager, is the building up of a load which will increase the station's load factor. The load factor may be defined as the ratio of the total demand in K. W. H. on the station for a given period, say a month, to the rated output of all the station machines in K. W. H. for the same period. If the load factor is high, it means that the machinery is operating more efficiently. The different machines are doing more to earn their share of the constant expense attendant upon their installation so that the plant is operating in every way more nearly at its maximum efficiency than when the load factor is lower. The load curve of a station is a rather irregular line, and of course has a shape varying with the nature of the service supplied, but in

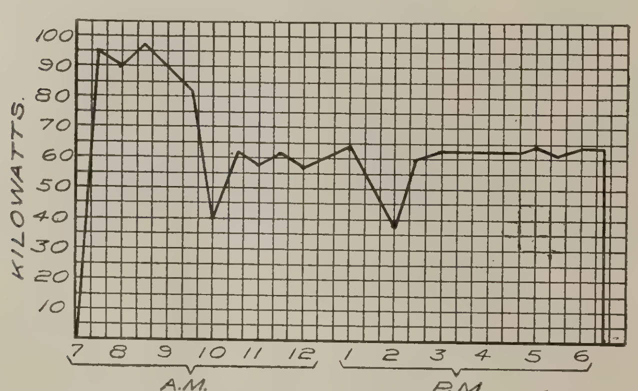


FIG. 2. BOX FACTORY LOAD.

practically all cases there is a pronounced peak in the curve at some time in the early part of the evening, the time of the peak varying with the time of the year. In order to raise the load factor of the station it is necessary to fill in as much as possible, that part of the curve occurring before the peak. A good motor load is the principal means to this end. If a station carries a very large lighting load it is of importance to obtain such a power load that it will commence to go off as the lighting load comes on. Regarding the development of an off peak load, the following quotation from a paper presented before the National Electric Light Association, is of interest: "We feel that the matter of developing business off the peak is of greatest interest to us all, as we have millions of dollars invested which are lying idle the largest portion of the time. If this investment could be utilized to produce revenue during the period when it is idle, it would materially change central station operation."

CHARACTER OF LOADS FOR DIFFERENT INDUSTRIES.

An example of a station load curve is presented in Fig. 1, which shows a small morning peak about 9 o'clock, due to the power load, and a high evening

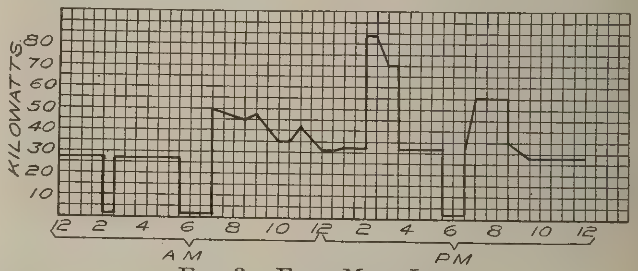


FIG. 3. FEED MILL LOAD.

peak in the neighborhood of 5:15 o'clock, due to the lighting load. In the early morning the curve dips quite low and through the middle of the day another dip or "valley" occurs. The load factor for this curve is about 33 per cent. In many instances special rates or other inducements are made to certain customers whose load is rather large, to induce them to operate so as to have their largest load come on at certain hours of the day, thus filling in the valley of the station curve. Figs. 2 to 9, inclusive, are some typical curves of representative loads operating on central station lines, taken from a paper read before the N. E. L. A. by H. J. Gille. A study of these curves in connection with the station load curve of Fig. 1, will show that to a greater or lesser extent the power loads overlap the evening peak. It has been suggested that if power users could be induced to reduce the mid-day shutdown from an hour to thirty minutes and close down a half hour earlier in the evening, the peak load difficulties would be helped and the "valley" in the load curve, occurring from about 12 to 1 o'clock, would be affected also.

The following data given in connection with the curves shown may be of interest. Fig. 2 shows the load of a box factory having a connected load of 70.4 horsepower, a maximum demand of 100 kilowatts, and using 120,000 kilowatt-hours per year. Fig. 3 is a feed mill load; connected load 125 horsepower and using 306,992 kilowatt-hours per year. Maximum demand, 75 kilowatts. Fig. 4 is a printing establishment with connected load of 27.5 horsepower; maximum demand 16.5 kilowatts and using 24,926 kilowatt hours per year. Fig. 5 is a coffee roasting plant with connected load of 7.5 horsepower and a maximum demand of 6 kilowatts and using 7,341 kilowatt hours per year. Fig. 6 is a shoe factory with connected load of 111.5 horsepower, a maximum demand of 65 kilowatts and using 137,983 kilowatt-hours per year. Fig. 7 is a structural steel plant having a connected load of 75 horse-

*See article by Mr. Jesse Adkins, "Southern Electrician" for December, 1910.

power, a maximum demand of 45 kilowatts and using 81,732 kilowatt-hours per year. Fig. 8 is a wagon factory with a connected load of 33.75 horsepower, a maximum demand of 18 kilowatts and using 30,000 kilowatt-hours

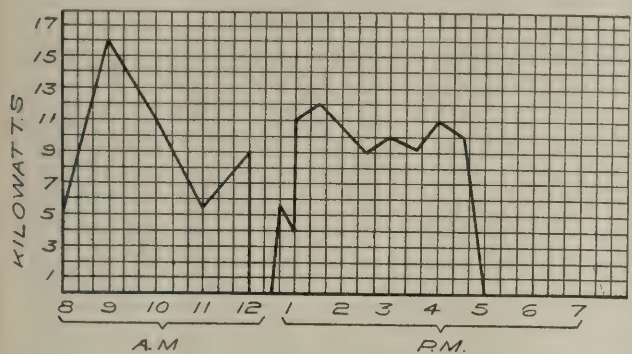


FIG. 4. PRINTING PLANT LOAD.

per year. Fig. 9 is a woodworking shop with a connected load of 129.5 horsepower, a maximum demand of 44 kilowatts, and using 66,200 kilowatt-hours per year.

POWER REQUIREMENTS OF TEXTILE MILLS.

One of the largest manufacturing industries in the South and one in which the use of electricity has made very rapid progress, is the cotton mill. The first electrified mills were the Columbia Mills, of Columbia, S. C. The electric drive was applied to these mills in 1894, and over 1,000 horsepower in induction motors was installed. At the present time in North and South Carolina the lines of the Southern Power Company supply in the neighborhood of 80,000 horsepower to over one hundred and fifty cotton mills. This popularity of the electric drive for cotton mills is due, to a large extent, to the following factors: flexibility, reliability, simplicity, cleanliness, steadiness of running and ease of control.

On account of the necessity for a constant speed, the alternating current system with induction motors has become the favorite installation. Another excellent reason for the use of induction motors is their sparkless operation. When the air is liable to be filled with fying lint, the

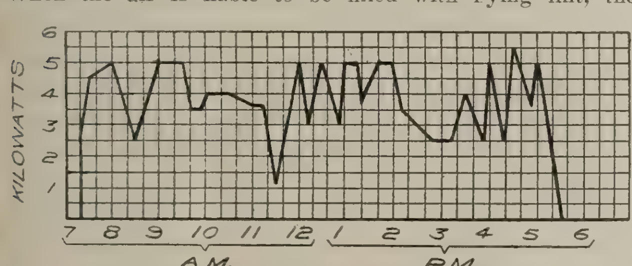


FIG. 5. COFFEE ROASTING PLANT LOAD.

direct current motor, with the probability of sparking at brushes, is a considerable fire risk. The larger electric machinery manufacturers have investigated the requirements of textile mill operation very thoroughly with the result that special motors and systems of control have been designed.

Motor drive has been applied to practically all the operations taking place in a textile mill, from the picker, where the raw cotton is given its first beating and cleaning, to the looms, where it is woven into the innumerable forms of cotton cloth found in the dry goods market. The pickers are usually individually driven and require from 4 to 6 horsepower. In the latest type of picker drive, the rotating member of the motor is mounted directly on the beater shaft, while the stationary member is mounted on a bracket bolted to the frame of the picker. Due to the low operating speed of carding machinery, the group system of driving is usually used, 75 or more cards being driven by one motor. Drawing frames are ordinarily operated in groups of 3 or 4 and require motors of about 3 horse-

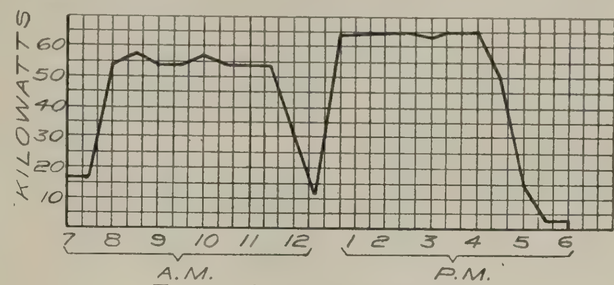


FIG. 6. SHOE FACTORY LOAD.

power for a 3-head frame. Recently induction motors and silent chain drive have been applied for driving these machines, and such arrangement promises to overcome many disadvantages of the older style of drive, such as slipping of belts, waste of power, slowing down when a frame is started up, etc. Warpers are usually direct driven by motors of about one horsepower rating, the later installations being so arranged that the motors are automatically stopped when the stock breaks.

Ring spinning frames require varying amounts of power depending upon a number of conditions, such as character of stock, speed of spindles, quality of lubricant used on spindles, weather conditions, etc. Roughly one horsepower will drive from 40 to 70 spindles, a fair average being 50 spindles per horsepower. Both the group and individual drive have been applied to spinning frames. One method of group driving being to place a motor at the ends and between the two frames which it drives through friction clutches. Another group drive mounts the motor on the ceiling, its shaft extending far enough through the end

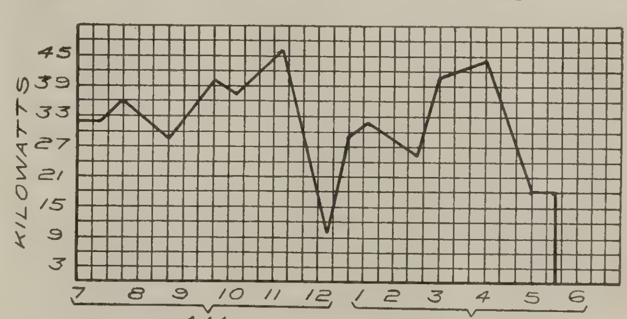


FIG. 7. STRUCTURAL STEEL WORKS LOAD.

frames to allow a pulley on each end. These pulleys are centrally flanged and each takes two belts and drives downward to two frames. In one installation, for example, six 20 horsepower motors drive 24 frames. Individual drive is applied to spinning frames by mounting the motor on a bracket fastened to the end of the frame and either driving the cylinder through silent chain, where variable speed is a requirement, or the motor shaft is made long enough to extend into the cylinder and drive it directly.

Due to the large number of looms usually employed in the weaving portion of the textile industry, consequently the high cost of individual drive, looms are for the most part group driven. The power required per loom varies from $\frac{1}{4}$ to 2 horsepower, depending on whether plain or fancy goods is being woven, and upon the width of the cloth, character of goods, etc.

The following table shows some of the load characteristics of five Southern cotton mills operating from central station power:

TABLE I. OPERATING DATA ON COTTON MILLS, PRINTING AND WOODWORKING SHOPS.

H. P. Installed	No. of motors	Hrs. per week factory operation	Annual K.W.H.	Max. demand	Ratio actual to full load K.W.H.
190	9	60	278568	----------	.63
127	4	----------	89444	100	.30
117	5	60	141156	----------	.52
560	13	60	741900	330	.57
739	29	60	1212400	538	.70
		Printing Plants.			
123	75	55	72594	----------	.277
60	--------	48	77810	30	.696
50	8	60	39201	20	.337
		Wood Working Shops.			
25	1	50	13900	25	.286
40	1	55	8700	40	.102
85	5	55	101700	75	.557
55	4	60	24000	41	.188
262	35	60	300000	200	.492
55	2	60	43620	----------	.338
312	23	60	300000	200	.413
22	2	60	4570	11	.089
20	1	54	15947	15	.380
5	1	36	3451	4	.495

PRINTING AND BOOKBINDING.

The printing and bookbinding industry offers a large field for the application of electricity. The many operations and machines that are required to make a finished book or newspaper are all, in a great measure, open to the use of electricity. In getting out a large daily paper speed and reliability are important factors and electrically driven machines go a long way towards raising these factors to a maximum. In a newspaper plant of the most modern type, every possible operation is done electrically. The copy is conveyed from the editorial rooms to the compositors by small conveyors driven by electric motors; the typesetting is done by linotype machines driven by small motors; proof presses are motor driven; the matrices or molds, for the plates from which the paper is printed are made and dried on electrically operated and heated machinery; the matrices are carried to the stereotyping department on elevators or conveyors driven by motors; the plates after being moulded, trimmed and shaved to the proper size are placed on the presses, where electricity again comes into play as a driving power. Numerous other applications are made in the newspaper field, for instance, the arc lamps for photographic and photo-engraving processes; small motor driven saws for trimming cuts; paper hoists, etc. Outside the large newspaper field a great many uses are found for electricity by the book binders and job printers. The current is not only used for power and lighting purposes, but a great many heating devices are used, such as glue pots, solder pots, soldering irons, finishing and branding irons, stamping and embossing presses, sealing wax heaters, and many others.

The second section of Table I shows some of the load characteristics of some printing plants operating from central station supply in three representative Southern cities.

WOODWORKING INDUSTRIES.

The woodworking industry uses numerous high speed machines, to which the application of electric drive has been made. Individual drive for the greater part of the machines is in general most satisfactory. In the ordinary factory operated by shafting and belts, the friction load ranges from about 20 per cent. to 65 or 70 per cent. of full load. It is more often nearer the larger percentage than the smaller. It is not claimed that the electric drive will do away entirely with the transmission losses of shafting and belts, but it is possible to make an electric installation with individual drive where these losses are somewhat reduced. The efficiency of the shaft drive may be quite high at full load, but owing to the high constant friction loss, it falls off rapidly as the load decreases. An electric installation may be so designed that the efficiency of transmission remains practically constant throughout the range of loads. This is accounted for by the fact that motor efficiency is high in the region of full load while the line efficiency is higher as light load is approached.

In cases where the machines are operating for long periods during the day, such that the shafting is running fully loaded, driving a greater part of the time, the shaft drive approaches its highest efficiency. This condition is not realized in many shops, in fact the usual condition is far from this ideal. For instance in a shop operating woodworking machines and running 570 minutes per day, an average day's run showed results about as follows as to the length of time various machines were in operation during the day: Jointer, 120 min.; cut-off saw, 14 min.; rip-saw, 75 min.; 36-in. planer, 100 min.; borer, 240 min.; band saw, 135 min.; shaper, 100 min.; Bradley hammer, 59 min.; mortising machine, 8 min.; tanging machine, 11 min.; rounder, 24 min.; emery wheel, 40 min.; blower and shafting, 570 min. This plant was originally driven by a 30-horsepower and a 5-horsepower motor, and the yearly kilowatt hours amounted to 36,240. A change to individual drive was made and the 30-horsepower motor replaced by 21 motors aggregating about 100 horsepower. The net saving with the individual drive amounted to $230.00 per year. The shafting in the original installation of this plant was mounted on roller bearings, making the friction loss considerably less than would be found in the average case. The cost of power in this instance was 5.5 cents per kilowatt hour.

Aside from the saving made possible with individual drive, the increased production effected is worthy of consideration. Individual drive is not advocated in all cases. Factors having a bearing on the economy of group or indi-

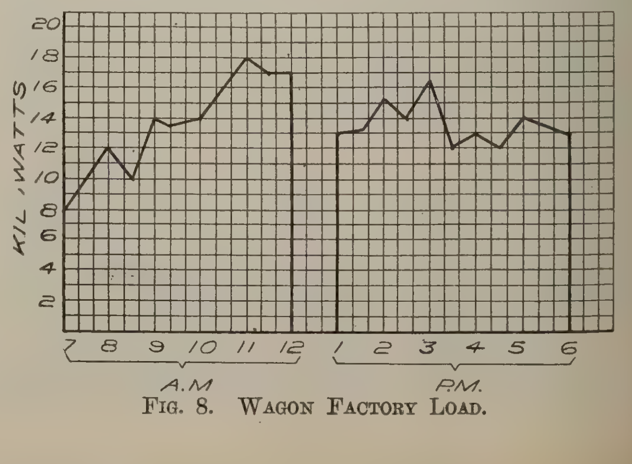


Fig. 8. Wagon Factory Load.

vidual drive are: form of contract where power is purchased from a central station. If the contract minimum is based on the connected load, the group drive will obtain the lower minimum. In regard to the cost of power, where individual drive is used, the decreased power consumption generally demands a higher rate per kilowatt hour. Large machines should invariably have individual drive. Where a number of machines run together or where the product passes through a number of machines in sequence, the group drive is usually preferable. Overhead room and lighting, is another consideration. The usual belting of the group drive is a disadvantage in this case. Where floor space is valuable the individual drive can usually be applied to the greater number of machines in the least space.

The third section of Table I shows some data for a number of woodworking shops located in the Southern States and obtaining their power from central stations.

Table III gives power requirements of various woodworking machines:

TABLE III. POWER REQUIREMENTS OF WOODWORKING MACHINERY.

	Size	Horsepower.
Single surface planer		3.5–7.5
Double surface planer		7.5–15
Tenoners-single end		2–5
Tenoners-double end		7.5–15
Cross-cut saw	8 in. to 30 in.	1 to 15
Rip saw	8 in. to 48 in.	1 to 35
Swing saw	14 in. to 60 in.	3 to 15
Band saw	1 in. saw and 2 in. saw	2 and 5
Jig saw	4 in. stroke.	3
Lathes		1 to 5
Boring machines		1
Double Spindle shaper	1¾ in.	7.5
Buzz planes & joiner	8 in. to 30 in.	1 to 5
Cylinder planes	15 in. to 36 in.	7.5 to 25
Drum Sanders	30 in. to 72,in. 1 to 3 drums.	3 to 16
Dove Tailers		2 to 3
Hollow chisel mortisers		2 to 5

AGRICULTURAL APPLIANCES.

A field for the use of electricity that has only recently begun to be opened is the agricultural industry. As yet not much along this line has been done in the South. A notable exception is found, however, in Virginia on the farm of Thomas F. Ryan and in North Carolina at Biltmore. In both these instances the power is generated on the place. The uses found for electric current in farming operations are many. In the dairy use is made of the electric cow milker, motor driven cream separator, motor driven churns, and where perishable products are considered, electrically driven refrigerating outfits are very useful. Other uses to which electric power may be put around the farm are: motor driven pumps for irrigation and for house and barn service; hay presses, threshers, saws, grist mills, washing machines, irons, vacuum cleaners, and others. Some data on the requirements of farm machinery is given in the following Table:

TABLE IV. POWER REQUIREMENTS OF FARM MACHINERY.

Thresher	5	Horsepower
Cow Milker	½	"
Grindstone	¼	"
Grist Mill	15-30	"
Refrigerating outfit	5-25	"
Pumps	½-25	"
Cream Separators, 350 to 650 gallons milk per hour	½	"
Cream Separator, 850 to 1,000 gallons milk per hour	1	"

COST OF ELECTRIC POWER.

It is practically impossible to give definite figures on the costs of electric installations unless exact conditions are known. Motors of the same horsepower but having different speeds cost more or less depending on the speed,

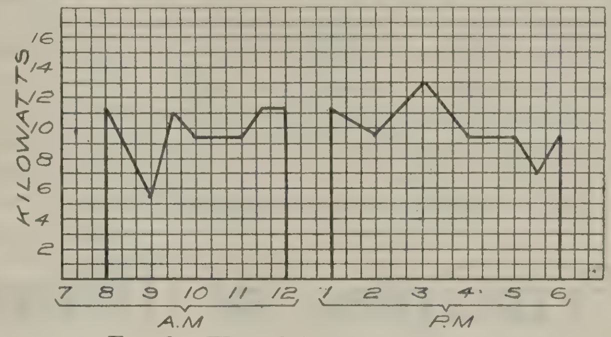


Fig. 9. Wood Working Shop Load.

the lower the speed the higher the cost. This is particularly true of induction motors. For example, a 3-horsepower polyphase induction motor wound for a speed of 1,700 revolutions per minute, would cost about $65.00, and a motor of the same horsepower and voltage, but having a speed of 1,150 revolutions per minute, would cost $85.00. Fig. 10 shows average values for the costs per horsepower of a standard line of small direct-current motors. Standard polyphase induction motors of the same sizes will cost from 30 to 50 per cent. less than the direct-current motor prices obtained from the curve. Single-phase alternating current motors will cost considerably more than polyphase machines.

TABLE V. COST DATA FOR SMALL POWER STATIONS.

Return tubular boilers installed	$10 to $12 per H. P.
Water tube boilers installed	14 to 16 per H. P.
Single throttling engines installed	5 to 10 per H. P.
Single high-speed engines installed	10 to 15 per H. P.
Single Corliss engines installed	20 to 25 per H. P.
For condensing and compounding engines add about 30 and 50 per cent.	
Auxiliary pumps (about)	$2.50 to $5.00
Generators	$20 to $25 per K. W.

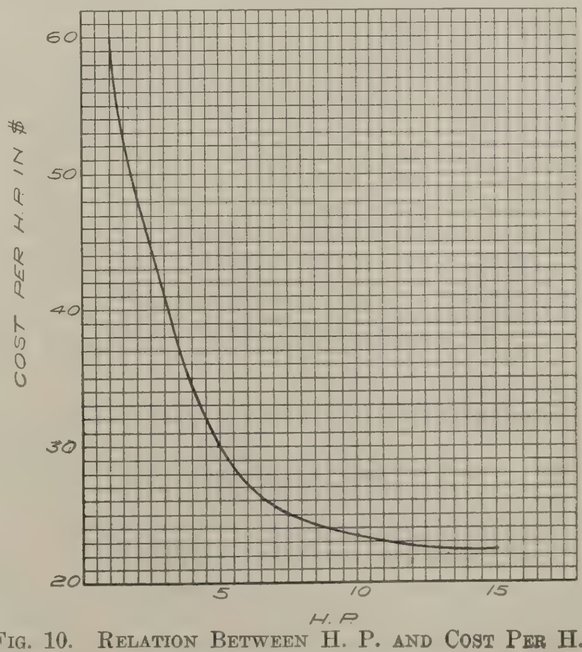


Fig. 10. Relation Between H. P. and Cost Per H. P. for Small D. C. Motors.

For direct connected units, the cost will be from 35 to 50 per cent. greater than for belted. Average steam piping costs $2.00 to $3.00 per horsepower.

Aside from the actual cost of the completely equipped plant, other items must be taken into consideration in determining the cost to generate electric power. Some of these are as follows: Superintendence, fuel, water, oil, repairs, depreciation, insurance and taxes.

RELATION BETWEEN ACTUAL LOAD AND CONNECTED LOAD.

A figure of some interest appears in some of the tables shown, under the head of "Ratio actual K. W. H. to full load K. W. H." The factor is obtained by dividing the figures in the "Annual K. W. H." column by the yearly K. W. H. figured from the "horsepower installed" and the given hours per week of operation and allowing fifty-two weeks per year. It will be noticed that in most cases given, this ratio is rather small, indicating motors larger than necessary. Motors should be carefully chosen and every effort made to have them as near as possible to the size required for the work. Any motor running lightly loaded is running at a low point on its efficiency curve, which means that a larger percentage than necessary of the power being supplied by the mains, is going to make up the losses in the motor.

Principles of Illuminating Engineering.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN)

BY A. G. RAKESTRAW.

IN THIS article those illuminants which produce light by means of electricity will be considered. These represent the highest development of the art, and while in their nature they are limited in use to those localities where current may be economically generated and distributed, yet we find to-day practically all but our smallest towns and even a considerable share of our rural and semi-rural territory enjoying the advantages of electric light. The conversion of electrical energy into light is caused by the passage of the current through a conductor, the resistance of which converts the energy into the form of heat, which if sufficient in quantity raises the conductor to incandescence. The electrical energy has been changed to radiant energy, part of which is visible and part not visible. Not all of the heat generated, however, appears as radiation, but part is lost by convection, or carried off by air currents, and part is lost by conduction, or carried off by the filament anchors, leading in wires, carbon supports or other parts of the lighting device. The proportion which the radiant energy bears to the total input is called the radiant efficiency, while the proportion of the luminous to the total radiation is called the luminous efficiency.

The incandescent conductor may be either in the form of a solid, a vapor, or matter in the process of combustion or volatilization as in an electric arc. We have therefore three primary classes of electric light, the incandescent filament, the arc, and the vapor lamp. The first two of these were brought out about the same time and have both passed through many stages of improvement before reaching their present forms, while the vapor lamp is a later production. We may further divide filament lamps into those operated in a vacuum and those operated in air. Of these classes, we will take up the former, to which belongs what we commonly call the incandescent lamp.

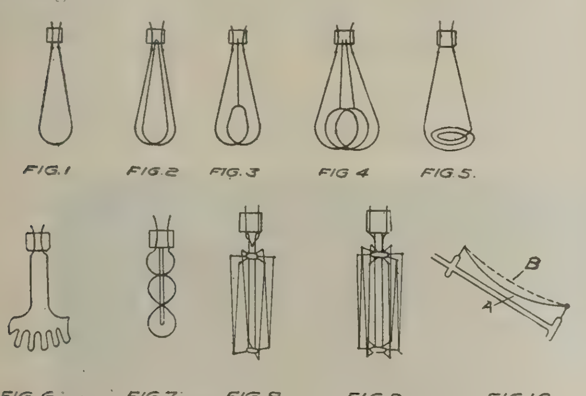
It has been said that, any bungler can devise complications, but that it takes genius to reduce them to simplicity, and the incandescent lamp is a remarkable demonstration of this truth. Nothing could be simpler, and yet it is safe to say that there is no single article which has been made the subject of more study, and which has passed through more experimental forms. The form of lamp is now well standardized, consisting simply of an exhausted glass globe in which is mounted a conducting filament. The different lamps differ only in size, material employed for the filament, and in the details of the mounting. The first material employed was platinum, which did not require a vacuum for its operation, but in other types the filament must be in a vacuum or surrounded with inert gas to prevent rapid oxidation and consequent destruction.

We have studied the law of radiation from "black bodies" and know that the higher the temperature to which a radiant body can be brought, the whiter will be the light, and the more efficiently will light be produced. The devlopment of the incandescent lamp, after certain difficulties of construction were overcome, has been mainly directed towards the discovery of material for the filament which would endure a high temperature without too rapid disintegration. The determination of the particular efficiency at which it is best to operate each particular type of lamp, is a question of balancing the losses, and can only be determined when all the conditions are known. Any lamp may be operated at a higher temperature and greater efficiency by raising the voltage, but at a decreased life, and if we know the cost of the lamps, and the cost of current we can determine the most economical conditions of operation. Specific examples of this will be given when we come to consider the cost of light.

Incandescent filaments are of two kinds, carbon and metallic, and each of these is again subject to subdivision. The ordinary carbon filament lamp for a number of years occupied the whole field of incandescent lighting. While decidedly yellowish and even orange in color, burned at less than full voltage, and also rather expensive, often inefficiently installed without reflectors, frequently hung just in front of the eyes of those who were compelled to work by it, yet its convenience and cleanliness soon won for it an important place in illumination.

Carbon occupies a unique place between the metals and the non-metals. It occurs in two forms, the amorphous and the graphitic. The first form is without crystalline structure and is softer and vaporizes more readily. By treating a filament of amorphous carbon with a special process it is possible to convert part of the amorphous carbon to the crystalline or graphitic state, rendering it harder, and less volatile, and more of a metallic nature, hence the name, "metallized filament." This was the first improvement in the incandescent lamp, towards operation at higher temperature, and increased the efficiency about 20 per cent.

The first carbon lamps were made for 50 volts and had a simple hairpin filament as shown in Fig. 1. When used on 110 volts, two of these were connected in series as in Fig. 2. Later the oval anchored filament shown in Fig. 3 was introduced and it is now the standard form for 110 volts, the double anchored filament of Fig. 4, being standard for 220 volts. The nominal rating of the incandescent lamp as we know, is in a horizontal direction, while the candle power in the direction of the tip is much less. For instance a 16 candle power lamp hanging vertically, throws only about 7 or 8 candle power on a horizontal surface. The development of efficient reflectors has completely overcome this defect, but there have been attempts to improve upon this distribution by the use of peculiarly shaped filaments such as shown in Figs. 5 and 6, while others have apparently discovered some great advantage in winding the filament in a serpentine fashion around a central support as in Fig. 7.



FIGS. 1 TO 10. THE EVOLUTION OF INCANDESCENT LAMPS.

In general, the carbon filament, including the metallized type, has the advantage of low first cost, rugged construction, and wide range of sizes, being made for 2 to 5 candle power on 110 volts, and 8 to 50 candle power on 220 volts. The smaller sizes are not as efficient as the larger ones. For instance a 16 candle power lamp takes 56 watts; or 3.5 watts per candle; and 8 candle power takes 30 watts, or 3.75 watts per candle; a 4 candle power requires 18 watts or 4.5 watts per candle and a 2 candle power takes 10 watts or 5 watts per candle. It is therefore better to use the larger sizes wherever possible. The same rule applies to voltage. The 220 volt lamps are not as efficient as the 110 volt, besides being more expensive, and are only used where needed on a 220-volt power circuit, or in similar circumstances.

The metallic filament class of incandescent lamps is of comparatively recent introduction, and marks an almost revolutionary change in the electric lighting situation. Several metals have been employed, but the two in common use are tantalum and tungsten. The word "Mazda" is also used in this connection to denote the most improved product of the engineering laboratories of the National Electric Lamp Association. At present "Mazda" is a tungsten lamp, but if in the future some metal were employed having superior qualities, the term "Mazda" would apply to it as well. The metal filaments have several characteristic points of difference as compared with the carbon filaments. Being very refractory, they operate at a high temperature, with consequent high efficiency. Being of low specific resistance, a long length of filament must be enclosed within the bulb, requiring special methods of support. They do not fail by disintegration or vaporization, but by fusion, and they possess the advantage of frequently fusing together after breakage, and continuing to burn as well as ever. They also possess the advantage of a positive temperature coefficient, that is, the resistance increases with the temperature, which is not the case with carbon, and therefore are a good deal less affected by voltage variation. Besides being much more efficient, the light is of a better quality, and the bulbs do not blacken perceptibly, at least with the more improved methods of construction.

The tantalum has a long drawn wire filament mounted somewhat as shown in Fig. 9 and was used in a good many installations until the introduction of the new forms of tungsten lamps. The tantalum lamp is yet used wherever an efficient lamp is desired that has to stand a good deal of rough handling. It is peculiar, in that it operates with a long life only on direct current, and this of course also limits its field of usefulness considerably.

Electrical Business in British South Africa.

Consul Edwin N. Gunsaulus, Johannesburg, Transvaal, gives some interesting facts relative to the progress of electricity on the Witwatersrand as shown in the annual report of the Government mining engineer. There was a large increase in the use of electrically driven machinery in connection with the mines, the horsepower of motors having risen during the year ended June 30, 1910, from 76,299 to 108,354. Owing to the fact that the electrification of the power supply of a majority of the mines is now rapidly going ahead, this total will be largely increased during the present year. This scheme contemplates not only the employment of motor-driven turbo-compressors for supplying compressed air, but motors will also be used for winding and pumping and in a majority of cases for the mill drive.

The rated capacity of the stations now in process of construction by the Victoria Falls Power Co. and the Rand Mines Power Supply Co. (Ltd.) is: Brakpan, 12,000 kilowatts; Simmer Pan, 18,000 kilowatts; Driehoek, 3,000 kilowatts; Rosherville, 50,000 kilowatts; Vereeniging, 40,000 kilowatts. The first three are practically completed, and the Rosherville station is under construction. In addition to the supply available from the above mentioned companies, several groups of mines have their own electric power stations either in process of construction or enlargement.

Consul E. A. Wakefield, in a recent report states, that in all the larger towns of Cape Colony either gas or electricity is available for lighting purposes, while several have both. Rates are high as compared with charges in the United States, but coal must be imported from Natal and is quite expensive. Outside the larger municipalities kerosene lamps are much used, although stores, hotels, and some houses have acetylene gas plants installed.

Trade of this character here is almost invariably carried on through importing houses which act as agents. If one or more of these firms could be interested in a lighting system and it proved satisfactory, a good business could be done, as the farming community is prosperous just now. When the average Cape Colony farmer has the means, he is willing to invest in modern appliances.

A Hydro-Electric Development for Irrigation Work at Hanford, Wash.

(*Contributed to* SOUTHERN ELECTRICIAN)

BY FRED S. SLY.

THE installation described in what follows is noteworthy as an illustration of an economical and efficient method of utilizing low head water powers which are subject to extreme variations in head resulting from flood conditions. It also shows an excellent example of modern engineering practice in irrigation work where the head is insufficient or the topography makes it impossible to deliver water to the surrounding country by gravity. In such cases it has been found possible to generate electrical power at one point on a river and transmit it to electrically operated pumping stations located at other points on the river, as desired. These take water from the same river and elevate it to irrigating ditches on a higher level.

FIG. 1. INTERIOR OF POWER HOUSE SHOWING GENERATORS AND EXCITERS.

The principal consideration affecting the design of the power station was that of the extreme variation between low water and flood level, the minimum head being 18 feet and the maximum 27 feet. In order to place the generator and electrical apparatus above the highest flood water, vertical triplex units were adopted. By choosing a triplex turbine, a suitable speed was obtained for direct connection to the generators. By means of step-up and step-down transformers and a pole line, power is transmitted from the generating station sixteen miles to a pumping station down the river, where induction motor-driven single stage centrifugal pumps deliver the water from the river into irrigating ditches. This pumping station is built for four pumping units, two of which are now installed and in operation. The total power available at Priests Rapids will permit the installation of several other pumping sub-stations at some future time located as required by the demand for irrigating water, and all obtaining their power from the central generating station.

Both from an engineering and economic standpoint, the inception and successful development of this project is an important event. It illustrates the entire feasibility of reclaiming, for cultivation, lands heretofore undeveloped on account of lack of water available for irrigation by a gravity system. All the land within the radius of supply from the plant of the American Light and Power Company is exceedingly fertile and the advent of ample water for irrigation purposes will undoubtedly result in the rapid development of this country.

LOCATION AND LAYOUT OF PLANT.

The power station is located at Priests Rapids on the Columbia River in Yakama County, Washington, near the Benton County line. The river in this section flows in a southeasterly direction for some miles and then makes a wide sweep to the south and west, which direction it follows till it reaches the Pacific Ocean. At the point where the American Company's plant is located, the river forms what are known as Priests Rapids. By means of a dam, reservoir and canal, protected from the river by retaining wall and embankment, provision was made for an ultimate development of 9800 H. P. from a minimum head of eighteen feet. A total of about 90,000 H. P. is available from the river at this point. The present power station is designed for a normal capacity of 2600 H. P. The dam was built across the southern channel of the river, through which, at low water, there is a flow of about 12,000 cubic feet per second. A short distance above the dam, an intake 140 feet wide and 700 feet long connects the river with a natural lagoon and uses part of the water backed up by the dam. This lagoon is from one to seven feet deep at low water and three-quarters of a mile long. At its eastern end, a canal about a mile in length carries the water to the power house intake. Gates were installed at the junction of the lagoon and the canal to regulate the supply of water and a retaining wall and embankment were built from the dam along the lagoon and the length of the canal to afford protection from the river. By extending the wing dam up along the island, which divides the main channel from the one across which the dam was built, it will be possible to economically increase the head two feet at low water. This head could, of course, be further increased by extending the dam farther up the river, which may be done as the demand for power increases.

The canal extends about a mile from the power house intake to the head gates at the lower end of the lagoon. It is 67 feet wide with side slopes 1½ to 1, except for a short distance in the rock where it is only 60 feet in width. The excavation for the canal amounted to about 175,000 cubic yards, nearly all of which was earth and coarse gravel. An embankment was built to afford protection to the lagoon and the canal from the river. This extends about two miles from the intake at the upper end of the lagoon to the power house. The first 4000 feet of embankment below the intake has a timber bulkhead on the river side while a 1½ to 1 slope is maintained on the canal side. The top is eight feet wide. The posts supporting the bulkhead are 8 by 10 inch Washington fir, set one foot in bed rock and eight feet apart, and anchored by one inch rods to deadmen buried in the embankment. The sheeting is 5 in. x 12 in., 4 in. x 12 in. and 3 in. x 12 in., all sixteen feet long. The remainder of the embankment, about 6000 feet, is eight feet wide on top with a 1½ to 1 slope on both sides. The river side is covered with a layer of loose rock six feet at the base and tapering to a point near the crest. All of the embankment was built with material excavated from the canal.

The canal head gates are made up of ten gates of the butterfly type and one pad gate. Each of the butterfly gates is eighteen feet long with a vertical depth of seven feet measured from the canal bottom. The planking above the gates extends twelve feet vertically and is supported by bents eighteen feet apart. The gates swing on a horizontal shaft supported by three low bents and are operated by means of continuous cables attached to the top of the gates. These pass through pulleys fastened to the base and about seven feet from the downstream face of the gates. The cable then passes over a windlass at the top of the bents and back to the gates. By operating the windlass, the gates can be pulled down to a horizontal position to open and by reversing the operation they can be raised slightly when the excess of water pressure on the lower half of the gates, assisted by the current, aids the windlass in closing the gates tightly.

POWER HOUSE DESIGN.

The general design and construction of the power house may be seen in connection with the plan and sectional views shown in Figs. 2 and 3. The substructure is of reinforced concrete construction, resting on bed rock, and is about 67 feet square at the foundation. Owing to the extreme fluctuations of the water level of the river, it was necessary to place the generating floor 58 feet above the lower draft floor. The excavation for the entire building consisted of 6000 cubic yards of earth and 2000 cubic yards of solid rock

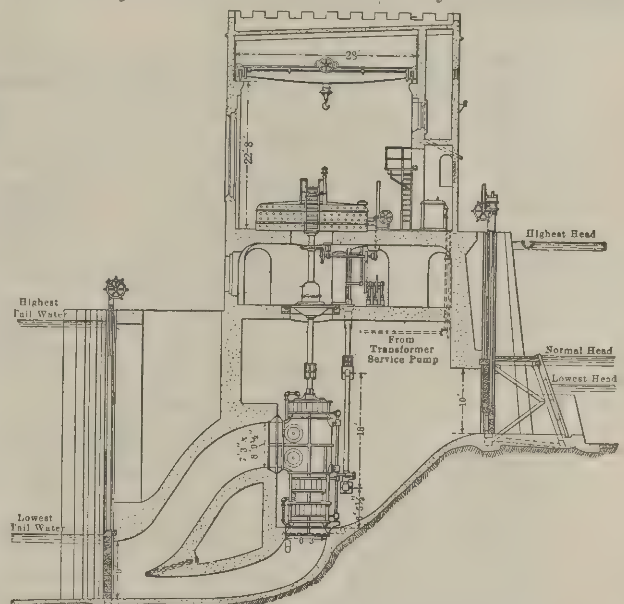


Fig. 2. Section Through Power House.

which was all accomplished by hand. The headrace wall was extended fifty feet on each side of the building, thus providing for the future installation of four additional units. The lower draft tubes are eleven feet below the low water mark of the river. Both the thrust bearing and generator floors are of concrete reinforced with steel beams and rods and arched so as to carry the weight of the generators, thrust bearings and other apparatus. The superstructure is reinforced concrete with a flat concrete roof 32 feet above the generator floor, giving the building a total height of 90 feet. The pilasters support beams which carry a ten ton hand operated crane running the length of the station. The transformers are placed in a bay built on the headrace side of the building. An outgoing line tower for the high tension lines and lightning arrestors is located above this bay. The low tension bus-bars are placed in the bay above the transformers. A vertical shaft bilge pump is supported on two I beams placed just inside the building on the tailrace side over the exciter turbine draft tube. This pump is used to empty the water in the main and exciter turbine wheel pits and is driven by a 15 H. P. direct current motor mounted upon the thrust bearing floor. Another smaller pump of the same type, supported a few feet above the main bilge pump and driven by a belt from the motor shaft, is used to furnish cooling water for the transformers. Concrete compartments for the 2200 volt oil switches were constructed on the thrust bearing floor.

TURBINES AND GENERATING EQUIPMENT.

The main turbine units are of Allis-Chalmers design and of the vertical triplex type, 2000 B. H. P. maximum capacity, designed to run at 150 R. P. M. under a normal head of eighteen feet but guaranteed to operate satisfactorily under heads varying from 18 to 27 feet. The arrangement of the turbines, as shown in Fig. 2, consists of a twin center discharge turbine mounted on the same shaft above a single turbine. The twin turbine runners discharge into a cast iron center discharge casing which is rigidly connected by column construction to the lower single turbine which discharges downward. The runners of the first turbine installed are of cast iron and those of the second turbine are plate steel vanes cast into hub and girder rings, the standard Allis-Chalmers construction for low head work.

the gates. The gates move in channel bar guides and are protected by steel plates along their edges which reduce the friction and prevent wear. The exciter unit is also supplied with a head gate constructed of heavy timbers reinforced with angle irons, and sliding in a structural steel frame. Tailrace gates are provided for both the generator and exciter turbines, making it possible to pump out the turbine wheel pits for inspection and repair.

To each of the main turbines a 900 K. W. 3 phase, 60-cycle 150 R. P. M. vertical shaft revolving field generator is direct connected. The exciter generator is a 60 K. W., 120 volt, 500 ampere, 225 R. P. M. direct current machine, direct connected to the single vertical turbine previously described. The generator is compound wound so as to maintain the voltage constant at 120 volts from no load to full load, and is capable of carrying momentary overloads of 75 per cent. without flashing or serious sparking. It is of ample capacity to furnish exciting current

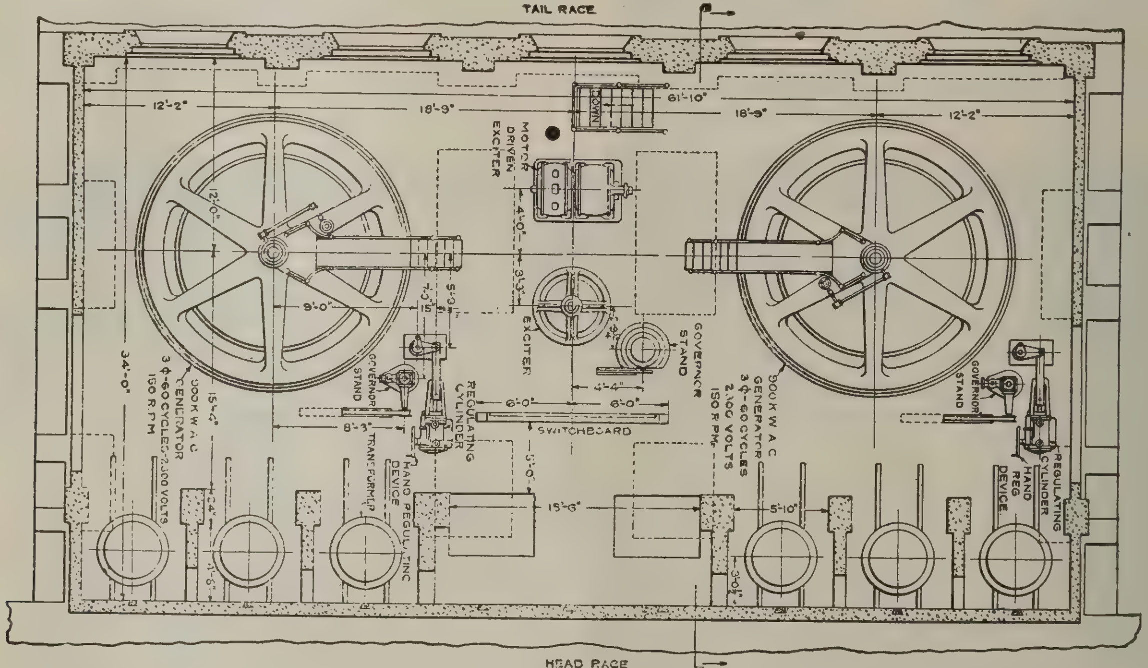


FIG. 3. PLAN OF POWER HOUSE.

Swivel or wicket type turbine gates are installed, operated through shifting rings and links from a heavy gate shaft. The thrust bearings furnished with both generator and exciter turbines are of the oil bath self contained type and are located on the intermediate thrust bearing floor. This type of thrust bearing effects considerable saving in oil over othertypes and its simplicity makes it economical both from operating and maintenance standpoints.

The concrete draft tubes are designed to lead the water from the center discharge casing and lower runner with uniformly decreasing velocity and minimum hydraulic disturbance to the tailrace, thus abstracting the maximum practicable amount of its kinetic energy. The exciter turbine is a vertical, single runner, open flume turbine of 100 B. H. P. 225 R. P. M. direct connected to a vertical 60 K. W. compound wound exciter. Excitation is also provided by means of a motor generator set of the same capacity.

Head gates are constructed of timbers reinforced by steel beams, provided with cut rack and pinion hand operated hoists. They are provided with a filler gate by means of which the water pressure may be equalized before raising

for two generators of the size of the main units. A 60 K. W., 120 volt, 85 H. P., 2300 volt, 875 R. P. M. motor generator set is also provided. This unit is located on the generator floor of the station and is used as an auxiliary source of exciting current. The adoption of this motor generator set instead of a second turbine driven exciter resulted in a considerable saving in space.

The switchboard includes two A. C. generator panels, two exciter panels, one induction motor panel, one transformer panel and one outgoing line panel. All instruments, switching apparatus, etc., necessary are provided, including hand operated remote control 2200 volt oil switches and an electrically operated automatic oil switch for the 22000 volt line, 22000 volt lightning arrestors and choke coils. The transformer equipment consists of six 400 K. V. A. oil filled water cooled delta connected transformers wound for 2200 volts primary and 22000 volts secondary. They are mounted in the bay back of the switchboard. These transformers are capable of carrying a 50 per cent overload continuously for twenty minutes without injury and can safely carry 25 per cent overload for two hours. The 2200 volt oil switches mentioned are located on the intermediate or thrust bearing floor, and the low tension 2200 volt bus-bars are installed in the bay above the transformers. All of the low tension wiring is concealed and is carried in fibre conduits.

THE TRANSMISSION SYSTEM.

A pole line transmission system 16 miles long connects the power house to the pumping station. The poles are of cedar, 40 feet in height and placed 142½ feet apart, guyed with galvanized wire wherever necessary. Three phase current at 22000 volts is carried on No. 4 B. & S. hard-drawn copper wires spaced 54 inches apart and forming the points of an equilateral triangle. The line is transposed once every mile for the benefit of the telephone wires connecting the power house and pumping station as these are carried on the same poles. The telephone wires are transposed every ten poles.

THE PUMPING STATION EQUOPMENT.

The design and arrangement of the pumping station is shown in Fig. 5. It is built along the same general lines as the power station, both the substructure and superstructure being of reinforced concrete. The foundations rest on bed rock and are built high enough to place the main pump motor floor above the highest flood level of the river. The station is twenty-five feet wide by about thirty-two feet long and is built with provision for two more pumping units of the same general design as those now installed, with higher head capacity.

An intake tunnel eight feet in height and built of wood extends about 300 feet out into the river to a point where the intake crib is below the lowest water level of the river. A concrete line tower extends from the transformer bay above

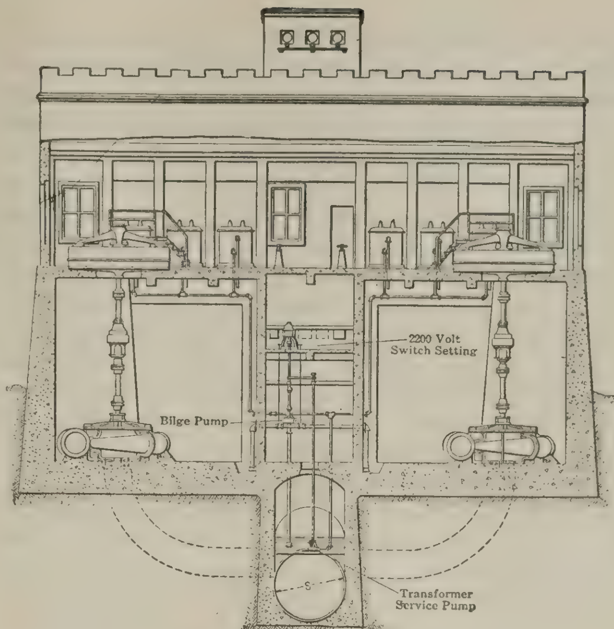


FIG. 5. SECTION THROUGH PUMPING STATION.

the level of the roof, similar to the line tower on the generating station. The floors are of reinforced concrete arch construction. The upper floor carries the two main pump motors, switchboards, transformers and electrical apparatus. The two pumping units now installed are at opposite ends of the station. A hand operated crane runs the entire length of the building and the crane girders are supported by the building pilasters.

The main centrifugal pumps are driven by two 450 H. P., 3-phase, 60-cycle, 175 R. P. M. induction motors wound for

FIG. 4. EXTERIOR OF POWER HOUSE SHOWING NATURE OF DEVELOPMENT.

2200 volts. There are three 300 K. V. A., 60-cycle, 3-phase, 22000-2200 volt transformers installed in the pumping station, of the same design as those described under power house equipment, and these are located back of the switchboard in compartments separated by concrete partitions. Space is allowed for the installation of three more transformers of the same size, back of the other side of the switchboard. The switchboard is of black enameled slate mounted upon a steel frame and consists of two motor panels, one line panel, one lighting panel, and one transformer panel. The oil switch operating the 22000 volt line is similar to that installed in the main power station except that it is hand operated and non-automatic. The mechanically operated distant control 2200 volt oil switches, choke coils, etc., are also similar to those in the generating station. The switchboard and transformers are located on the upper floor with the main pump motors. The high tension 22000 volt bus-bars are supported by insulators on the wall back of the switchboard. Lighting arrestors are inserted in the high tension line before connecting to the 22000 volt oil switches.

The two centrifugal pumps mentioned are of the single stage vertical shaft direct connected type designed to beliver 62.5 cubic feet of water per second against a total head of thirty-six feet. They are of the single suction type, the water being admitted at the bottom and discharged through a horizontal cast iron spiral casing. The runners are of cast iron and of the enclosed type. Self aligning thrust bearings, carrying the weight of the revolving parts, are supported on an I-beam construction above the pump casings. Thirty inch sluice gates are placed at the suction inlet of each pump with an operating valve stem extended up to floor stands and hand wheels on the intermediate floor. Thirty inch discharge valves are bolted to the discharge casings of the pump with valve stems also extended up to the intermediate floor. A vertical shaft motor-driven centrifugal bilge pump, similar to that in the power house, is located over the intake tunnel on the basement floor and is used both for emptying the intake well and for priming the main pumps. A small pump of similar design, and driven by a belt from the bilge pump shaft, furnishes cooling water for the transformers.

The entire plant is the design of the Allis-Chalmers Company, which company supplied and installed all the apparatus. Work on the erection of the power station was begun on March 20th, 1908, and the installation of the first unit was completed and current was sent over the transmission line on May 23rd, 1909. The second generating unit was erected during the summer of 1910.

Mechanical Integration of the E. M. F. When Even Harmonics are Present.

(*Contributed Exclusively to* Southern Electrician.)

BY MONTFORD MORRISON.

THE purpose of this article is to expose the theory involved in the discussion of flux, likewise voltage and current determination in special cases by means of the Harmonic Instrument described by Prof. F. B. Davenport in the June issue of the Southern Electrician. The above mentioned article was necessarily written within such short limits of time that not only a revision of the text was omitted from the procedure but the discussion on even harmonics, which had to be introduced at the close, was condensed into the shortest possible space and no attempt made to give a graphic analysis.

Prof. Davenport is at present busily engaged in compiling and preparing matter for the press, and therefore I am expanding the condensed portion of his June article for him. It is hardly believed that a complete survey of the odd harmonic discussion would warrant the time required of the reader or the writer, hence the indulgence of the reader is expected. The June article discussed at length, waves having only odd harmonics present and the reader is advised to review the equations and theory, as this article is written with the idea that the reader is thoroughly familiar with the preceding matter.

THE INSTRUMENT DEFINED.

The instrument under consideration determines the relative flux, voltage and current values directly and is not a wave analyser[1] as it is often thought to be from its general appearance. It is fundamentally a means of arranging the emf values to be integrated mechanically and is therefore a means of mechanical integration. The integration is performed by a meter whose deflection is proportional to the first power of the measured potential. This instrument is an essential element of the system, hence a part of the method. The method is then a mechanical integrater for the emf.

SURVEY OF THE METHOD.

The fundamental element of the method employed by the instrument is borrowed of the calculus. The integra-

[1]The following list is printed for the benefit of the readers interested in wave analysers:

Grabowski (Theorie des Henricischen Analysators): Wiener Berichte 110, 717 (1901).

Henrici: Phil. Mag. 38, 110 (1894); Proc. Phys. Soc. London 13, 77 (1895)[2] Katalog math. und math.-phys. Modelle, Apparate und Instrumente, Muenchen 1892, S. 125 (herausg. von Walter Dyck).

LeConte: Phys. Rev. 7, 27 (1898); Zeitschr. f. Instrumentenk. 18, 342 (1898), Ref.

Lyle: Phil. Mag. 6, 549 (1903).

Michelson and Stratton: Amer. Journ. of Science 5, 1 (1898); Zeitschr. f. Instrumentenk. 18, 93 (1898), Ref.

Pierce: Elec. World 57, 916 (1911).

Sharp: Proc. Phys. Soc. of London 13, 89, 599 (1894-95); Phil. Mag. 38, 121 (1894).

Terada: Reports of the Tokyo Phys. Math. Soc. 1905; Zeitschr. f. Instrumentenk. 25, 285 (1905), Ref.

J. Thomson: Proc. Roy. Soc. London 24, 262 (1876).

W. Thomson: Proc. Roy. Soc. London 24, 266 (1876).

Wiechert und Sommerfeld: Katalog math. und math.-phys. Modelle, Apparate und Instrumente, Muenchen 1892, S. 214.

Yule: Proc. Phys. Soc. of London 13, 403 (1894-95); Phil. Mag. 39, 367 (1895).

[2]See "Mechanical Integration."

tion of any curve depends upon the area under it, since the given curve represents the rate of change in the curve to be found. For the rate of change in a curve is represented by a series of ordinates, the altitudes of which determine the direction of the differential curve and therefore the area. It can be shown that the integral for any series of points on a curve or on the section of a curve is directly proportional to the algebraic sum of the areas to the right and left of the ordinates of the points on the curve.[2] If only odd harmonics are present in an emf the proposition may easily be made to apply. The application to odd harmonics was expressed mathematically in a clear way in the previous article with all the intermediate steps and we shall represent it here graphically.

Take any curve *a* having only odd harmonics present and a period of 2 *pi*. To the angular value of any ordinate a_1, a_2, a_3, add *pi* and erect an ordinate, the point representing the sum of the two angular values. The sum of the two ordinates will be zero.[8] We will call this proposition (1). Conversely, if any sets of ordinates at a distance of *pi* apart are equal to zero, then only odd harmonics are present. As will be seen special sets of ordinates such as zero, *pi* or any multiple of *pi* and in some cases *pi* over two or a multiple of *pi* over two, may be equal to zero as is the case with the curve with which we are working, but to come under this corallary any possible set in the period must equal zero if spaced at a distance of *pi*. Therefore the area from any a_1 value to the first whole *pi* value to the right or left is equal to that included between any other a_1 value and its corresponding whole *pi* value.

Now, we may not have any instrument at hand to read the algebraic sum of the areas, but almost any direct-current voltmeter is calibrated to read the average height of a positive pulsating emf, and therefore the algebraic average of a pulsation emf having plus and minus values. But the algebraic average is the area divided by the base, hence directly proportional to the area. Then our algebraic average reading will be directly proportional to an algebraic sum reading of the area. If we take a wave and commute it at any points such as a_1, we obtain the result shown in *b*. If a direct-current voltmeter be placed in circuit, we shall have a reading directly proportional to the algebraic sum of the areas at the right and left of the ordinates at which the commutation takes place. Therefore by the preceding proposition this is proportional to the integral at that point, hence the flux also. This is the theory of the odd harmonic method. In the even harmonics curve *c* it is clearly shown that the above reasoning does not hold true. It was completely expressed in mathematical form in the preceding article, but a graphic representation in this review will serve to renew the equations in the readers' mind, beside giving the man whose training has been to prepare for research work an actual insight into the working of the formulas, which is so necessary in his line of work.

It is evident that the method as discussed cannot be applied to a complete wave in which there are even harmonics present. We shall discuss later on in this article how this might be accomplished with a special instrument.

The wave may, however, be commuted and some of its components replaced to fit the definition of an odd harmonic wave and then eliminate the added matter. Rather than develop a formulated mathematical proof, we shall discuss the action graphically. Curve *d* represents a wave in which there are both even and odd harmonics, the fundamental, second and third. The first step of the instrument is shown in curve *e*. In the last half period of every cycle the ordinates are reduced to zero by keeping the circuit open during its time, leaving periodic positive impulses separated by a time equal to their length. In curve *f*, the impulses are put into alternate plus and minus positions, separated as before. It will be noticed at this point that, if the impulses were brought together making

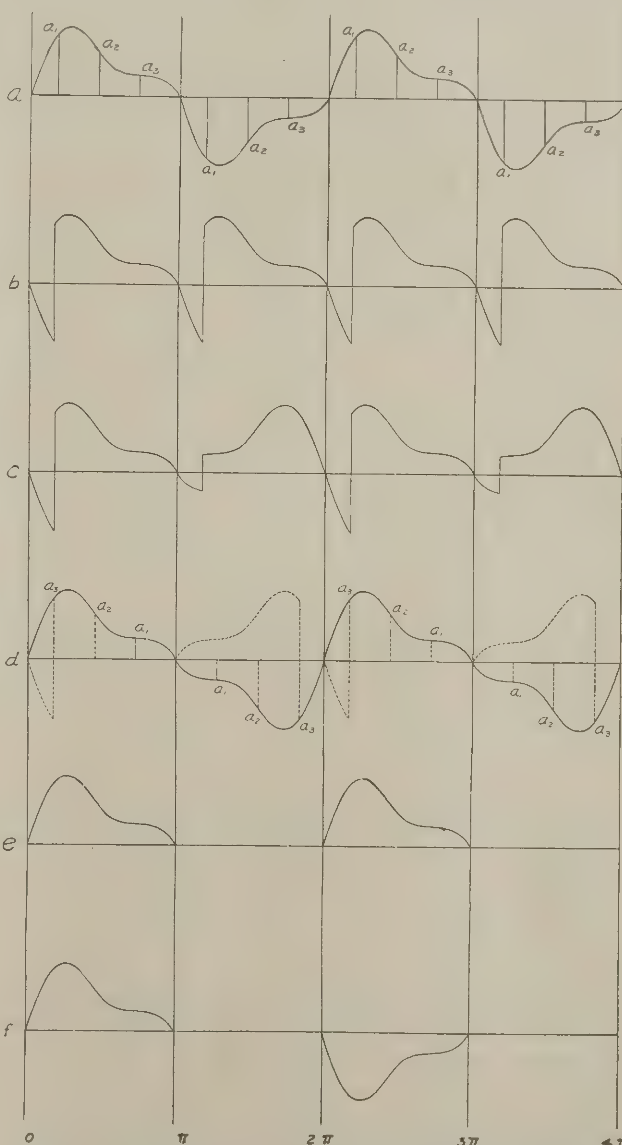


FIG. 1. GRAPHIC ANALYSIS OF THE OPERATION OF THE HARMONIC INSTRUMENT.

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[8]For more complete discussion see:

Clifford: Proc. Lond. Math. Soc. 5.
Finsterwalder: Zeitschr. f. Math. u. Phys. 43, 85 (1898); Zeitscher. f. Instrumentenk. 19, 283 (1899).
Fischer-Hiunen: E. T. Z. 22, 396 (1901).
Hermann: Pfluegers Archiv 46, 44 (1890); Journal de Physique (3) 7, 141 (1898); Zeitschr. f. Instrumentenk. 18, 158 (1898), Ref.
Houston and Kennelly: Elec. World 31, 580 (1898); E. T. Z. 19, 714 (1898); Zeitschr. f. Instrumentenk. 19, 372 (1899), Ref.
Langsdorf: Phys. Rev. 12, 184 (1901).
Loppe: Eclair. Electr. 16, 525 et 32, 287 (1902).
Lyle: Phil. Mag. 6, 549 (1903) and 11, 25 (1906).
Mace de Lepinay: Journ. de Phys. (3) 8, 137 (1899); Zeitschr. fuer Instrumentenk. 19, 257 (1899).
Prentiss: Phys. Rev. 15, 257 (1899).
Runge: Zeitschr. f. Math. u. Phys. 48, 443 (1903); E. T. Z. 26, 247 (1905).

the ends meet, proposition (1) would apply, hence the wave could be resolved into odd harmonics. This is not possible, but we may fill up the spaces with such curves as would not destroy the possibility of our omitting the even harmonics from the equation of components and therefore apply the method.

If a periodic second harmonic replace the zero ordinates of curve *f* with the plus and minus values as shown in curve *g*, we arrive at the point where one-half of the even harmonic wave is ready to be commuted and receive the action of the voltmeter. While we have discussed these curves showing the "steps" it is well understood that these transformations must and do take place simultaneously. Attention is directed to the fact that the period of the wave *g* has changed and is no longer 2 *pi*, but 2Π, which in the linear measure of the graphs is equal to four times 3.14159 +, and from this, *g* has a frequency of one-half that of *d*. It will be appreciated that for all purposes in practice, *g* may be regarded as a continuous curve and subject to formulation, being periodic. More than that, inspection will show that sets of ordinates separated by a distance of Π will have a sum of zero and by corallary (1) only odd harmonics are present. Also the ordinates of the plus or minus lobes of the interposed harmonics may be varied to make the curve theoretically continuous, that is, tangent at the point of meeting on the axis of abscissa.

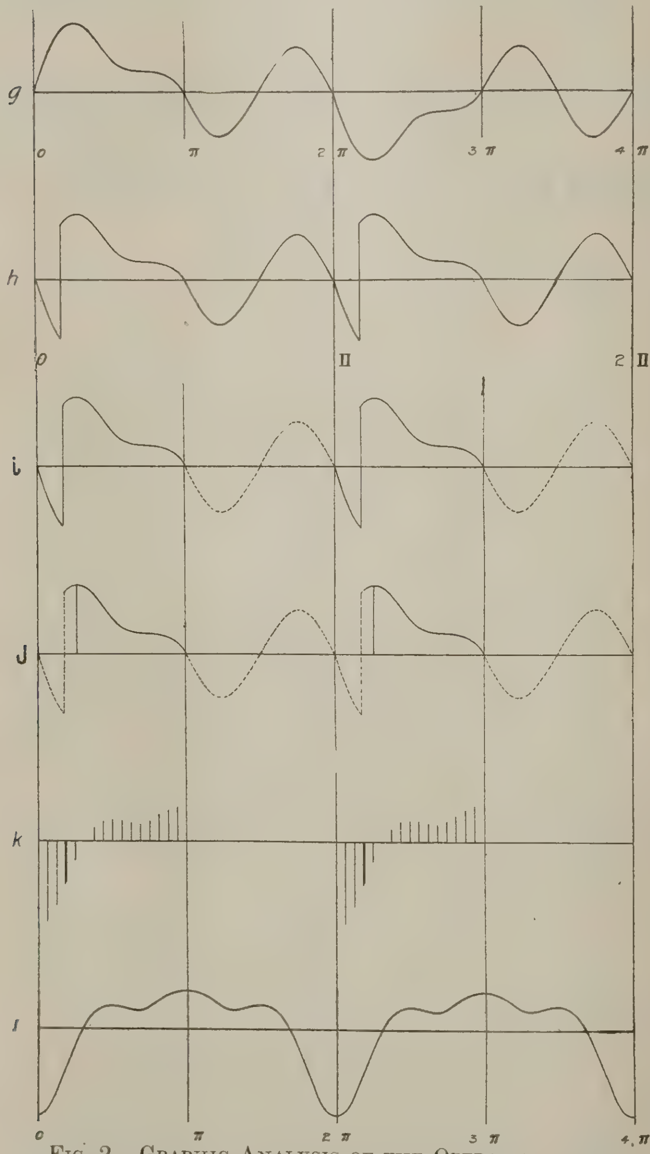


Fig. 2. Graphic Analysis of the Operation of the Harmonic Instrument.

When the statement is made that only odd harmonics are present the meaning is more nearly this: If the periodic wave be resolved into harmonic components, none of the components are even harmonics. It may seem queer to say that waves having only even harmonics can be resolved into waves of the dimensions termed odd, but they can be, nevertheless. When we consider the original law of Fourier which in English is, "Every periodic motion whatsoever may always be considered as the resultant of the superposition of a definite number of pendular vibratory motions, or is always resolvable into a definite number of commensurate simple harmonic motions," we see that he was very particular to make every idea precise and positive except to say that every periodic motion whatsoever *is* a resultant of harmonic components. Regarding this Helmholtz says, "It is only a mathematical fiction, admirable because it renders calculation easy, but not necessarily corresponding with anything in reality," which shows that his investigation has given evidence that it is a method of representation and not a truth. In view of these facts the resolving even into odd harmonics does not seem unreasonable. The mean daily temperature for a year may be resolved into harmonic components, but this does not represent a truth in nature. However this law may represent a truth in many cases, for instance, if a set of alternators giving a sine wave with frequencies of f, 2f, 3f, . . . nf, were lined up on the same shaft or run at fixed speeds and connected in series without receiving any external effect, the resultant emf recorded and formulated, the components should be the fundamental, the second, third, up to the nth harmonic, representing the frequencies of the several alternators with their proper amplitudes.

The use of the interposed second harmonic not only allows the curve to be easily formulated, but it is believed that it assists the taking of the volunteer reading. One might say that it cancels itself and therefore would give the identical result that would be obtained with the blank spaces in its place. However, if these impulses were a second apart the voltmeter needle action could almost be followed by the eye and the closer they are brought together the quicker the action until, when they touch, the action ceases and the needle becomes steady, the action is lost, that is, on commercial emfs the needle is as steady as one would care for. The naked eye could hardly perceive any vibration.

The voltmeter function begins with curve *h*. This represents the wave after being commuted and as the current flows through the voltmeter. In the first place the voltmeter cancels the second harmonic which was interposed, leaving the original curve as shown in *i*, but in its commuted condition. The algebraic average of the positive lobe being equal to that of the negative, hence the cancellation.

It is believed advisable to repeat here that statements such as "leaving a portion of a wave standing" and "the next steps" only mean that the analysis is divided into steps for clearness but the whole process is necessarily simultaneous. The result of curve *i* on the voltmeter may be conceived as shown in *j*. Since the average altitude is directly proportional to the area, we may work with the and in the case of metal filament lamps are more fragile than the larger ones. For this reason I always advise the largest units that can be used with good distribution.

Lighting by means of long tubes such as the mercury vapor and the Moore lamp reduces the number of units required and yet retains the advantage of the small units, namely a well diffused and uniformly distributed light, if properly spaced. Furthermore with these lamps the intrinsic brilliancy is low, and the general appearance is pleasant and restful. The advantage of the Linolite lamp over the round bulb incandescent appears to be that for the lighting of desks, pictures, and especially show windows. It is possible to produce the effect of a line of light instead of scattered points of illumination which for these purposes is much preferable.

Is Wattless Current a Waste? Ans. Ques. No. 228.

A low power factor indicates a certain amount of lost power, or rather ineffective capacity. If we have 100 amperes flowing under a pressure of 110 volts, and the current and voltage are in phase, the power will be 110 × 100 or 11000 watts or 11 K. W. In this case the power factor is 100 per cent. If however the current should not be in phase with the emf, but lag 60 degrees behind it, we would have a power factor equal to the cosine of 60 degrees or 50 per cent., and the power would be 50 per cent. of 11 K. W. or 5.5 K. W. Now there is a certain wattless current in the sense that since the current is not in phase with the emf. it does not count for its full value, but only half, and we might therefore theoretically divide the current into two parts and say that 50 amperes was effective and 50 was wattless, since it produced no power. But the term wattless energy is incorrect. If it were wattless it would possess no energy at all.

However, there is a waste, and it is as follows: In the above case there are 100 amperes flowing where 50 would do the work if the power factor were 100 per cent. Now we lose the power that it takes to force this extra 50 amperes, which is doing no real work, through the windings of the transformer, generator, and over the line, etc. We have to get larger machines and transformers, and run heavier lines, than we otherwise would. In this case there is a waste, and a serious one. A power factor of 75 per cent. is rather below the average for station operation. I could not say what expense would be justified to raise it to say 85 per cent. or 90 per cent. If you have to drive rotaries or motor generators at some point, it will certainly be of advantage to drive them by a synchronous motor adjusted for leading power factor. Otherwise it is a question whether the expense of a synchronous machine would be justified.

A. G. Rakestraw.

Discussion on Synchronous Motor, Question No. 214.

Editor Southern Electrician:

I have read with interest the material appearing in the July issue on raising the power factor by the synchronous motor operated as a synchronous condenser. The method given by Mr. Hoke is very simple and plain and is the one usually employed. I notice that Mr. Chatfield has endeavored to treat the problem in a different way, endeavoring to make a theoretical analysis by vector diagram. While this is possible, it is as presented by Mr. Chatfield very confusing and I believe he has in several instances given the wrong interpretation to the conditions. I would suggest that he deal in the vector quantities as K. V. A. and K. W., as this will often help to straighten out matters. Further A. C. machines depend upon K. V. A. values for their capacity rather than K. W.

One of the conditions which I believe decidedly questionable is the subtracting of the 38 H. P. carried by the 50 H. P. induction motor when considering the system with the synchronous motor in operation. According to the conditions of the original question, the 38 H. P. motor load was to be carried by the synchronous motor, and as this 38 H. P. represents the energy component of the generator output for that motor load, the system or the generator is not relieved of it by the installation of the synchronous motor. What Mr. Chatfield is driving at and what he thought he did was to take account of the inductive load eliminated by taking off the system, the 50 H. P. induction motor partially loaded. What he should have done was to determine the wattless energy due to the motor, subtracting it from O. A. and then ascertain the value of the power factor for the system under these conditions, for evidently the power factor will be higher than .718 as he calculated for the original case.

In solving problems of this nature it is always best to take the simplest method. A very good way of viewing this particular case is to conceive it as two problems. What size must the synchronous motor be to raise the power factor as desired? Then having determined this value, how much larger must it be, if any, to carry a mechanical load of a certain amount and take care of the losses. My comments in regard to this latter question, published in the July issue also, cover the points in regard to it.

H. L. Williamson.

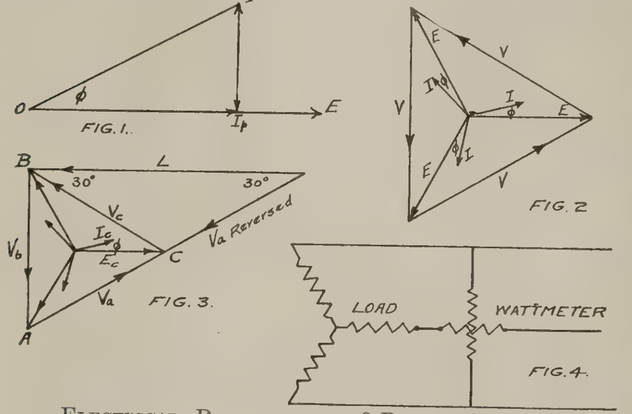
Discussion on Questions 205, 218 and 223.

Editor Southern Electrician:

The discussion of power measurements by Mr. Bates and others opens up a very interesting subject, which I would like to discuss in a general way and show the relation between the various methods taken up. This subject is interesting not only because of the various points of discussion incidental to the subject itself but also because it is intimately related to two other questions that have since appeared, No. 218 and No. 223. I shall discuss them all as one subject, as the last two cannot be so well discussed separately.

The power of any system is given by the equation $P = EIp$, where E is the voltage and Ip is the power component of the current. If it be direct current, it is all necessarily power current, but if alternating, the power component is only that in phase with the voltage. This can be best illustrated by the vector diagram, Fig. 1: OE represent the voltage, OI the current, OIp the power component, and IIp the wattless component of current. OI means the length of the line from O to I. By inspection of the diagram it will be seen that Ip equals $I \cos \Phi$ where Φ is the phase angle between I and E. Therefore we get, by substituting for Ip its equivalent $I \cos \Phi$, the equation, $P = EI \cos \Phi$ and also $Iw = I \sin \Phi$. This equation holds for three-phase systems as well as single, but it is necessary in applying it to remember that there are three phases to be measured and to see that we get the phase voltage across the potential coil and not the line voltage. The phase voltage may be measured either as Mr. Bates shows in his diagram or by tapping the neutral of some Y connected machine. If we think the phases are not loaded alike we can test them separately, but one reading is usually sufficient and we need only multiply it by 3 in order to find the total power.

The necessity for using the false Y will be apparent upon inspection of Fig. 2. The three vectors E represent the phase voltages and the vectors V represent the line voltages. Since the angles at the points of the triangle are 60 degrees, the phase angle between E and V is half of 60 or 30 degrees. By the principles of elementary trigonometry, the line voltage equals twice the product of the phase voltage and the cosine of 30 degrees or $V = 2E \cos 30$ degrees $= (2E\sqrt{3})/2 = E\sqrt{3}$, hence $E = V/\sqrt{3}$. The power of each phase equals the product, $EI \cos \Phi$, so the total power will be $3EI \cos \Phi$. Therefore $P = 3EI \cos \Phi$, or by substituting for E its value $V/\sqrt{3}$ we get the equation $P = (3\,VI \cos \Phi)/\sqrt{3}$, which can be simplified to $P = \sqrt{3}\,VI \cos \Phi$, by multiplying both terms of the fraction by $\sqrt{3}$. We see therefore that the power is equal to $3\,EI \cos \Phi$ or $\sqrt{3}\,VI \cos \Phi$, where E is the phase voltage measured from any line to the center of a Y connected machine, (or set of resistances) and V is the line voltage measured between any two lines.



ELECTRICAL RELATIONS IN 3-PHASE CIRCUITS.

A wattmeter will give a reading equal to $EI \cos X$ where E is the potential or voltage applied to the potential coil, I is the current in the current coil and X is the phase angle between E and I. This reading would not necessarily represent the power of a circuit because E might come from a different circuit than I and certain peculiarities of connection might give the wrong value of X. This would be the case if the meters were connected as Mr. Hayward suggests, but although the individual readings do not represent the power of any circuit, yet it can be proven mathematically that the sum of the readings is equal to the total load.

With Mr. Hayward's connection the current I is the phase current but the voltage is not the phase voltage E but is the line voltage V and is 30 degrees out of phase with E, see Fig. 2. It will also be seen from inspection of Fig. 2, that the phase angle between I and V is 30 degrees plus Φ in one case, and is 30 degrees minus Φ in the other. Therefore the two readings will be $VI \cos (30° - \Phi)$ and $VI \cos (30° + \Phi)$. Transforming these two phase angles by the rules of elementary trigonometry we get, $VI (\cos 30° \cos \Phi + \sin 30° \sin \Phi)$ and $VI (\cos 30° \cos \Phi - \sin 30° \sin \Phi)$. Adding them together, the sine terms cancel out because of the difference of sign (— and +) and we get as the sum, $2\,VI \cos 30° \cos \Phi$. As the cosine of 30° equals $\sqrt{3}/2$, the sum will be $(2\,VI\sqrt{3} \cos \Phi)/2$, or $\sqrt{3}\,VI \cos \Phi$. This last quantity is the same as obtained by Mr. Bates' method and proves that both will give correct readings.

Discussion of Diagram by Mr. McCoy.

A vector representation of Mr. McCoy's diagram in the July issue is shown in Fig. 3. For the sake of simplicity I have assumed that the transformer ratios are one to one. The current coil is connected in phase C and the potential coil between A and B. This connection would ordinarily give Vb as voltage, which is $(90 - \Phi)$ out of phase with the current, but by reversing vector Va, which means reversing the transformer secondary as Mr. McCoy shows, we get L as voltage, since L is the vector sum of Vc and Va after Va has been reversed. Inspection of the figure will show that L/2 equals V cos 30° or $V\sqrt{3}/2$ and therefore L equals $V\sqrt{3}$ and it is in phase with the phase voltage Ec, and so is $\Phi°$ out of phase with I. The reading will then be $LI \cos \Phi$ and since L equals $\sqrt{3}$ V, it is $\sqrt{3}\,VI \cos \Phi$.

Therefore it appears that this connection will also give the correct reading. The point of special importance to be noted is the necessity for reversing one transformer secondary. If this is not done the voltage will be V instead of 1.732 V ($\sqrt{3}$ V) and the phase angle will be $(90 - \Phi)$ instead of Φ. This last should be carefully noted because it has an important bearing on question No. 218. I would suggest that the reader compare the vector diagram in Fig. 3 with Mr. McCoy's connection diagram.

Referring again to Mr. Hayward's method it is instructive to note the different readings obtained with balanced load and different power factors. The readings are $VI \cos (30° - \Phi)$ and $VI \cos (30° + \Phi)$ so it is easy to see why the readings depend upon the value of Φ and do not necessarily indicate unbalanced load when unequal as Mr. Rakestraw states in his answer to question No. 223. Unequal values of I would of course effect the relative readings, but the load is not likely to be unbalanced sufficiently to cause this effect to be at all comparable to that caused by the change of Φ. We can investigate the question by giving different values to Φ and noting the resulting readings. Thus if Φ is zero we have $VI \cos (30 - 0)$ and $VI \cos (30 + 0)$ which are of course equal to $VI \cos 30°$ or $(VI\sqrt{3})/2$ and the sum will be $\sqrt{3}$ VI.

We therefore see that if the current is equal (as read by an ammeter) and the wattmeter readings are also equal, it shows that Φ is zero, and the power factor is unity. If Φ is 60° (power factor 50%) the readings will be $VI \cos 90°$ and $VI \cos (-30°)$ or zero and $VI\sqrt{3}/2$, because the cosine of 90 is zero and the cosine of 30 or —30 is $\sqrt{3}/2$. It will be found in both these cases that the sum of the readings is $\sqrt{3}\,VI \cos \Phi$, as it should be. Also the first reading becomes negative when the value of Φ is greater than 60°, because the cosine of any angle between 90° and 180° is negative. If the load is not balanced we may assume that Ia equals KIc where Ia is one value of current, Ic is the other and K is the ratio between them, which can be found from the ammeter readings. Then if the readings of the wattmeters are the same we have $VIa \cos (30° + \Phi) = VIc \cos (30° - \Phi)$, or $VKIc \cos (30° + \Phi) = VIc \cos (30° - \Phi)$ and cancelling out VIc, we get $K \cos (30°$

area and imagine it thus: The voltmeter subtracts the minus area from the positive and leaves that which is shown by full lines in *j*. The flux is proportional to the area of *j*, which is given its relative value in *k* by the heavy ordinate, having a minus sign given us from the equation relating to emf and flux.

To obtain a complete flux curve, we can by this method integrate only 180 degrees with one arrangement of connections. If it is known that both positive and negative lobes are similar, one set of readings will suffice. The first 180 degrees obtained will be plotted in position and then plotted with its time reversed as shown in *l*. There are several ways of assisting one in deciding about the symmetry of a wave, for instance, a direct-current voltmeter thrown across the line would show whether or not the area of the negative lobe equaled that of the positive. If, however, no information whatever can be obtained other than to know that the current is periodic (if the circuit is known this is known) the surest procedure is to integrate with the instrument both lobes separately and then plot them in position. It is evident that the flux wave should plot out a continuous curve by this method.

THE SPECIAL INSTRUMENT.

An instrument might be designed to do the work indicated by the dotted lines in *d*. The reversing mechanisms beginning together at the point *pi*, the initial position would allow the unchanged emf to go through the meter. The commuting mechanisms then diverge with a fixed ratio, giving all like sections the same algebraic sign. This is the result obtained in *b*. But this would work only when even harmonics are present and the positive and negative lobes are similar.

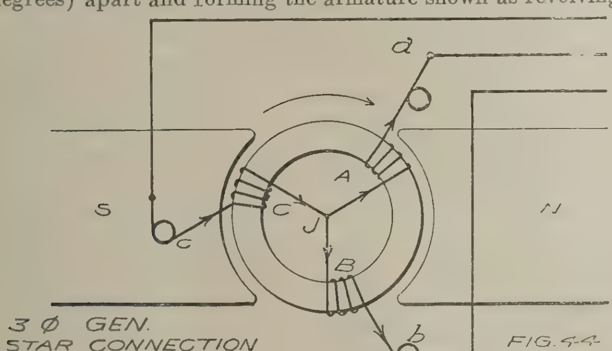
Alternating Current Engineering.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN)

BY WILLIAM R. BOWKER.

PREVIOUS mention has been made in the parts of this article preceding this one, to the theory and practical generation of polyphase currents. It is now advisable and essential that this branch of the subject be gone into somewhat more in detail, with the object of attaining a clear understanding of a rotary or rotating magnetic field.

Before dealing with this subject, however, it is desirable to again deal with the generation of polyphase currents. Figs. 44 and 45 present two outline diagrams of a polyphase generator in its most elementary form, assembled with three coils or bobbins of wire A, B and C set equidistant (120 degrees) apart and forming the armature shown as revolving in a clockwise direction between the north and south poles of a two pole dynamo.



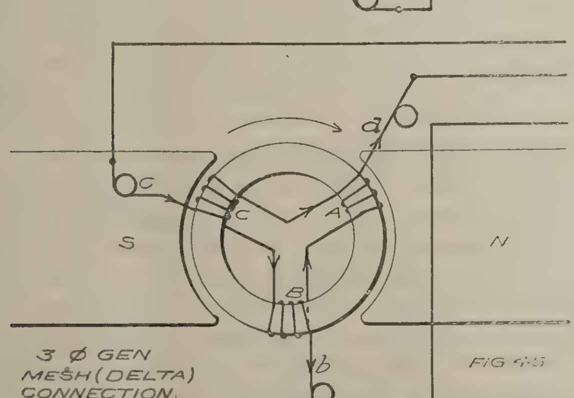


FIG. 44. THREE PHASE GENERATOR STAR WITH CONNECTION; FIG. 45. THREE PHASE GENERATOR MESH (DELTA) WITH CONNECTION.

In Fig. 44 is shown the ends of the coils connected in three-phase star in which one end of each of the three coils A B C are brought to a common junction J. Fig. 45 shows the three coils connected in delta. The three free end connections are each brought to a slip ring on which presses a brush at b, c, and d. Obviously in practice the three slip rings would be mounted on one shaft, but they are here shown separated for clearness of description. This arrangement as shown would be impossible in practice if so assembled.

From the previous information set forth at the beginning of this article, in reference to the theory of generation of a current of electricity, it is understood that the electro-motive force in the coil A Fig. 45, is increasing in value, while that in B. is diminishing, but generated in the same direction as that in coil A, as shown by the arrowheads. At the same time, the value of the emf in coil C is decreasing, being generated in an opposite direction to the currents circulating in coils A and B. It must be remembered that the emf and current increase in value to a maximum at 90° and 270° positions and decrease after passing it, to a minimum at 180° and 0° and flow in opposite directions when cutting the lines of force from opposite directions.

Obviously as the armature revolves, each separate coil A, B and C. will pass through the same relative positions, thus generating the same cycle of alternations and emf, but they will attain the maximum and minimum and intermediate values at different instants of time, owing to the angular spacing (120°) of the coils, relatively to the 90°, 270°, 0° and 180° positions. This giving rise to a current and emf, differing in phase, producing in this case a three-phase current differing in phase by one-third of a period that is 120° which is one-third of 360°.

Further it is realized that while the coils A and B (for both Figs. 44 and 45 in the positions as there shown) are delivering current to the lines to which they are connected, at that same instant the coil C is receiving current from the line and this is equal in amount or numerical value to the sum of the currents in A and B. The currents from A, B and C are intermediate in phase and obviously if the current in C at any particular instant is equal to the sum of the currents in A and B, then the value of the current in A or B will at the same instant, be equal to the difference of those in B and C and A and C respectively.

It should be clear then, that at any particular instant, one line may be carrying a positive current equal in magnitude to the sum of two negative currents in the other two lines, while an instant later two lines would be carrying a positive current equal in magnitude to the negative current carried by the third line and so on. The emf and current in all three lines are of course alternating but differing in phase by one third of a period.

In Fig 46, a simple diagram is shown of a single-phase generator, transmission lines and power utilization by means of a synchronous motor. The generator consists of an iron ring, over each half of which is coiled a number of convolu-

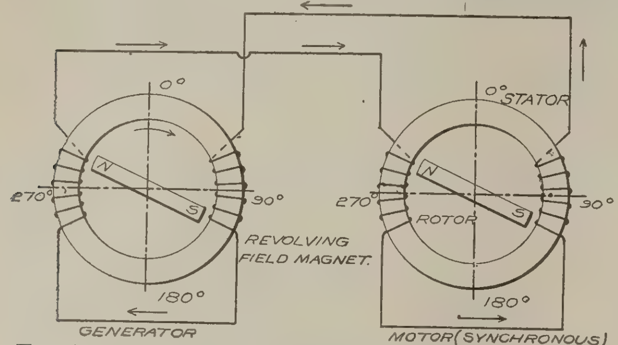


Fig. 46. Principles of Single-Phase Transmission.

tions of wire, which represents the generator armature, and a revolving field magnet. If this magnet is caused to rapidly rotate, it generates currents of electricity by electro-magnetic induction in the coils while they are being cut by the magnetic field. The strength and direction will vary according to the relative position and proximity of the north and south poles of the revolving magnet to the fixed armature coils.

If the ends of the windings are connected as shown, the free ends led to transmitting lines (two for single-phase as shown), and the lines deliver the current to the stator primary of an exactly similar machine as the generator, the ingoing and outgoing currents will produce north and south magnetic polarity in the stator coils of the motor. By mutual induction the rotor field magnet will be reacted on (if previously rotating at synchronous speed) dragging it around and causing it to revolve in synchronism with the generator revolving magnet.

The strongest currents will be induced along the line xx that is at the 90 and 270 degree position of the generator coils; and the greatest mechanical torque, due to the magnetic dragging effect, will occur along the line xx in the motor. A generator and motor constructed as shown would not be suited to practice, owing to a tendency to pulsate, caused by the great variation in current strength and mechanical torque, resulting from the unequal actions and reactions, due to the absence of symmetry throughout the electrical and magnetic system.

If we take the same iron circuit, and assemble on it four coils A, A_1 and B, B_1 or bobbins of wire as shown in Fig. 47, set at an angular displacement of 90° apart, and cause the field magnet to revolve (generator side) it will on successively passing the coils A, A_1 and B, B_1 induce in them alternating currents which attain a maximum and minimum emf and current strength every 90°, that is one quarter of a revolution. This will give rise to two-phase currents, whose phase difference is one-quarter of a period and said to be in quadrature. These alternating currents, although differing in phase, will be of equal strength and the same relative angular positions of the coils and field magnets.

If these currents are led out of the armature and connected to four live wires, transmitted and delivered to a machine similar to the generator, they will in flowing induce in the iron core on which they are wound an oscillatory magnetic field of north and south polarity which varies in strength and reverses in polarity. In revolving, the iron core produces what is known as a rotating or rotary magnetic field by its mutual inductive action and reaction on the rotor magnet drags it around or causes it to revolve. The magnetic drag is so great that it exerts a mechanical torque and is capable of performing mechanical work.

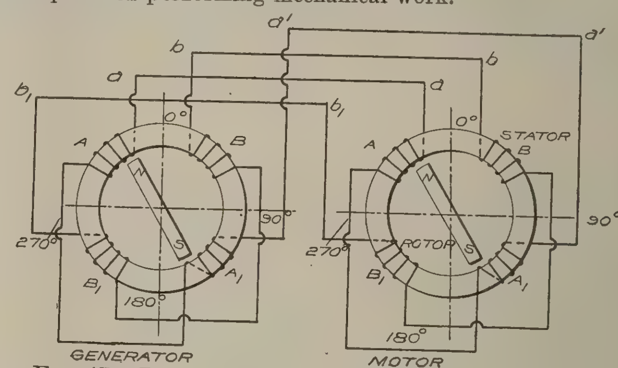


Fig. 47. Principles of Two-Phase Transmission.

In the generator, the revolving field magnet, by electromagnetic induction generates currents of electricity in the coils A, A_1 and B, B_1 which when received by the motor and introduced at A, A_1 sets up an oscillatory magnetic field, a north pole increasing in strength being produced at A, Fig. 47, and a south pole at A_1 gradually decreasing in strength reverses in direction. The same takes place at B, B_1 and these polarities being produced at a quarter period time interval, combine and result in giving a rotary magnetic field.

This arrangement would as before in Fig. 46, tend to be too pulsating in action, and to overcome this, the machine could in practice be so constructed that the generator armature and motor stator cores be wholly wound or covered with suitable conductor coils or convolutions of wire. In place of a two pole revolving field magnet in the generator and a two pole rotor magnet, it would be so built and assembled as to conform to a magnet composed of several poles, thus multiplying the number of alternations, increasing the frequency, and rendering the inductive action and reaction more continuous throughout the combination, thus obviating providing the essential condition of smooth working.

A Correction.—In my article on "Alternating Engineering" published in the June issue, page 234, first column, the latter part of the description referring to Fig. 40 says, "Its armature being wound with a double circuit to bring about this transformation, etc." This is rather ambiguous and may create an erroneous impression of what is intended. It should read, "The converter armature is wound as a single armature, similar to an ordinary direct current generator, but there is a circuit arrangement at each end, one for the direct current, and the other for the alternating current.

WM. R. BOWKER.

The Design and Operating Features of the Single-Phase Repulsion Motor.

BY C. H. SCOTT.

MANY central stations and isolated plants find it both convenient and economical to combine their lighting and power loads on single-phase circuits. To successfully build up this dual field, a single-phase motor is required whose design and operating characteristics will allow favorable comparison with the starting torque, maximum overload capacity, efficiency, power-factor, mechanical simplicity and general reliability of the polyphase induction type. On this account the single-phase repulsion motor has many interesting features. We reproduce therefore material appearing in the General Electric Review taking up the electrical characteristics of this type of motor as follows:

The resistance-reactance type of motor is already so well known as to need but a moment's comment. This motor will continue to fill those service requirements for which it was specifically designed, that is, constant speed duty and the acceleration of loads requiring light or moderate starting torque up to 150 per cent. of normal.

For variable speed service and to accelerate loads whose static friction or inertia demands a reserve of torque in excess of the inherent limitations of the "split phase" or resistance-reactance motor, the repulsion type has been developed.

DESIGN THEORY OF REPULSION MOTOR.

The leading characteristics of the direct current series wound motor operating through a wide range of speed and torque, are well known. This type has, however, no inherent speed regulation and its use is consequently confined either to fixed loads like fans or pressure blowers, or to varying loads where the motor controlling device is constantly under the operator's guidance. The speed, torque and load characteristics of the commutator series alternating current motor is distinctly analagous to that of its direct current prototype, and this design therefore fails to meet the requirements of constant speed service; this service demanding a motor that will maintain good regulation after having once been brought up to speed, with torque values increasing at satisfactory efficiency as speed decreases. In other words, the characteristics of a motor for constant speed service should approach those of the direct current compound motor having the usual proportion of series field winding.

The repulsion induction motor possesses this combination of series and shunt characteristics; namely, a limited speed, with increase of torque with decrease in speed. To secure the necessary starting torque in the straight repulsion motor, a direct current armature is placed in a magnetic field excited by an alternating current and short circuited through brushes set with a predetermined angular relation to the stator field. To further improve the operating characteristics of the plain repulsion motor, a second set of brushes, viz., the compensating brushes, is placed at 90 electrical degrees from the main short circuiting brushes, or energy brushes. The compensating field is auxiliary to the main field and impresses upon the armature an electromotive force in angular and time phase with the electromotive force generated by the main field. In addition to correcting phase relation between current and voltage, thus giving approximately unity power-factor at full load and power-factors closely approaching unity over a wider range of load, the compensating field serves to restrict the maximum no-load speed; and also permits, where varying speed service is involved, slight increases over synchronous values. The compensated repulsion induction motor is capable of operating either above or below synchronous speed, and possesses heavy starting torque and high power-factor at all loads, as well as excellent efficiency constants. This motor has no tendency to spark or flash over, since the armature coils successively short circuited by the energy brushes are not inductively placed in the magnetic field and have consequently only to commutate their generated voltage.

POWER-FACTOR.

The importance of power factor, that is, the relation of true to apparent power, in an alternating current circuit and its effect upon both generator capacity and voltage regulation demand the most careful consideration in all cases where electrical apparatus of an inductive nature, such as arc lamps, static transformers and induction motors, is to be employed. While the belief is current that a decrease in power-factor from unity value does not demand an increase of mechanical input, this is not strictly true, since generator and line losses become larger with decrease in power-factor and manifest themselves as heat, the waste energy to produce this heat being supplied by the prime mover. Apart from the poor voltage regulation of alternating current generators requiring abnormal field excitation to compensate for low power-factor, a part of the station's rated output is rendered unavailable and consequently produces no revenue. The poor steam economy of underloaded engines is also a serious source of fuel waste.

Careful investigations have shown that the power-factor of industrial plants using induction motors of various sizes, with changing load cycles, averages between 70 and 80 per cent. For plants supplying current to underloaded motors, a combined factor as low as 50 per cent. might be expected. Since standard generators are seldom designed to carry their rated load at less than 80 per cent. power-factor, the net available generator output is therefore considerably reduced.

With repulsion induction motors of mixed sizes, operating between ¾ and full load, the combined plant power-factor should equal or exceed 90 per cent. At half load, this combined value should not be less than 85 per cent.

STARTING CURRENT AND TORQUE.

To render efficient service, single-phase motors must be able to develop sufficient turning moment, or torque, to accelerate from standstill loads possessing large inertia or excessive static frictions, such for example as meat choppers and grinder, sugar or laundry centrifugals, heavy punch presses and group driven machines running from countershafts with possibly over-taut belting, poor condition of alignment and lubrication, etc., etc.

The starting torque demanded by the average type of industrial drive will be found to vary between 100 per cent. and 300 per cent. of normal. The repulsion induction motor, if started by directly closing the line switch, will develop from 250 per cent. to 300 per cent. full load torque, with current in like proportion.

From standstill these motors attain full speed under load in from two to five seconds, with normal frequency and voltage. The motors are ordinarily fused for 200 per cent. of normal full load current, exception being made for special service conditions where the percentage of starting to full load torque is excessive. As a general rule, starting boxes are not required up to and including the 2 horsepower sizes, while from 2 to 5 horsepower the use of a rheostat is optional, depending upon the degree of care to be exercised in maintaining voltage regulation. Starting boxes should preferably be used on the 7.5, 10 and 15 horsepower sizes, especially where light and power circuits are combined.

If motors of 2 horsepower and larger are installed on the same secondaries with arc or incandescent lamps, or where it is otherwise deemed essential to minimize current rush at starting, the use of a rheostat will secure full load torque with 225 per cent. full load current.

Owing to the exceedingly high power factor of the repulsion induction motor, current values, both at starting and full load, are markedly below those of other single-phase induction motors. If we compare, say a 3 horsepower repulsion motor with a 3 horsepower squirrel cage motor, each having a full load efficiency of 77 per cent., we shall find that the first motor, which we will designate as "A" motor, has a tested full load power-factor of 98 per cent., while the second motor, which we will call the "B" motor, has a tested full load power-factor of 80 per cent. Both motors are guaranteed to develop full load torque with 2¼ times full load current. On this basis motor A will require 31.5 amps. and motor B, 36.5 amps. The example should clearly indicate that the proper method to determine the perferable motor should always consider true ampere values rather than percentage of starting current to full load. In the case at hand, motor A will develop the same torque with 87 per cent. of the current required by motor B.

APPLICATION OF REPULSION MOTORS.

Repulsion induction motors are entirely automatic and may be thrown on the line without the use of rheostat, clutch coupling, or other external starting device. They are particularly suitable for operating refrigerating machines, air compressors, house pumps or other similar apparatus where a float switch or pressure regulator is used to close or open the supply circuit. Should the power service fail and the motor switch remain closed, these motors will not be injured in the slightest degree when the power on the line is resumed. Furthermore, no damage can result by opening or closing the line switch when the motor is at any point in its cycle of acceleration or deceleration.

Repulsion induction motors safely permit carrying very heavy overloads without sparking, down to or near standstill. This invaluable feature is not attainable with single-phase motors operating at full speed as induction motors, since upon excessive overload the motor will decelerate to the point where the automatic switch opens. A critical point may therefore exist where such a motor will hunt and become unstable, burning its switch contacts and otherwise causing trouble.

The Telephone Substation.

(*Contributed Exclusively to* Southern Electrician.)

BY L. O. SURLES.

WHILE originally the receiver as we know it today was used as both a receiving and transmitting instrument, it was soon evident that for the telephone to be a commercial success, a more efficient transmitter must be devised. Three means of producing electric waves in relation to sound waves are known, based on the following principles: Electro-magnetic, electro-static induction and microphonic contact. Now, the receiver used as a transmitter is of the electro-magnetic class. Probably its inability to produce electric pulsations of sufficient magnitude to make a good transmitter, is that the volume of the diaphram is not great enough to strengthen the inductive action and still be sensative enough to the voice vibrations to record them. As only a small percentage of the energy of the sound waves reaches the diaphragm, the true value both as regards energy and wave form, is still further reduced. Therefore, not more than one percent of the energy generated at the sending end of the line is received as sound at the receiving end.

As the electro-static transmitter brought out by Mr. Edison was limited to the shortest lines and could only be used under very favorable conditions, the details will not be covered here. However, it consisted of an arrangement of condenser plates behind the mouthpiece which vibrated with the sound waves, thus varying the capacity of the circuit. The articulation of this type was excellent, and like the electro-magnetic type could be used as both transmitter and receiver. To provide a source of current which could be boosted to sufficient power by the vibration of a diaphragm, an independent supply had to be devised, the control of which was regulated by the vibrations of the diaphragm. In other words, a relay or transformer operated by local current supply which would supply to the line a stronger current with the same proportionate value as the original sound waves produced at the diaphragm. The telegraph relay operating the sounder at the distant station is a simple example of the principle involved.

The basis of the modern transmitter lies in the fact that considerable resistance exists in a circuit where there is imperfect contact between two or more of its parts. This resistance is decreased when pressure is applied, and this is virtually the action of the old Blake transmitter in which a diaphragm of sheet iron rested against a globule of platinum which in turn was in contact with a carbon button. The platinum and carbon being connected with the circuit and forming the variable resistance which was necessary to promulgate the undulating currents so necessary in transmission of speech by means of the electric current.

Later carbon balls, pencils, and even diaphragms were introduced in various forms and combinations with increasing success, developing from the single contact electrodes to the multiple contact type. It was found that the more multitudinous the contacts the more sensative the action, until by reducing the size to a mere coarse powder-like carbon, and increasing the number of contacts that the ideal transmitter sought was being brought nearer perfection. This brings us down to the Hunnings transmitter, which was the forerunner of the kind most widely used today and in which the original Hunnings principle is still evident in substance, that is, the carbon electrodes separated in a small chamber by a short space, in which a small quantity of granular carbon is placed. We now know this as the "Solid Back" transmitter so familiar to all.

The four essential parts of this type are: (1) The base plate which forms the substantial support for the diaphragm and mouthpiece, (2) the diaphragm, (3) the bridge and, (4) the carbon cup or capsule which constitutes the variable resistance cell. The front electrode has free motion and is rigidly attached to the main diaphragm. The specifications of a first class transmitter are, (1) that it shall be of compact, substantial and durable construction, (2) the variable resistance cell shall be air-tight and moisture proof; (3)the diaphragm shall have free motion and yet properly damped to eliminate excessive side noises, (4) it shall not be subject to "packing" or unnecessary heating; (5) it shall be equally capable of being used on both long and short lines with uniform efficiency.

THE INDUCTION COIL.

The receiver originally used alternately as receiver and transmitter, was the direct cause of the search for an efficient transmitter with greater latitude and power. This having been accomplished, still greater development was sought whereby the comparatively feeble voltage of the battery would be increased sufficiently to overcome the resistance of the line and deliver the voice currents at a greater magnitude. In order to do this, a step-up transformer was introduced into the circuit. Telephone men know this as the induction coil.

The construction consists in taking a core of iron, usually composed of a number of soft iron wires formed into a rod, and provide it with heads as for an electro-magnet. Between these heads is wound two distinct circuits. For use with local battery, it is customary to wind the primary nearest the core and of larger wire and fewer turns than the secondary, which is wound over the primary and well insulated therefrom. Terminals are provided by which connection may be made with the windings. The transmitter is connected to the primary circuit while the receiver and line are connected to the secondary. The undulatory currents set up by the transmitter are transformed into an alternating current of much higher tension than that in the local circuit, the receiver at the distant station being connected to the line circuit, receives the boosted waves in a much greater amplitude. This gives louder articulation at the receiving station.

The relation of the wave in the secondary is so near that in the primary that the difference is inappreciable, the variation being nearly in proportion to the number of turns in the secondary. Line losses in transmission are proportional to the square of the value of the current in the primary, and the energy transmitted is proportional to the product of the voltage and amperage. Thus, if we reduce the current and increase the voltage, the same efficiency of transmission will be accomplished with less loss.

Due to arcing of the carbon particles in the variable resistance cell of the transmitter, only low voltages are practical but by means of the induction coil we are able to transform the low voltage and comparatively high amperage of current in the local circuit into high voltage and small amperage in the secondary circuit. As the voltage is the factor which overcomes the ohmic resistance of the line, the current vibrations are delivered at a much more desirable strength than if no induction coil were employed. As to the coil to secure the demands placed upon it and operate at the highest efficiency in connection with the circuit with which it is connected, quite a latitude of successful operation accompanies the average design of coil. To secure the best results it should be designed and proportioned with due regard to the type and resistance of transmitter, kind of receiver and strength of primary current to be employed in its operation.

Extensive experiments are usually made after these other factors are decided upon and a number of coils of different proportions in the resistance and number of turns of the primary to that of the secondary, until the best efficiency is obtained. The coil for use with those particular conditions is then designed accordingly. There are, therefore, no set rules by which a coil may be designed. Usually, however, in coils for use with local battery the primary winding is nearest the core, while in common battery work the reverse is the case.

The specifications surrounding the mechanical design are of no less importance than those of the electrical design, and that coil which nearest arrives at the requisites of both factors is considered ideal. A large amount of mutual inductance, with as little impedence, requires that the primary be of large sized wire, with a fair sized core of a sufficient length to permit of the necessary number of turns being laid as close as practicable to secure perfect insulation. Silk covered wire is preferable to cotton covered; wire to be continuous with splices, even and uniform winding, insulation between secondary and primary to consist of four layers of paraffined paper, and two in the middle of the secondary, terminals should be strong and rigidly connected to the head as not to loosen. The core should be of the softest annealed Swedish iron wires, varnished fiber heads are preferable to wood and mountings are provided to suit the different sets with which they are to be used. This subject is to be continued in the next issue.

Nine Thousand N. E. L. A. Members.

The brilliant and successful administration of W. W. Freeman, as president of the National Electric Light Association, came to a close June 30 with a total of no less than 9,214 members. He began his term with a total of 5,736, which would give a gain of 3,478 for the 12 months. This is, of course, unprecedented in the annals of engineering bodies, but it is believed that the coming year under President Gilchrist may see the figures matched, as there is a strong movement on foot in all parts of the country toward the formation of company sections and the affiliation of State associations.

Installing and Operating D. C. Plants.

(*Contributed Exclusively to* Southern Electrician.)

BY L. A. COLE.

THE purpose of this article is to take up the installa- and operating features of small direct current equipments. While the subject may be familiar to a large number of readers, the importance of some of the features mentioned will warrant a review. Proper installation of generating equipment determines to a large degree its successful operation. It is due to the fact that the small equipment is often neglected on this score that the writer is going into details of the why and wherefore of connections and operating methods.

Beginning with the switchboard, Fig. 1 illustrates one for a mixed service, with three power panels and two lighting panels. The instruments necessary are three ammeters, one voltmeter and at the top of the board, three circuit breakers. On account of the nature of their service and the fire underwriter's regulations, switchboards are constructed of a fireproof material, that most used being marble, or slate slabs. In locating a switchboard, a place should be selected where there is no danger of fire, convenient for operation and so placed that an electrician can work behind it, on connections. No instruments or switches should be placed nearer than eighteen inches from the floor and no steam or water pipes should run over or alongside the board. Switchboards or the slabs are usually bolted to an angle iron frame such as shown in Fig. 1. The usual design and arrangement of switchboards is such that all switches, volt and ammeters, wattmeters, and circuit breakers are placed on the front with all connections on the back, and the generator panels separated from the feeder panels. The bus-bars are usually constructed of flat copper bars resting on brackets bolted to the back of the slabs. These brackets should hold the bus-bars very rigid about six to ten inches from the back of the panels. The switches should be so constructed that connections lead back through the slabs and pass through the copper bars, held by nuts on each side of these strips. All switches should be so placed that gravity will tend to open rather than to close them, also on constant potential systems, the switches should make and brake readily as well as quickly so as to keep the contacts from burning by arcs when the switch is opened or closed when under heavy current.

It is customary to fasten rheostats to the back of the switchboard allowing the stem to project through to the front and operate by a hand wheel. All automatic cutouts, that is, fuses and circuit breakers should be placed on each feeder leaving the feed panel or board. When the feeder is to be used for incandescent lights, fuses can be used with the first cost much less. When motors are to be operated from a feeder, however, a circuit breaker should be used to take care of the sudden and excessive call for current to which all motor circuits are constantly subject.

When running street lighting circuits, lightning arresters should be placed on each side of every overhead circuit leaving the building and should be mounted upon non-combustible bases so constructed that an arc will not be maintained after a discharge has passed these arresters. It should be placed in an easily accessible place and clear of combustible material, also as near as possible to where the wires leave the building. A permanent ground connection should be made of heavy copper wire, using nothing less than No. 0 or 1 B. & S. gauge, and run in as straight a line as possible, soldered to a piece of copper bar, the end being buried deep into moist earth. On out-going A. C. circuits a chock coil is often introduced on the circuit between the arresters and the generator which practically offers little resistance to the passage of the generator

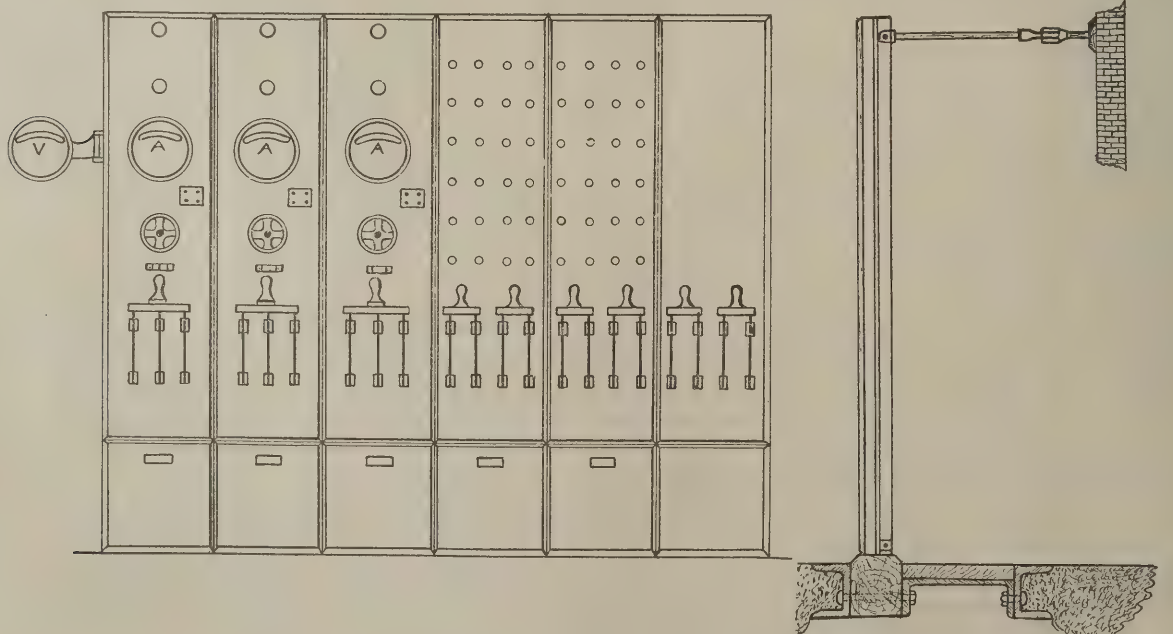


Fig. 1. Switchboard Construction and Arrangement.

current but has a retarding influence on a lighting discharge and makes the ground connection a much easier path for travel.

Among the other instruments necessary for a switchboard are the recording wattmeter, which records and accounts for the output of the dynamos or generators, and should be placed on the front of the board at a height to admit of reading easily and accurately.

When compound wound generators are operated in parallel, the ammeter should be placed in series with the lead which comes direct from the brush of the generator and not from the series coils or field winding as all the current would not be indicated by the ammeter, part being at times taken off by the equalizer connections. Fig. 2 shows the switchboard connections and location of the necessary controlling instruments such as are usually required for the operation of one dynamo used for incandescent lighting. The connections of a compound wound dynamo and the manner in which the simple shunt wound generator is connected differs but slightly as both dynamo leads are attached directly to the brushes. As here shown the ammeter is placed in series with the brush lead. While in a single unit switchboard it would make no difference, if another machine and another panel is installed so as to operate two dynamos in parallel with equalizer connections, such arrangement would make it unnecessary to make changes in instrument connections from those shown. In Fig. 2, one dynamo lead is connected to the lower right hand terminal of the main or dynamo switch at F, which is the lead from the end of the series field coils, generally called the series lead. The brush lead is connected to the

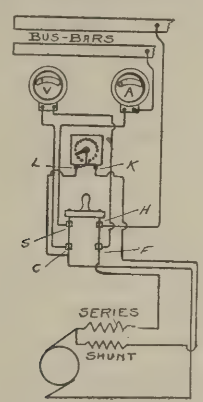


Fig. 2. Wiring Diagram for Single Machine.

main switch at C. When the main switch is closed the circuit is closed on ten bus-bars through ammeter A. The third wire or rheostat connection is run from the free end of the shunt field coil to the resistance box at K, with a wire from the resistance box at L to the brush side of the line at C, completing the shunt field circuit. The object of making the field connection below the switch is so that the magnetism of the machine may be built up and maintained independently of the opening or closing of the main switch. Another reason is that it is bad practice to quickly open a shunt field circuit on account of the inductive discharge which follows the break, liable to result in a breaking down of the insulation of the shunt field winding. There are methods provided for preventing this, as discharging through a resistance or coil.

The manner in which connections for generators to be run in parallel are made is shown in Fig. 3. These connections are similar to Fig. 2 with the exception of the voltmeter, the voltmeter wiring being so arranged that by means of the switch M, the voltage of each dynamo may be indicated by the same voltmeter. This is necessary, however, only when building the voltage of the second dynamo after the first has been running. The equalizing connection shown is for the purpose of maintaining equal voltage at the two dynamos and is employed when com-

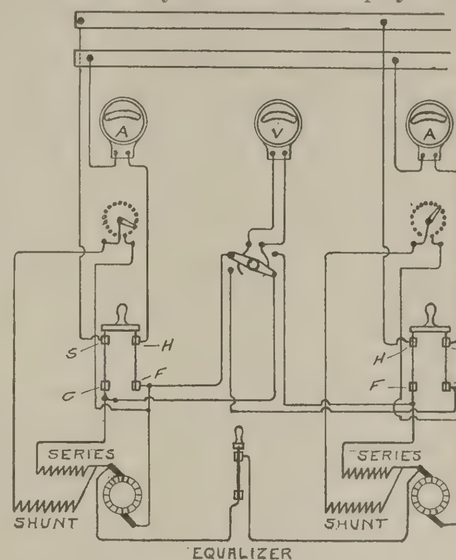


Fig. 3. Wiring Diagram for Two Machines in Parallel.

pound wound generators or dynamos are used. To parallel two machines as show in Fig. 3, proceed as follows: After the dynamos have been started and are running steadily at their normal and rated speed, by means of the right hand rheostat build up the voltage to the desired point and close the right hand dynamo switch, then close enough lighting circuit switches to place a fair load on the dynamo as indicated by the ameter A. By means of the left hand rheostat and alternately shifting the voltmeter switch make the voltage of the left hand dynamo exactly equal to that of the other, then close the equalizer switch and the left hand dynamo switch watching the ameter A, which should at once take part or about half of the load, the two ameters indicating about the same. The remaining lighting and power circuit switches may be closed and the load equalized by moving the arms on the rheostat.

When a shunt wound generator is being operated, the starting should be as follows: Run the generator for a time at low speed without load and with all switches open. Go over the machine carefully and study it mechanically, seeing that it runs smooth, and all oil gauges show the proper amount of oil. If everything is satisfactory cut in all of the field resistance and close the field switch, then gradually bring the machine up to the required speed and also adjust for proper voltage. Set the brushes at a point where there is no sparking, put in the circuit breaker and the main switch and bring the load on gradually, adjusting the field rheostat to balance the drop in the voltage due to the increase of the load. If the dynamo or generator does not build up, it has either lost its residual magnetism or the fields are not connected properly to the armature leads. Disconnect the field, and separately excite for a few minutes to bring up the voltage, then reconnect. If it will not then build up, reverse the field connections to the armature.

Southern N. E. L. A. News.

Annual Convention of Mississippi Electric Association.

The third annual convention of the Mississippi Electric Association held at Gulfport, Miss., June 20 to 23, established a record for this organization. Over 100 members and guests of the association spent the entire time of the three days, in one continuous round of enthusiastic business sessions interspersed with pleasure in such a way as to bring genuine satisfaction to all and make the convention one to be remembered. The past history of the Mississippi Electric Association is brief. The annual conventions, although characterised by enthusiasm on the part of those who were the back-bone of the movement have never before been held under so successful circumstances where it was evident that all were working for the one purpose, namely, to bring all the central stations in Mississippi together, each to co-operate with the other and build up an organization characteristic of the field in which the various stations are working. The first convention was held at Jackson, Miss., in 1909, attended by only 15 members and a lack of enthusiasm was noticeable. The second convention at Greenville, Miss., was attended by over 60 members and the good work done during the time between these two conventions, in the short space of only one year, was evidenced by the enthusiasm of all in the work. At Gulfport this year, this spirit has spread to such an extent that it had taken others into its grip and the result is that the association has a flying start. Its present benefits and future influence is keenly felt by every station which it represents, a number now including over 50 per cent of the private electric companies of the state.

The selection of Gulfport as the meeting place for the convention proved a wise one from many standpoints. Gulfport is one of the growing young towns in Mississippi, it is the home of one of the most progressive central stations of the association, and has accommodations suited for a convention of large size, rivaled by no other place of its size in Mississippi or the South. The Great Southern Hotel was the official headquarters, which with its 250 spacious and elegantly furnished rooms, the majority of them facing the salt water and recieving the refreshing breezes coming directly from the Gulf, made it a delightful place. Besides these natural conditions, making it a good convention place, was added the benefits to be derived by guests at a place of this nature, through a management experienced in serving the public, a qualification always appreciated by a gathering of public utility men. The general manager, W. N. Driver, of the Great Southern Hotel, gave the convention his entire attention, creating a feeling of friendliness, the impression of which on all the members is ably expressed in the resolutions adopted and appearing elsewhere in this issue. Much of the social success of the occasion was due to the enthusiasm injected by this genial host who is a past-master in handling large crowds and making all feel at home.

All of the sessions of the conventions were held at the hotel, which was splendidly decorated for the occasion. Upon approaching the spacious front entrance a cordial greeting was presented through a sign made up of large letters and reading "Welcome Mississippi Electric Association." The entire lower floor was one blaze of beautiful colors, gaily colored bunting being draped gracefully so as to catch the gentle breezes coming in across the Gulf. Red, white and blue were the colors predominating. Across the lobby, a sign, "Greeting Live Wires" was a further appropriate and hospitable welcome. The magnificent dining room was also handsomely decorated and contributed its share to the attractiveness of the place. The unique Rose Trellis Garden was set aside for holding the sessions. This garden overlooked the waters of the Gulf and was an excellent place to carry on the work of the convention.

FIRST SESSION.

The convention was formally opened Tuesday morning at 10 o'clock by an address of welcome delivered by Judge J. H. Neville of Gulfport. Since the president of the association Mr. S. W. Greenland of Columbus, Miss., had been called to other fields of activity and unable to be present at the convention, the vice-president Mr. Jack Abbott presided and introduced the speaker. Mr. Neville said in part as follows: "I deem myself particularly honored in having been invited to deliver an address of welcome to what we regard the best city east of the Mississippi and indeed in the South. You are all business men and you have come here to transact business, I am sure of this from reading your program. Let me say therefore that there is not a more ideal place to transact your business than in this delightful city of Gulfport and I want you to feel that you are welcome to our city. Fourteen years ago there were but three houses in this city and today we have a splendid electrical system, one of the best hotels in the United States and all other necessary improvements. I have been looking forward to this meeting since January last and now I say to you, our city is open, all you have to do is to walk in and take possession." Mr. Jack Abbott, of Jackson, Miss., responded to the address of welcome in an able manner. After this response several announcements were made and the members retired to an executive meeting.

SECOND SESSION.

The second session was opened Tuesday afternoon at 2 o'clock by the reading of a paper on, "The Relation of Employees to Company and Public," by Mr. A. B. Paterson, of Meridian, Miss. On account of the fact that Mr. Patterson was unavoidably detained, Mr. Knight of Meridian presented his paper, an abstract of which is as follows: Mr. Paterson stated in his paper that upon analyzing the subject, it suggested, first, the relation of the employee to the company. It is assumed that the party entering the service of the Public Service Corporation has first given thought to the possible future and has decided that the prospects are bright, providing he is successful in rendering satisfactory services. The question then comes up as to what satisfactory service is and how it should be rendered. Satisfactory service means, first, loyalty to the company; second, a thorough knowledge of duties and the diligent application to same; third, sufficient interest in the operation of the company to inform other departments of deficiencies of service and if necessary assist them in correcting such. Further, there should be no hesitancy in making suggestions of any kind that would further the best interests of the company.

The employee should remember that from the company he is receiving his livelihood and that upon the company's prosperity, depends his. He should analyze his position and immediately begin to improve along the lines in which he is most deficient. Each employee should have a thorough knowledge of the conditions of the company franchises, of the city code, of what a corporation consists and its proper position with reference to the public.

The second subject taken up by Mr. Paterson is the relation of the employee to the public. In this connection, he stated that it is particularly important that every employee from the office boy to the President should realize this fact and regulate his conduct accordingly, namely that each one owes his employment to the public. The company has been granted the privilege to perform an essential service from which its stockholders eventually expect interest on their investment. The antiquated idea that public sentiment can be disregarded or in any manner overlooked has long been out-grown.

It is therefore, essential that a study be made of the question of how to best administer to requests of the public and then adopt such measures as will accomplish the most satisfactory results. Some of the important duties which would tend to maintain friendly relations are as follows: 1. The pleasant reception of complaints; 2. the prompt handling of complaints; 3. The satisfactory adjustment of all complaints; 4. The true statement as to the cause of any deficiencies and when same can be remedied; 5. Polite and intelligent replies to all inquiries. In conclusion the employees duty to his company should be loyalty and competence diligently applied which would mean satisfactory service rendered to the company. His relation to the public should be such that it will place the corporation which he represents in a better light with the public, and in so doing, will be a man most valuable to his employer.

The following members took part in the discussion following the reading of the paper, bringing out many interesting points in regard to the policy of their respective companies and the methods which they pursue to create a better feeling between the utility company, and the public. Mr. W. H. Gorenflo of Gulfport; Mr. W. B. Moorman of Vicksburg, Miss; Mr. C. S. Stephens of Hattiesburg; Mr. W. G. Clark of Jackson; Mr. W. R. Herstein of Memphis, Tenn.; Mr. Henry Crittenden of Greenville, Miss.; Mr. Percy Sterns of New Orleans, La.; Mr. I. H. McArthur of Meridian; and Mr. Jack Abbott of Jackson.

Mr. Gurenflo of Gulfport stated that the railway commission had supervision in his territory and as far as the city council and city authorities were concerned, the number of the difficulties which other public service corporations met with, did not come up. However, all complaints were carefully investigated and every measure was adopted to correct any mistakes or avoid any friction with the people using contral station service. Other discussions brought out the feeling that too careful attention to complaints cannot be given and that an investigation and remedy should be made in those cases where the company is at fault. In those cases where the public may be at fault, a compromise should be effected in a friendly way, always aiming at securing public friendship rather than enmity. Mr. Stephens of Hattiesburg mentioned the fact that a commission form of government was in operation at his city and that the workings of his corporation with the municipal authorities were pleasant. Mr. Crittenden of Greenville, Miss., stated that his company had an inspector who tended to all cases of accident, getting all information possible and reporting same. Everything possible was then done to remedy the matter with those concerned. He further stated that a solution of all problems arising was always pushed to a satisfactory end due to the fact that the company realizes it is living by the public and desires the public to realize the true state of conditions. Mr. I. H. McArthur of Meridian advised that careful attention be given to all accidents and everything done to keep complaints out of court. An attorney was employed for this purpose by his company and reports were turned over to him promptly as they came in and all matters settled by compromise in the easiest way possible. Mr. Jack Abbott brought out the fact that in a number of towns a certain class of lawyers desire to take up cases against corporations. He stated that it was their policy to keep down accidents and insist on employees being polite and careful under all circumstances, endeavoring to bring this about by securing efficient men. He advised that the only method of keeping good relations between public and company was to maintain eternal vigilance, training the men to appreciate the conditions and treat the public with courtesy.

The next paper on electric heating devices from the viewpoint of the central station was prepared by H. G. Mauger of the General Electric Company and delivered by Mr. L. Callender of Atlanta, Ga. The following is an abstract of Mr. Mauger's paper: Through this paper, the author advised an enthusiastic exploitation of electric heating devices, stating that the bulk of heating device revenue comes from the residence customer, and will thus develop the residence business. Statistics show that residence business has been neglected, not more than 15 per cent of the residences in the United States within reach of a Central Station service are connected. The author advises house wiring campaigns, on the installment plan and in co-operation with the electrical contractors, stating instances where such had been very effective. In referring to the popularity of the electrical flat iron, Mr. Mauger advised the sale of the small disc stove and coffee percolators, as such among the other devices, makes an attractive income of diversified load factor. Further the progressive Central Station man realizes that the more cords by which he can bind the public to him, the more indispensable his organization becomes to the community.

Among the electrical devices that have special application in the South is the electric radiator. Two lamp luminous radiators are now available, taking 500 watts, which will fill the need of Mississippi climate in winter.

As to the amount of money that can be profitably spent for this new business getting, it was stated that 5 per cent of the gross annual income has often been well spent, half being spent for salaries and commissions to personal and the balance for the various kinds of advertising and publicity. Further some Central Stations spend from $1.00 to $2.00 to secure business which will earn $4.00 gross per year. The author advised selling devices at a profit.

The means for effecting the production of current consuming devices may be classified as follows: Personal solicitation; show room display; private demonstrations; public demonstrations; display advertising; solicitation by letter.

The decision of this paper was spirited, showing considerable interest on the part of everyone concerned. The following advanced suggestions: Mr. S. M. Jones of Laurel; Mr. A. H. Jones of McComb City; Mr. D. H. Braymer of Atlanta, Ga.; Mr. L. Callender of Atlanta Ga.; Mr. O. A. Acuff of Meridian; Mr. W. B. Moorman of Vicksburg, Miss.; Mr. W. F. Gorenflo of Gulfport; Mr. Jack Abbott of Jackson; Mr. A. W. Starliper of New Orleans and Prof. C. E. Reed of the A. & M. College.

Mr. S. M. Jones stated that in Laurel some effort had been made to introduce flat irons. No public demonstration had been made and the work had been done only through personal solicitation with some newspaper and circular advertising along with monthly bills. While the percentage of people using flat irons was not large, about 50 or 60 customers had them installed. The irons are sold practically at cost. He stated that the first cost of the iron and especially stoves seemed to prevent placing them in numbers. He therefore expressed the desire that the prices on these devices be somewhat lowered. Mr. A. H. Jones stated that he was very optimistic over the future of electric heating devices in McComb City where there was no gas. He stated that about 80 per cent of his customers have an electric iron. He also referred to the high prices stating that such prevented the general introduction. The devices which have been most popular in McComb are the flat iron, toaster, and coffee percolator. Recently disk stoves have been introduced and some of the larger sizes. The stoves are often placed on approval and if satisfactory the customer allowed to pay for these on the installment plan. Mr. Jones stated that the city schools had established a domestic science department and the electric cooking proposition was active. For a two disk stove seperate meters are put in and a separate rate is given. Mr. Callender of Atlanta, in answer to Mr. Abbott regarding the best selling heating devices, stated that the disk stove and toaster were about on a par where the coffee percolator and chafing dish came next. The flat iron of course being classed first as the best selling device. Mr. Moorman stated that although he was operating in a gas town and making no special effort to push heating devices, flat irons were bringing good results. They were placed on trial at about 90 per cent of them are purchased. Sewing machine motors are also in use, these are being placed on trial the same as with irons. Mr. Gorenflo of Gulfport, stated that irons were taking very well while toasters could not be sold. Cooking devices were not being pushed on account of gas competition. He found it difficult to sell a toaster for $3.50 when the customer could buy a gas apparatus to do the same work at a much cheaper price. He stated that the company sells about two irons per week without any advertising. Mr. Callender of Atlanta stated that the rate on electric heating which he usually found among central stations was five cents per kw. hour. Some stations have a rate of four cents and others a rate of three, however, these rates include the usual range.

THIRD SESSION.

The third session was called to order Wednesday morning at 10 o'clock with Mr. Jack Abbott presiding. The paper scheduled in the program on, "The Economy of a 750 K. W. Engine," by Mr. D. R. Tomlinson was omitted, due to the fact that Mr. Tomlinson was unable to attend the convention. Instead of this paper, a lecture was given by Mr. H. W. Karstens of the Holophane Company. On account of the fact that a dark room was required to bring out features of this lecture, it was held at 4 o'clock Wednesday afternoon.

Steam Turbines formed the subject of an exhaustive paper presented by Edmund Dreyfus of the Westinghouse Machine Company. An abstract of this paper is as follows: The national trend toward establishing efficient systems in our industries, first became noticeable among the larger stations. We now see, however, the smaller stations being governed likewise by this far reaching influence. Our present need in regard to prime movers which especially brings into light the values of the steam turbines involve, (1) The most direct conversion of available energy into effective power, eliminating all possible working parts and wearing surfaces which therefor induce (a) Minimum attendance and supervision; (b) Least cost to supply and maintain; (c) Economy and convenience in space requirements.

The various classes of turbines are well understood, however it may be desirable to bring out some interesting facts in connection with various types. The commercial turbines built today belong to either of the so-called impulse or the reaction type or as in some cases combine features of both. There are obvious cases where it proves best to employ either reaction blading entirely, the straight impulse wheel or a proper combination of both types as hitherto noted. For large sizes, turbine records fairly indicate that the Parsons design has not only established the highest thermodyamic efficiencies but has also proven to be less subject to the deterioration in economy in continuous service.

Each of the various types of turbines have had their advocates and their predominance in some sections has been due to a great extent if not entirely to trade relations rather than to any real underlying merits of design. A fair impression may be had of their respective importance when a summation is made of the extent of turbine developments, both in this country and abroad. From statistics, we find there exists today approximately 14,220,000 horsepower of Parsons turbines and about 6,950,000 horsepower of all forms of a purely impulse turbine.

A new development which becomes of special interest is an impulse type of turbine designed for the generation of small power. It is mainly in this field that the greatest variation of working pressures are usually found, hence it is very important that the design admit of wide range of application and at the same time involve the least change in construction in order that it may be economically and commercially adapted to fluctuating requirments.

The low pressure turbine will undoubtedly be found a benefactor to the small reciprocating engine plant. In many of these stations the engines have been operated non-condensing for the reason that the expense in running condensing would scarcely be warranted in event of a small return effected. Since the turbine works so efficiently in the low pressure ranges, station operators may safely expect to improve their plant economies from 30 to 100 per cent. through installing the low pressure turbines to work on the exhaust of their engines. Generally the construction of the low pressure turbine differs in no wise from the complete expansion turbine only in that it omits the higher and intermediate pressure elements. Frequently electric stations find it profitable to also supply a heating load. This is found practicable and economical with the proper selection of a turbine.

After reading Mr. Dreyfus' paper, a number of illustrations were examined showing the various features of construction of turbines now in use. On account of the lack of time this paper was only briefly discussed.

The next paper taken up was, "The Necessity of a Commercial Department," by Mr. A. H. Jones of McComb City. An abstract of Mr. Jones' paper follows: The development of commercial activities in Miss., has been given but little attention. Most of the plants in the state started at a time when the commercial applications of electricity were but little understood and appreciated. The nature of the load in the early days was not as diversified as at present. Motors were little thought of, in fact, a day circuit was found in only the largest towns; flat irons, electrically heated cooking devices were unknown; residence, store and street lighting constituted the entire business. The entire time of the manager was devoted to plant operation and outside construction work. As time has passed, however, certain standards have been set and the customers' wants increased. The increase in uses of electricity has caused no decrease in the burdens on the manager, for if he is fully alive, he is well posted on operation, accounting, new business getting and the relationship between the company, the customer and the public generally. On account of these conditions, the manager is liable to neglect through necessity, the new business end of his duties. He will take what new business that comes to him but will not have time to wage an energetic campaign, to get all the business legitimately belonging to the company would take up his entire time. This condition exists today in all the larger towns in Mississippi. With one or two exceptions it is probably true that no consistent and successful new business campaigns have been undertaken in Mississippi. By this is meant that no such campaigns have been given the sole thought of an able aggressive commercial man.

The possibilities in any community have not been exhausted, it would therefore seem that there should be the courage and conviction to pursue the possibilities until they are captured, for when these are accomplished, other opportunities will present themselves so that an aggressive commercial department need have no fear of ever reaching the saturation point. Some of the latent possibilities that a good commercial department brings into active existence are: motors, flat irons, electric signs, cooking and heating appliances, especially where gas is not available. The commercial department enables the influence of the company to grow and creates a new impression of the purpose of the Public Utility. A review of conditions existing today suggests these thoughts: 1. our original organizations have outgrown their usefulness; 2. the stability of the business demands that additional sources of revenue be provided for two reasons; a, the enhancement of the earning capacity of the plant; b, the necessity of rendering to the public generally that service which we are morally bound to give by virtue of our friendly rights. 3. With the present organizations over burdened and necessitating changes there remains but to reorganize and in the reorganization, create a new department to have charge of all new business and the proper care and handling of the old business. 4, this new department should be known as the commercial department.

Mr. Jones' paper was discussed by the following members: Jack Abbott of Jackson; Henry Crittenden of Greenville; W. B. Moorman of Vicksburg; O. A. Acuff of Meridian; W. F. Gorenflo of Gulfport; S. M. Jones of Laurel; J. Jumonville of Hammonds, La.; E. E. Esslinger of Hattiesburg; and C. S. Stephens of Hattiesburg. Throughout the discussion, it was evident that the members were in sympathy with the creation of a new business department but were emphatic in stating that the proper relation should exist between the new business department and the organization. The new business manager should have entire charge of the new business department and should be the go-between for the public and the central station. He should be a man thoroughly familiar with all outside business and know where a profitable installation can be made. Mr. W. B. Moorman of Vicksburg, Miss., stated that it was his policy to maintain good relations between the station manager of the public utility company and the general contractors and architects. He found a great deal could be accomplished by maintaining cordial relations between these men, for a closer touch is made possible with buildings going up and getting figures on same so as to draw plans and designs with a view of installing wiring such as will accommodate all the needs of electricity. Mr. A. O. Acuff of Meridian stated that he found the commercial department a very good means of reaching all the people and learning the various complaints which arise. He also stated that a commercial department made of a representative, commercial manager and a service supervisor had an opportunity to do more work in retaining old business than if they were made up of just a contract agent. It was his belief that good feeling can be created among customers by commercial departments than any other way.

On account of the extension of the morning meeting long past the dinner hour and on account of the extensive work planned for the executive session on the afternoon of Wednesday, the paper on, "Economical Care and Maintenance of Street Cars" by Jack Abbott was not read. The paper however was delivered to the Secertary and an abstract of it is as follows: In considering this subject, rugged and durable equipment is considered and divided into three sections. Electrical equipment; mechanical equipment and car bodies, with the curtains, signs, etc. The equipment of a car hardest to maintaining, depends upon local conditions. In hot countries and along the coast, it is the bodies, in cities, with high grade, the electrical equipment. The mechanical equipment always needs attention; good lubrication must be secured, and the smallest gear and wheel wear looked to.

Mr. Abbott referred to details of maintenance on the system in Jackson, Miss., stating that for economical maintenance of electrical equipment, he had found it necessary to train motor men very carefully and thoroughly. New motor men are found very expensive, not only through rough handling of equipment but through accidents. Improper acceleration is the worst of all abuses, effecting every part of the equipment and car itself.

In conclusion, Mr. Abbott advised the following for economical maintenance: Adopt rails heavy enough to keep the track easily maintained, depending on the weight of car, for light single track cars 75 or 80 lbs. A. S. C. E. Section tee rail, continuous joints, creosote or cypress ties on straight track with white oak ties on curves with tie rods to keep the rails from spreading and the curve from creeping. Standardize all switches and turn-outs and allow no fast running over same. Standardize all equipment motors, car bodies, trucks, axles and miscellaneous equipment. The overhead trolley should be put up 18 or 19 feet above the track and perfectly aligned, with only enough tension on trolley pole to keep same in contact with the trolley. Trolley wire should not be stretched too tight, as it will last longer and be less liable to break when there are 6 or 8 inch sag between the spans. This will increase the life of the trolley wheels.

The keen interest shown in scientific illumination was noticeable at the interesting lecture delivered by Mr. H. W. Karstens, Southern representative of the Holophane Company. The demonstration by Mr. Carsten was most instructive as well as interesting as he touched in general on all illuminating problems, showing the part that the scientifically designed products of the Holophane Company have played in the work. Street lighting units and residence reflectors were taken up. The strong residence campaign which the company is carrying on was also explained and the artistic and scientific reflectors in their numerous forms designed for residence lighting shown. A new development in the commercial line of reflectors includes the steel reflector for industrial lighting. This reflector shows high efficiency as compared with the more expensive and elaborate glass designs. Mr. Karston took up in detail the strong co-operative sales policy which the Holophane Co. maintains in connection with their scientific system of illumination together with their educational lectures and demonstrations to promote a higher standard of illumination among all who use electric light. Another interesting feature brought out was the manner in which the company takes care of the artistic side of illumination. An architectural department is maintained which co-operates with architects in designing lighting systems so as to harmonize with the particular structure in which the systems are installed.

QUESTION BOX.

A valuable benefit of the association work between times of conventions is brought about through the creation of a Question Box conducted in the interest of members. The routine of this department is something as follows: Questions on subjects of interest or upon which other companies desire information from members are sent to an appointed editor who compiles and distributes them in simple form to each member. The members then send in individual answers to the editor who again compiles and distributes the complete list of answers. It is the plan of the department to send out a list of questions each month and follow these by the answers, endeavoring to distribute questions the first of the month and answers the last of the month.

The members have taken considerable interest in the Question Box and the present editor, Prof. C. E. Reed, of the A. & M. College reports as follows: Three sets of questions have been distributed since the starting of the department and up to the time of the convention. In these three sets 17 questions were of a general nature on technical subjects and 72 answers were received. Ten questions took up features of policy and subjects of special interest to the management of stations. Answers to the first set of 5 questions falling in this class have numbered 19. It will be seen therefore that considering the fact that the work is not fairly organized, it is progressing in a favorable way from points of interest and value.

OFFICERS FOR 1911-1912.

At the executive session on Wednesday the officers for 1911 and 1912 were elected as follows: President, Jack Abbott, general superintendent of the Jackson Railway and Light Company; Vice-President, R. B. Claggett of

MEMBERS AND GUESTS ATTENDING MISSISSIPPI ELECTRIC ASSOCIATION CONVENTION.

Greenville, secretary and treasurer of the Delta Light and Power Co.; Secretary and Treasurer, A. H. Jones of McComb, general manager of the McComb City Light and Power Co.

Executive Committee: The above officers and W. F. Gorenflo, general manager of the G. & M. C. T. C., Gulfport; W. B. Moorman of Vicksburg, C. Z. Stevens of Hattiesburg; S. M. Jones of Laurel.

ENTERTAINMENTS.

The entertainment features were carefully planned and every detail well executed. On Tuesday afternoon the first day of the convention, the ladies were given a sight seeing trip through Gulfport. In the evening a reception and dance was given at 8 o'clock. This function was attended by all of the members and guests and greatly enjoyed.

On Wednesday afternoon, the second day of the convention, a sight seeing ride over the interurban system of the Gulfport and Mississippi Coast Traction Co., was enjoyed. The car started from the offices of the company at Gulfport going to Biloxi and stopping at the old home of Jefferson Davis. The party was ushered through the grounds and buildings, the history of this noteworthy place being explained. The trip was supervised personally by general manager W. F. Gorenflo of the Gulfport and Mississippi Coast Traction Company.

At 8 o'clock on Wednesday evening one of the most important and enjoyable social events was ushered into the program in the form of an elaborate banquet. The banquet was characterized by orchestra music and the best of congenial spirits among the 100 diners seated at one long table in the form of a cross. Judge J. H. Neville acted as toastmaster in an able manner. Toasts were responded to as follows: "Our Booster" by Oscar C. Turner of the Southern Wesco Supply Co., of Birmingham; "The Trusts" by H. F. Cameron, Manager of the Westinghouse Electric & Mfg. Co. of New Orleans; "The Real Trust Buster" by Percy Sterns of the Interstate Electric Co. New Orleans, La.; "What the A. & M. College is doing for the Electrical Interests of the State" by Prof. C. E. Reed of the A. & M. College; "Our Town" by Mr. Jack Abbott of the Jackson Railway & Light Co., Jackson, Miss.; "How He Does the Public" by W. R. Herstein of the Electric Supply Co., Memphis, Tenn; "The Atlanta Spirit" by D. H. Braymer, Editor of Southern Electrician, Atlanta, Ga.; "The Development of the Interurban Traffic" by A. Jones of McComb City Light & Power Co., McComb, Miss.; "The Ladies, God Bless Them" by C. Robert Churchill of the Electric Appliance Company of New Orleans; "Our Host" by W. F. Gorenflo of the Gulfport & Mississippi Coast Traction Co., Gulfport. The toasts were all of an original nature and exceedingly enjoyed by all those present.

It is most essential to state that this elaborate banquet was a complimentary one tendered the Mississippi Electrical Association by the following Southern Electrical jobbers. The Southern Wesco Supply Company of Birmingham, Ala., through Oscar C. Turner, president; The Electrical Appliance Company of New Orleans, La., through Mr. C. Robert Churchill, president; The Interstate Electric Company, Ltd., New Orleans, La., through Mr. Percy Stern, general manager; The Electrical Supply Company of Memphis, Tenn., through Mr. W. R. Herstein, secretary and treasurer. These companies are well known among central stations in the South, being actively engaged in the supply business in the operating territory of these companies.

The Southern-Wesco Supply Company is the youngest of the electrical jobbing houses of the South. This Company was organized only a few years ago in Birmingham, Ala., and is composed of Southern men catering to the desires of the southern electrical public, their record being so far one of continued successes. The officers of the Southern-Wesco Supply Company are: Oscar C. Turner, President; Roger V. Scudder, vice-president; Wm. M. Bowles, secretary; Jno. D. Turner, Jr., treasurer. The Company travels the states of Mississippi, Alabama, Georgia, Florida, North and South Carolina, Tennessee and Kentucky, and is represented by Mr. T. U. Nenon, F. P. Jeter, C. W. Burney and A. H. Shirley.

The Company carries a large stock of telephones in their warehouse and caters especially to the farmer line telephone business. Besides this, they are general agents and handle Wesco transformers, Sangamo meters, Triumph motors, Peerless incandescent lamps, Hazard and Waclark wire and cables, Holophane glassware, Wesco telephones, Wesco tape, Emerson, Trojan, Peerless and Wesco fan motors, Electra carbons, Red Shield, Automobile, and Columbia igniter dry batteries, American Electric Heater Company, Adams Bagnall Electric Company, Bryant and Perkins Electric Company, and Crouse Hinds Co. products, Wagner motors and many other lines.

The Electric Appliance Company (of New Orleans), of which Mr. C. Robert Churchill is president and general manager, is a branch house of the Electric Appliance Company of Chicago, one of the largest electrical supply houses in the country. This company covers the following Southern states: Louisiana, Mississippi, Alabama, Southwest Georgia, and Western Florida. Mr. Churchill has as his assistant manager, Mr. Davis, McMakin, formerly manager of the Dallas house of the above company and the following traveling men: H. C. Russell, who covers Florida; J. B. King, covering Mississippi; Edward Haspel covering Louisiana; Maurice W. Thomas, covering temporarily portions of Mississippi and Alabama; William F. Levison covering Alabama; Henry C. Vesy covering the New Orleans trade.

The company acts as general agents and carries in New Orleans extensive stocks for the Phillips Insulated Wire Co., Wagner Electric Mfg. Co., Indiana Rubber and Insulated Wire Co., Sangamo Elec. Co., Packard Electric Co., New York & Ohio Co., Adams Bagnall Electric Co., Bryant Electric Co., Perkins Electric Switch Mfg. Co., Nungesser Electric Battery Co., Crouse Hinds Co., American Electric Heater Co., and Thomas & Betts Co.

The Electric Appliance Company of New Orleans, is the outgrowth of a small electrical contracting business started by Mr. Churchill some twelve years ago. He was well known to the electrical trade before the organization of the company which he now heads, establishing in the early history of his business a reputation for straight-forwardness and honesty in his dealings, which has characterized him in all his movements. He is well known among the electrical men of the South and other sections. He is also well known in other directions, especially in connection with the National Guard, he being the Assistant Adjutant-General of the State of Louisiana. Unlike many electrical supply houses located in the South, neither Mr. Churchill nor any of his associates have any connection with any electrical contracting business, other than the actual selling of goods. Mr. Churchill is a firm believer in keeping to a particular line of business, the contracting business for the contractor, the engineering business for the the engineer. "Live and let live" he says, and this has proven of benefit to his house.

The Interstate Electric Company, Ltd., of New Orleans, La., was organized in 1903 and is now one of the largest electrical supply houses in the South. Besides the regular electrical supply business handled by this company, it also has a fixture department in which is carried a large assortment of electric and combination gas and electric fixtures. Automobile and gas engine ignition supplies are also carried. The Interstate Electric Company acts as Southern distributors for the following manufacturers: The Columbia Incandescent Lamp Co., Emerson Electric Manufacturing Co., Duncan Electric Manufacturing Co., Pittsburg Transformer Co., Crescent Insulated Wire & Cable Co., Benedict & Burnham Manufacturing Co., American Electrical Heater Co., C. S. Knowles, K. W. Ignition Co., National Carbon Co., Diehl Manufacturing Co., Century Electric Co.

The officers of the Company are as follows: Chas. Weinberger, president; Percival Stern, general manager; Edward Jumonville, secretary-treasurer; F. B. Stern, assistant manager.

The sales organization is composed of a number of traveling representatives covering the states of Georgia, Florida, Mississippi, Louisiana, Texas, Oklahoma, Arkansas and Tennessee. These men are as follows: I. L. Conaway, Walter T. Spranley, S. A. Williams, Charles Jumonville, F. Walker, C. J. Clossman, William T. Spranley, P. Hogan, M. J. Elgutter, F. K. Levy, A. A. Levy, L. L. Hirsch, S. R. Yundt, L. J. Kitziger.

The Electric Supply Company of which Mr. W. R. Herstein is general manager, operates in the States of Kentucky, Tennessee, Alabama, Mississippi, Louisiana, Arkansas and Missouri. This Company is engaged in the jobbing business exclusively, doing no retail or contracting business and enjoys a large and growing business in its chosen territory. It is owned and managed by Southern people and can be said to be "growing up with the country."

The Company issues an attractive catalogue and is represented by the following traveling salesmen: Mr. E. W. Frye, located at Birmingham, Ala., covering Alabama, East Tennessee and Middle Kentucky; Mr. T. B. Cabell, located at Jackson, Miss., covering Mississippi and Louisiana; Mr. W. Kleinschmidt, located at Little Rock, Ark., covering Arkansas and Missouri, and Mr. C. B. Rutledge, located at Memphis, covering territory in Arkansas, Mississippi, Tennessee and Kentucky contiguous to Memphis; C. J. Watson, Jr., city salesman for Memphis.

Among the manufacturers for whose products the Electric Supply Company is general Southern distributor may be mentioned the General Electric Company, Fort Wayne Electric Works, Phillips Insulated Wire Company, National Carbon Company, Indiana Steel and Wire Company, as well as the majority of the standard manufacturers of electric wiring and telephone material.

The final social event of the convention was a trip by boat to Ship Island on Thursday morning. The boat left at 10 o'clock and nearly the whole day was spent at the island. Excellent music was provided on the boat and bathing enjoyed at the Island.

RESOLUTIONS.

As an expression of the Association's feeling towards Gulfport and those who extended the many pleasures and courtesies during the convention, resolutions were read and unanimously adopted in executive session.

At this executive meeting it was voted to make SOUTHERN ELECTRICIAN the official organ of the Association.

Considering all in all the convention was more successful than anyone had anticipated and the benefits derived were all that could be hoped for. The choice of meeting place for the next convention was not determined at this meeting, it being the custom of the association to decide the meeting place at an executive meeting held some time the first of the year.

The New President.

In electing Mr. Jack Abbott as president of the Mississippi Electric Association, a recognition was extended to not only one of the ablest electrical engineers among its members, but to a central station man who has proven himself able in more ways than one. Mr. Abbott is a man who has come to be known through the many successful connections with Southern central station plants and from features in connection with these plants which are the result of his own initiative and thorough understanding of electrical power plant engineering.

MR. JACK ABBOTT, PRESIDENT
MISSISSIPPI ELECTRIC ASSOCIATION.

Mr. Abbott was born in Chickasaw County, Mississippi, November 29th, 1872. He received his early education at the Barton Academy, Mobile, Ala., and attended the University of Alabama during 1889 to 1893, graduating with the degree of M. E. in the last year named. After graduation he accepted the position as engineer of the light and power company at Tuscaloosa, Ala., where he remained from 1894 to 1896. After leaving Tuscaloosa, Mr. Abbott became superintendent of the light and water works at Okolona, Miss., and remained there one year, leaving to take a position as chief engineer of the Natchez Light & Power Company where he remained until 1898. He then entered Cornell University as a student, taking special work during the years 1899 to 1900. After receiving an advanced degree from this institution, he accepted the position as superintendent of the Ruston Light & Water Works, at Ruston, La., holding this position until 1892. During 1903

Mr. Abbott designed and erected the interurban road between Moss Point and Pascagoula. He then became connected with the Westinghouse Electric & Manufacturing Company at Pitsburg, remaining there from 1903 to 1905 in the turbine testing department of the Westinghouse Machine Company. He was called from this position to design and erect the Lake Charles, Louisiana Railway & Light Plant and in 1906 to ebuild the railway and light plant at Jackson, Tenn. In 1907 he was connected with the Interurban Railway connecting Sheffield, Tuscumbia and Florence, holding the position as chief engineer. In 1908 he was engaged again in reconstruction work and during the next two years rebuilt the railway and light plant at Jackson, Miss. At the present time he is general superintendent of the Jackson Railway & Light Company having entire charge of the system of this company.

Mr. Abbott has been connected with the association in official capacity since its organization, and his influence has been felt in the rapid progress which it has made in extending its membership and bringing together the central station men of Mississippi. With the association handed over to him in a growing condition, it is certain that with his wide acquaintance and organizing ability, it will continue along its present lines of rapid development.

Mr. A. H. Jones, who was re-elected secretary and treasurer of the Association, was born at Charleston, Mass., January 28th, 1881. He attended the Malden High School at Malden, Mass., graduating from there in 1896 and entering the employ of a large insurance agency in Boston, where he remained for two years. In 1908 he entered the Massachusetts Nautical Training School and graduated from the engineering department in 1899. In February of 1900 he entered the testing department of the General Electric Company, where he remained until September, 1902. He was then transferred to the Lynn works, and in December, 1902, was again transferred to the Atlanta office with headquarters in New Orleans. Mr. Jones was apparatus and supply salesman while in Atlanta, traveling in Mississippi and Louisiana. In June, 1894, he was given the special meter and arc lamp work in the Southern district, having charge of this work until November, 1904, when he resigned and came to McComb, Miss., as superintendent of the McComb City Electric Light & Power Plant. In June, 1905, the McComb City Electric Light & Power Company was organized to take over the old plant of McComb, and Mr. Jones was elected general manager. This position he now holds.

Mr. Jones married Miss Bridges, of Bridges, Miss., and has two children. He is interested in Masonry and has taken the successive degrees, belonging to the Blue Lodge, Chapter, Council, Commandery and Shrine. He is also an Elk and Pythian.

Besides the active connection with the McComb City Electric Light & Power Company, Mr. Jones is superintendent of telephone with the Liberty White Railway Company at McComb and member of the membership committee of the National Electric Light Association. As past secretary of the Mississippi Electric Association Mr. Jones has given his undivided attention to its progress and has been connected with eevrything that has made it a success. His re-election is significant of the value of his services, not only as a promoter of the good work of the association, but as an inspirer to others in being a personal representative of all that the Association stands for.

Large Rejuvenation of the Sons of Jove at Atlanta.

At the time this issue goes to press, plans are nearly perfected for holding in Atlanta, Ga., one of the largest rejuvenations ever held in the South. This rejuvenation is to be held on Tuesday, July 25th, and already nearly fifty candidates have been registered and will be given the oath of the order at that time. Among these candidates are practically all the division managers of the leading manufacturing and public service companies in Atlanta, as well as other representatives of local electrical interests.

After the rejuvenation, an elaborate banquet is planned to be held at the rooms of the Transportation Club, of Atlanta. Culpepper Exum, of Birmingham, Ala., will preside as toast master at the banquet and will be accompanied to Atlanta by A. H. Ford, president of the Birmingham Railway Light & Power Company, and Oscar C. Turner, past Jupiter, and president, of the Southern Wesco Supply Co. A complete report of the rejuvenation will appear in the September issue of SOUTHERN ELECTRICIAN.

The successful aspect which the rejuvenation now has is due to untiring efforts on the part of L. S. Montgomery, Jovian statesman for Georgia, and Southern representative of the National Metal Molding Company. Through his wide acquaintance, and by his enthusiasm both for the success of the order as well as all other electrical affairs, he has been most successful in enlisting principally all of the influential electrical men of the city of Atlanta, who will both benefit the order and be benefited by it.

Advanced Study in Electrical Engineering at the Massachusetts Institute of Technology.

The recently completed year at the Massachusetts Institute of Technology has found the graduate study which is provided in electrical engineering with an increasing number of students. Professor Jackson's lectures on the Organization and Administration of Public Service Companies were attended by a class of twelve graduate students and Professor Pender's lectures on Advanced Alternating Currents and the Transmission of Power were attended by an even larger number of graduate students. Professor Wickenden's advanced course in the Design of Central Stations and Distribution Systems has also been in demand.

Besides graduating the largest class from the undergraduate course which the Institute of Technology has heretofore graduated in electrical engineering, one degree of Doctor of Engineering and four degrees of Master of Science were conferred on men taking their major work in electrical engineering. The applicants for permission to become candidates for advanced degrees in electrical engineering are already more numerous than they were last year, and particularly is this true in respect to graduate students who intend to study the problems of electric railroads, electric transmission of power and the organization and management of public service companies.

Mean upper hemi-spherical candle-power is the average candle-power given by a source above the horizontal. The sum of the upper and lower hemispherical candle-power divided by two is equal to the mean spherical candle-power.

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.

SINGLE-PHASE INDUCTION MOTOR.

Editor Southern Electrician:

(233.) Kindly explain in the question and answer columns the inter-actions of main and starting coils used in single-phase induction motors of those types where the starting coils are cut out of circuit when full speed is reached. Also kindly advise if there is a practical method of varying or regulating the speed of these motors electrically? W. C. B.

OPERATING FEATURES OF POTENTIAL REGULATORS.

Editor Southern Electrician:

(234.) Kindly publish a diagram of electrical connections and explain the features of operation of the motor operated polyphase induction regulator. In what sizes are these regulators built and what are the practical working limits? What are the principles of operation of the polyphase regulator that differ from those of the single-phase regulator? A. T.

DESIGN OF TRANSMISSION SYSTEMS.

Editor Southern Electrician:

(235.) Kindly publish information from your readers connected with high tension transmission lines in regard to the following topics: What are the features of advantage of equilateral triangular spacing of circuits over the right-angle triangular or the vertical arrangements, other than appearance of line? What seems to be the general practice on Southern systems, to install transmission lines according to a certain system of sag, or to draw them taut regardless of location and temperature conditions? If any experience has been had with illuminum wire, kindly outline the economical and engineering advantages? H. D. A.

DELTA VS. Y CONNECTIONS.

Editor Southern Electrician:

(236). The writer would appreciate advice as to the generally preferred connection for a polyphase 60-cycle motor load where three single-phase transformers are to be used, the delta primary and secondary or the Y primary and secondary connection. When connected in Y, does each transformer coil carry more current than in delta to deliver same power? It would appear from the delta connections that each transformer gets full line voltage on primary and also delivers on secondary the voltage of motor circuit. In Y however, the primary of each transformer receives $1/\sqrt{3}$ times line voltage and the secondary delivers only $1/\sqrt{3}$ of the motor voltage. Is this reasoning correct? A. H. J.

POWER FACTOR OF INDUCTION MOTOR WITH CHANGES OF FREQUENCY OR VOLTAGE.

Editor Southern Electrician:

(237). I would like to know if the same results would be obtained as far as power factor of an induction motor is concerned, if it be operated on a higher frequency or on a lower voltage than that for which it is designed. I am informed that the power factor will be increased when operated on a higher frequency and also if on the lower voltage, it being lowered if the reverse of conditions is followed. If this is true, kindly explain the reasons. S. A. R.

TESTING AUTO-TRUCK ENGINES.

Editor Southern Electrician:

(238.) I desire to test a 4-cylinder auto-truck motor. Will have to run a 10-hour test at maximum load and know at all times the power developed. The motors are 35- and 40-horsepower. Kindly indicate the best method to use. I have a 220-volt direct current generator at my disposal, and ask if a lamp load would be advisable. How about a water-box load and what size must it be to place full load on engine? Give details of test and data that is required to compute efficiency and capacity. Also give diagram of electrical connections. C. F. B.

RESIDENCE LIGHTING CIRCUITS.

Editor Southern Electrician:

(239). I would like to see a diagram for a set of three way switches operating a hall light and the entire system of circuits controlled by a master switch. H. B.

Distribution Systems, Answer to Question No. 202.

The best system of distribution and transmission for the load mentioned consisting of office and factory lighting for 15 buildings and 100 horsepower, would be to run separate circuits, either two-phase or three-phase at 2,200 volts, one circuit to be used for the lighting load and one for the power load. This also gives the advantage of a spare circuit which can be used for both purposes in case of a break down. If the motor load is of a fluctuating character, it would produce bad results in the lighting circuit if both loads were taken from the same feeder. The factory can be run with 2,200 volt induction motors, requiring no transformers, and if direct current is needed for any special purpose it can be supplied by a small dynamo.

Tube Illuminants vs. Incandescents, Ans. Ques. No. 219.

The advantage of using large units over small ones in any system of lighting is that the first cost of installation as well as the renewal cost is less with large units. For example a 25 watt tungsten lamp sells for 65 cents while a 100 watt lamp, four times as large is $1.45 which is considerably less in proportion. The same thing is true of lamps in general. Furthermore the larger units are in general more efficient and less trouble. On the other hand the advantage of the small unit is the better distribution which can be obtained as well as greater diffusion. The small units however, require more complicated and expensive wiring,

$+ \Phi) = \cos (30° - \Phi)$. This proves that Φ is not zero because as K is not unity the angles $30° + \Phi$ and $30° - \Phi$ will not be the same. Therefore if the readings are equal and the load is unbalanced, it shows that the power factor is not unity, as Mr. Chatfield has correctly stated in answer to No. 223.

Consideration of Power Factor in Ques. No. 205.

Referring to question No. 205 it appears to be a question of the measurement of power factor and not of power. G. W. B. does not state whether the load is single or three-phase motors, but if it is the latter we can safely assume that it is balanced. Using a single meter as Mr. Bates suggests we get the reading $P = EI \cos \Phi$, where E is the phase voltage and I the current, which can be measured with a voltmeter and ammeter. Transforming the equation we have $\cos \Phi = P/EI$. Thus we see that we can find the power factor by dividing the wattmeter reading by the product of the current and voltage. The voltmeter must be connected to the center of the Y just as the potential coil of the wattmeter is connected. It may be well to test all three phases this way and compare results.

If the load is balanced we can find the power factor by Mr. Hayward's method also. Transforming the equation $P = \sqrt{3}\ VI \cos \Phi$, we get $\cos \Phi = P/\sqrt{3}\ VI$. V is measured across the line, since it is the line voltage and not the phase voltage. We can also find the power factor from the wattmeter readings alone by the following equation: $\text{Cos}\ \Theta = 1/\sqrt{[1 + 3\ (1 - n/1 + n)^2]}$, where n is the quotient obtained by dividing the smaller reading by the larger one. The proof of this equation is too tedious to be included here.

Operation of Cooper-Hewitt Lamp.

Editor Southern Electrician:

In answer to question No. 222, signed C. C. P., will say that light is produced by the passage of an electric current through mercury vapor, the vapor being rendered luminescent by the current.

The greatest part of the resistance to the current at starting is between the vapor and the mercury cathode. Therefore, the tube is tilted, allowing a thin stream of mercury to connect the anode and cathode. When the tube is returned to its original position the stream of mercury is broken, forming the arc. This breaks down the cathode resistance, which does not reappear unless the current falls below a certain minimum value. In the latest type of lamp the cathode resistance is broken down by means of a high tension current produced by an induction coil in the lamp mechanism and the tube does not have to be tilted at starting. A Reader.

The Cooper-Hewitt Lamp, Answer Question No. 222.

Editor Southern Electrician:

Allow me to submit the following replies to questions noted in the June issue of the Southern Electrician, which I trust may be of value to the interested parties. Referring to Question No. 222, the production of light by means of the Cooper-Hewitt lamp is based upon the fact that the mercury vapor spectrum contains a relatively large amount of luminous energy. This is utilized in the above apparatus by vaporizing the mercury electrode and bringing it to a glow electrically. The light thus produced is, in accordance with the mercury spectrum, of a greenish blue, which prohibits preservation of color values, and hence is in many cases a serious objection to its use. It is necessary to tilt the tube in starting the lamp in order to allow the mercury to flow down to the anode, or "positive" terminal, and thus establish the electric circuit. Upon this being accomplished the tube is tilted back to its operating position, during which process the mercury circuit is broken and the arc thus formed at the moment of rupture vaporizes the mercury, after which it is kept luminous by virtue of the discharge passing through it.

3-Phase Power by Two Wattmeters, Ans. Ques. No. 223.

It is assumed that C. L. M. refers to two wattmeters connected in the usual manner for measuring power in three-phase circuits, that is, with the current coils of the meters in series, one with each of two legs of the system and with the respective potential coils connected between the corresponding leg and the third phase, as shown in Fig. 1. It can be proven that with algebraically equal readings

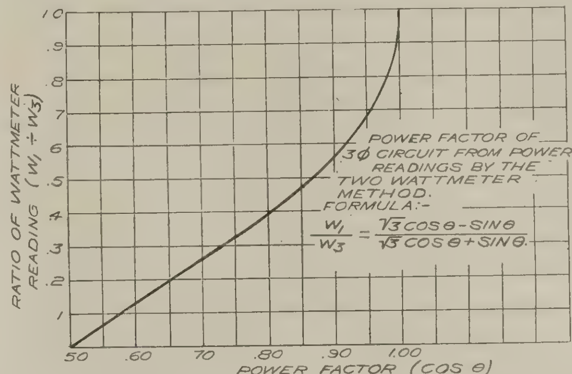


Fig. 1. Power Factor Curve, Above 50 Per Cent; for Below Read .4 P. F. Instead of .6 P. F., etc.

on the two instruments the power factor will be unity (100 per cent). This is based upon the fact that the ratio (W_1/W_2) of the readings of two wattmeters thus connected is:

$W_1/W_2 = (\sqrt{3}\ \text{Cos}\ \Theta - \text{Sin}\ \Theta)/(\sqrt{3}\ \text{Cos}\ \Theta + \text{Sin}\ \Theta)$. In this expression Θ is the angle of which the cosine expresses the value of the power factor of the system, that is the angle of lag between the current and voltage of the system.

The curve in Fig. 1 is plotted from assumed values of this lag angle Θ and affords a ready means of determining the power factor of any three-phase system from the two wattmeter readings, and without calculation. The proof of above formula is not presented as it was not considered essential in this case. C. C. Hoke.

Motor Connections, Answer Question No. 224.

Editor Southern Electrician:

Referring to question 224 in the June issue, I submit the following: For the 19 horsepower motor, the output = 19 H. P. × 746 = 14,174 watts. Assuming an efficiency of 85 per cent., which is safe enough, 14,174/.85 = 16,675 watts input. 16,675 watts/220 volts = 75.7 amps. A line from the source of supply to the motor should be provided of sufficient cross section to insure an emf of 220 volts at the motor when running at full load. As the emf generated is usually 230 volts, a 10 volt drop would be allowed, and the following formula used: $D\ W\ K/P\ E^2$ in which,

D = Total distance of transmission one way in feet, assume 500 feet.

W = Total watts delivered to the motor.

P = Per cent. loss in line in watts = 10 volts $\times$ 75.7 amps. = 757 watts and 757 $\div$ 16,675 = 4.5 per cent. = P.

E = Voltage at motor end of line, 220 volts.

K = Constant = 2,160 for direct current. For alternating current the value of K is obtained by dividing 2,160 by the square of the power factor for single phase systems, and by twice the square of the power factor for three-phase, three or four wire, or for two-phase four wire. Therefore, $D\ W\ K/P\ E^2 = 500 \times 16{,}675 \times 2{,}160/4.5 \times 220^2 = 82{,}695$ C. M.

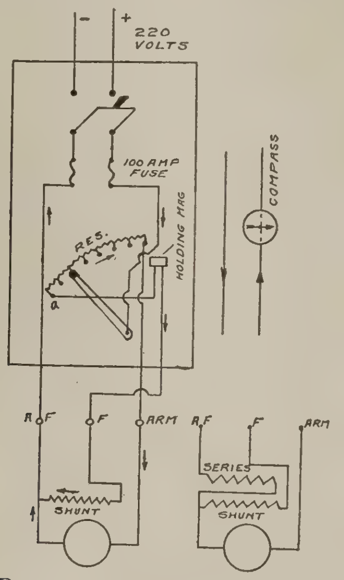


DIAGRAM OF MOTOR CONNECTIONS.

For ordinary practice, when it is desired to run the compound with the series field in, at all times the starting panel will answer for both providing they take approximately the same amount of current. As the starting resistance is called on to carry the current for only a short time, in this particular case, the continuous carrying capacity at the end (a) should be about 25 amps., gradually becoming larger up to about 50 amps., at (b). The total resistance being such as to cut the applied emf down about 100 volts, when the lever is on the first point.

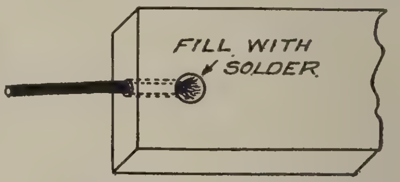
The writer knows of no way the polarity of the line can be found without the use of instruments. This can be determined, however, after the circuit is closed and current flowing by using a very inexpensive pocket compass. When a direct current flows in a conductor a magnetic whirl is set up, so to speak, around it in a direction depending upon the direction of the flow of current. If away from the observer the whirls or lines of force are clockwise. When the compass is placed close to the conductor the needle will tend to lie parallel to the lines of force and point in the direction they are going. If placed above the conductor and the needle points to the right, the whirls are clockwise and the current is flowing away from the observer looking along the conductor. Knowing the polarity of the compass used the polarity of machine poles can be determined also.

J. H. GARRETT.

Soldering Flux, Answer Question No. 225.

Editor Southern Electrician:

In reply to question 225 in the June issue, L. A. C. asks for information on soldering cables to carbon bushers. As I know of no flux that will cause solder to adhere to carbon, I am pleased to give L. A. C. a sketch showing a method of cabling carbon brushes. Bore holes in the brushes as per sketch. The end hole should be the size of cable to be used, about 5-8 inch up, the side hole should be about 4 times the diameter of the cable and bored a little below the end hole, so that they will come together well. Push the cable through end hole into the other and flatten the end of same, then solder with the following flux: 1 part new cut muriatic acid; 1 part wood alcohol and 1 part glycerine.



SOLDERING CABLES TO CARBON BRUSHES.

Give the acid all the zinc it will dissolve, then pour in the alcohol and glycerine and stir thoroughly. This makes a good soldering flux for any class of work.

A. G. CROTHERS.

Is Wattless Current a Waste? Answer Question No. 228.

Editor Southern Electrician:

In regard to question No. 228, appearing in the July issue, I will advise that wattless current is not exactly a waste, it is more in the nature of a nuisance, the dictionary says that a nuisance is that which gives trouble and vexation. This definition fits the case. If there is inductive apparatus in a system, there will be a component of the total current in quadrature with the energy current and this is given the name wattless current. There is actually but one current flowing, as there is but one emf, but this wattless component will vary in amount as the reactance is increased or diminished in the circuits. The wattless component of the current does no work in the circuit but increases the total current and thereby the heating of the conductors. There is no power consumed in forcing the component of the current through the circuit which is called wattless. The reason for this may be explained by considering that the power taken by this circuit is used to charge a condenser. In this case therefore, the charge all flows back to the generator or sets up a counter emf which tends to send current back into the generator as the emf reverses. If it were possible therefore to have conductors without resistance, a true wattless current could exist in which case the total current would be in quadrature with the impressed emf and the circuit would give back as much energy as it received.

It will be seen therefore that for any given energy load at a lower power factor, there is no greater load imposed on the prime mover than would be the case if the power factor were 100 per cent. except for greater copper losses in the electric circuit due to the larger current flowing. The wattless current limits the capacity of the generator and other parts of the electrical circuit by loading such up with unproductive current. This will be readily realized as the capacity of any system is determined by the product of amperes and volts or KVA as measured by ammeter and voltmeter and not by the energy or K. W. as measured by a wattmeter. The current load on a generator will only correspond to the energy load on the prime mover when the kilo-volt-amperes equal the kilowatts or the power factor is 100 per cent. At any lower power factor the generator carries more load relative to its rating than the prime-mover, and full load can only be put on the prime-mover by a large overload capacity of the generator. It will therefore be seen that the low power factor requires an extra expense in increased size of electrical apparatus for any particular load when operating under 100 per cent. power factor. Ordinarily the prime mover is so chosen that it will operate at its most economical point when the generator attached to it is at its full load point. If the power factor is low, say 70 per cent., then when the generator is operating at full load the prime-mover is operating at 70 per cent. The power factor on the prime-mover cannot be increased without danger of overheating the generator, consequently the central station or operating company must either put up with the prime-mover operating at 70 per cent. of the full load or apply the obvious remedy of using the synchronous condenser. The action of the synchronous condenser when operated with over-excited fields is simply that of an alternating current generator running idle on the system. The leading current caused by the over-exciting of the fields flows through the generator and neutralizes a certain amount of current which otherwise would flow through the generators attached to the prime-mover. The synchronous condenser provides a path for the unproductive current, shunting it off from the main generators and causing it to pass through these separate generators. The power factor of that portion of a load which passes through the generators attached to the prime-movers is therefore increased and the increase may be brought up to any desired extent.

It is well to remember that a high power factor as compared with a low power factor should not be striven for, without carefully considering the means by which the higher power factor is to be obtained. Power factor may be raised by decreasing the inductive load or by increasing the energy load. A higher power factor by the first method is always a gain, while by the second method, a gain will depend upon whether or not the increased energy load brings an increased revenue. The greatest proportionate improvement secured by a given amount of leading current by means of a synchronous condenser is when the power factor of the system is low. The further addition of this leading current when the power factor reaches say 90 per cent. reduces the apparent energy slowly, it is necessary therefore to investigate conditions and strike an average where expense and upkeep of condenser do not exceed saving in apparent energy or the expense which would be caused through the addition of larger sized distribution apparatus.

H. F. Boyle.

New Apparatus and Appliances.

The Electric Sign Projector.

A new and attractive medium for display advertising is coming into use as the result of the invention of the Electric Sign Projector, which throws a bright sign or catch phrase on the sidewalk. The essential features of the projector are a powerful but small lamp, three lenses and a stencil containing the advertisement. The lamp, which is a hundred candle power of the glower type, operates on the regular lighting circuit of 110 volts, either A. C. or D. C. The lenses, the glower and the stencil are located in a metal tube 14 inches long, as shown in the accompanying illustration. The tube is separated at the end occupied by the lamp so as to provide for the insertion of a small globe which makes the light available for illuminating the window in which the sign projector is placed. The pedestal for the tube to rest upon completes the outfit. It can be placed on a bracket or attached directly to the ceiling, in the window, above the door, or in any convenient place, and the tube may be adjusted to suit the position and height, being capable of adjustment to any angle. It is focused the same as an opera glass.

The Electric Sign Projector.

The advertisement as it appears on the sidewalk is not round as shown on the stencil, but slightly elliptical. It varies from 3½ feet longest diameter up, according to the distance of projector above the sidewalk. While primarily intended for sidewalk advertising, the projector may be used for throwing ads on walls and ceilings as well. It has been effectively used by department stores as a wall sign to call attention to special sales. The Electric Sign Projector is manufactured by the Pittsburg Electric Specialties Company, No. 927 French Street, Pittsburg, Pa., a new company organized to manufacture and market this and other electrical specialties.

Mazdalite Lighting Units.

The Delta-Star Electric Company, of Chicago, has developed a complete line of moderate priced lighting units for use with Mazda lamps, one of the various forms being shown in the accompanying illustration. This fixture is designed for use in place of the enclosed arc lamps and has the advantage of low initial and maintenance cost as compared to the comparatively expensive arc lamp. The Mazdalite fixture, so-called, is adapted for use with any size lamp up to 250 watts, depending upon the illumination desired. The distribution curve is so calculated that a very uniform illumination is secured. The reflector and hood

MAZDALITE UNIT.

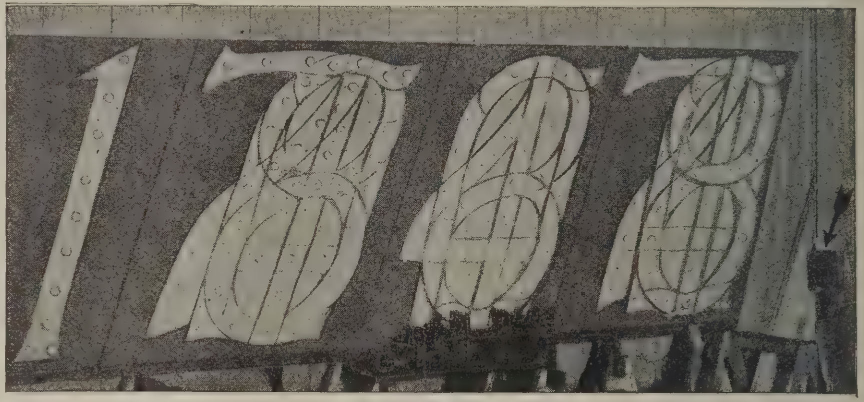
is formed from a single sheet of steel, fire enameled white inside and blue outside, thus giving a permanent durable finish and reflecting surface. The fixture is weatherproof and is made with and without the enclosing globe which in dusty locations serves to collect the dirt and protect the lamps. The units are shipped by the makers ready to be connected to the circuit, permitting rapid and economic installation.

A Large Storage Battery.

A contract has been made by the Consolidated Gas, Electric Light & Power Company of Baltimore, Md., with The Electric Storage Battery Co., of Philadelphia, Pa., for the installation of a large battery to be used for emergency service. This battery will consist of 152 cells of the Exide type, each cell containing 133 plates. Each of the 152 lead lined wood tanks will measure 4 feet 2 inches in height, 21¾ inches wide and 6 feet 6⅞ inches long, and will weigh without plates or electrolyte 940 pounds. The total weight of the entire battery equipped with plates and electrolyte, when ready for service will be approximately 1,079,200 pounds. This battery when fully charged will supply sufficient electric current to light 120,000 twenty-five watt Tungsten lamps for one hour or 240,000 such lamps for twenty minutes, having an output of 4000 H.P.

These emergency or stand-by storage batteries are used by the large electric lighting companies to provide for unusual demands in current caused sometimes by a temporary accident to electric generating machinery, or by sudden darkness preceding a thunderstorm, or as recently experienced in New York City by a heavy snow fall which within ten minutes increased the demand for current on the New York, Edison Co.'s system from 100,000 H.P. to 166,000 H.P. In this case the rate of increase in current was so rapid that it was impossible to connect additional engines with sufficient rapidity and the storage batteries were called upon to meet the emergency, thus saving New York City from darkness.

These batteries are popularly called The Watch Dogs of the System, as they are instantly ready to supply enormous quantities of electricity, thus insuring electric light at all times and at the same time protecting electrical apparatus from sudden strains caused by large demands for current. The Electric Storage Battery Company has installed



NEW YORK KLOK MONOGRAM.

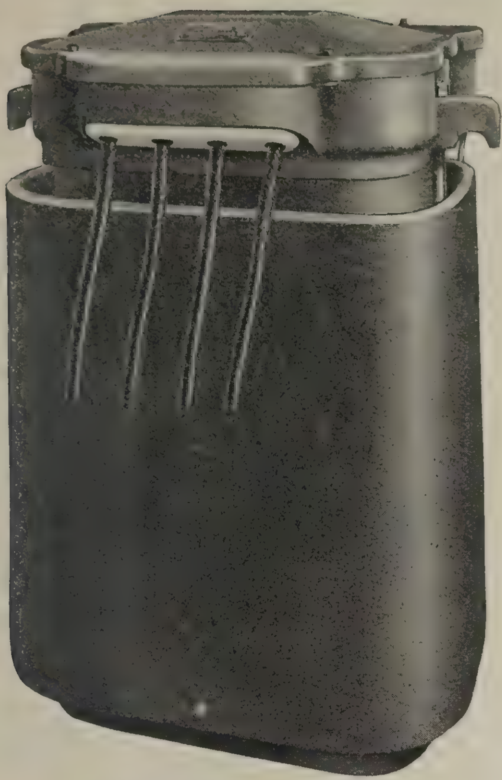
44 batteries for the New York Edison Co., many of which are almost as large as the one now being built for the Consolidated Gas, Electric Light & Power Co., of Baltimore. Similar batteries have been supplied to the electric lighting companies in Chicago, Atlanta, Minneapolis, Brooklyn, Boston and Spokane, and many other large electric lighting companies, appreciating the protection from such batteries, are now considering an installation.

The New York Klok Monogram.

The accompanying illustration shows an ingenious sign for indicating the exact time at night. The sign is operated through a flasher used in connection with a special clock movement and the mechanism is such that the time is flashed every minute, as 12:07, 12:08, and so on. The sign itself commands attention and becomes a permanent fixture, being referred to for correct time at night. When installed in connection with an advertisement the sign is of additional advantage, in that the value of a display is increased by the attention created and held among those who refer to it frequently. This sign is manufactured by Betts & Betts, of 303 W. 53d St., New York City.

Allis-Chalmers Lighting Transformers.

The general design of lighting transformers has been well established for many years, but occasionally marked improvements in details have been made which have greatly increased the practical value of this type of electrical apparatus. The new line of lighting transformers which the Allis-Chalmers Company is now placing on the market brings out this point very fully, as departures have been made from older designs. It is claimed that these changes have produced a transformer in which the heat is conducted to the air from the coils in a much more rapid manner than is usually the case, thus insuring a transformer with an exceedingly low temperature rise. The greatest visible change in these transformers is a provision, in the larger



ALLIS-CHALMERS TRANSFORMER.

sizes, of three cooling surfaces in the ordinary plain case transformer. This is accomplished by encircling the main case with a jacket and providing for the circulation of oil between the two. Both the tank and the jacket are made of boiler plate. They are connected at top and bottom by short tubes leaving an air space between the two. All joints are welded making the tank and jacket seamless, and preventing the chance of leakage. In addition to the three radiating surfaces provided, the space between the jacket and the tank forms a flue which causes currents of air to ascend at a considerable velocity, thereby exerting a scrubbing action on the surface which greatly facilitates heat dissipation. This style of tank is used on all lighting transformers from 20 K. V. A. to 50 K. V. A. inclusive. The tubes connecting the top and bottom of the tank and jacket and thence to the air. Provide for a continuous and positive circulation of the oil. Tests made on these show that this circulation is rapid, and that heat is quickly conducted from the transformer through the oil to the surface of the tank and jacket.

An entirely new departure has also been made in the 40 K. V. A. and 50 K. V. A. sizes by so arranging the coils that there is a ventilating space between them which allows full and free circulation of the oil. These sizes are wound with two low voltage and one high voltage coil, the latter being placed between the other two. The coils are separated from each other and the space between them provides ventilating ducts on each side of the high voltage coil through which the oil can readily circulate. This ventilating feature helps to make a transformer that is extremely cool in operation.

All these transformers are supplied with the 5 per cent and 10 per cent taps. These taps or leads are connected near each end of the primary winding and enable normal secondary voltage to be secured, even if the voltage supplied the primary coil is 5 per cent or 10 per cent below normal. These transformers are designed for use on 2,200 volt or 1,100 volt lines. The use of the taps makes it possible to step down from 2,200 volts in nine different ratios and from 1,100 volts in six different ratios. The Allis-Chalmers Company claims that these many special and useful features give a transformer having extremely satisfactory operating characteristics and one which is unexcelled for central station work.

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.

ALEXANDER CITY. The Industries Light & Power Company which has recently been formed and is planning the construction of a dam and power plant for electric light and power to this place.

BOAZ. The city is about to receive bids for installing an electric lighting plant. The mayor is W. H. Bartlett.

CENTERVILLE. The Centerville Light & Power Company has been incorporated with a capital stock of $15,000 by J. P. Kennedy, H. L. Reynolds, J. N. Lightsey, O. C. Oakley.

DOTHAN. The city has decided to vote on an issue of bonds for the construction of a new water works system and electric light plant. The site has been selected and plans have been prepared for the power house to cost approximately $75,000. Teh mayor is J. Baker, an dother information can be obtained from him.

EUFAULA. The city is yet considering the installation of an electric light plant. Considerable discussion is taking place and some definite decision will be reached in the early future. The city is now being supplied with lighting by a temporary dynamo that has recently been installed.

HARTSELL. It is understood that bonds to the amount of $28,000 have been sold, the proceeds to be used for the installation of an electric light plant and water works system. X. A. Kramer, of Magnolia, Miss., is engineer.

GADSDEN. The Gadsden Concrete Company desire prices on steam boilers and engines. The president is G. P. Little. This company also desires prices on electric motors.

GADSDEN. The Alabama Power & Light Company has filed articles of incorporation. The incorporators are R. A. Mitchell, E. D. Hollingsworth, T. S. Kyle, O. R. Goldsman and D. C. Allen. The company proposes to develop water power on the Little River near Blanche, about 30 miles south of Gadsden. They also propose to install plants on other streams in this section.

RUSSELLVILLE. The city has decided to construct an electric light and water works system, bonds to the extent of $24,000 having been issued. The work is under the supervision of Prof. Kay of the University of Alabama.

TUSCALOOSA. A franchise has been applied for by S. G. Blair and H. B. Foster to construct an electric light plant.

FLORIDA.

DAYTONIA. The proposed new franchise for the Schantz Electric Light Company has been voted down.

FORT MEADE. The Fort Meade Electric Light Company has recently been incorporated and has plans under way for the equipment of its plant. J. G. Fancy is president.

LAKELAND. It is the plans of the Lakeland Hotel Company to install in their new hotel steam heat, electric service and a telephone system. The cost of the hotel will be about $8,000.

OCALA. The Lake Weir, Ocala and Silver Springs Suburban Railway Company has recently been incorporated and plans to build an electric railway between Lake Weir and Ocala and Silver Springs. The company is capitalized at $50,000, and the officers are D. S. Woodgrove, President; E. W. Davis, secretary and treasurer, and X. A. Kramer, general manager.

PLANT CITY. According to recent reports the city is considering the installation of an electric light plant. The mayor can give other information.

PORT LUCIE. An electric light plant is under construction for this place. J. H. Rogers is interested, and information can be secured by addressing him at Sewalla Point, Fla.

ST. PETERSBURG. It is understood that the St. Petersburg Investment Company are to construct a power plant and car barn. The consulting engineer is R. E. Ludwig, and the manager of the company is H. Walter Fuller.

GEORGIA.

ATLANTA. The Appalachian Power Company has applied to the railway commission for authority to issue stocks and bonds to the amount of $205,000. The company has acquired expensive power rights on Panther Creek in Habersham County, and these it proposes to develop. The president of the company is L. B. Magid, of Atlanta.

ATHENS. The Athens Electric Railway Company is enlarging its power plant, increasing the output from 1,000 horsepower to 1,200 horsepower. It is also understood that the company will increase the capacity of the Tallahassee Shoals plant.

ARAGON. It is understood that the Georgia Power Company has secured a site in Aragon where it proposed to erect a transformer station. This station will receive energy from the Tallulah Falls plant, by way of Atlanta, and from there transmit it to Cedartown and Rome.

AUBURN. The city has voted a bond issue for sewer and water works system. The engineers are J. B. McCrary Company of Atlanta.

BARNESVILLE. Bonds have been issued to the extent of $3,000 for lighting purposes. Bonds have also been voted and sold for schools and water works.

BAXLEY. It is understood that the issue of bonds is under consideration for an electric light plant.

CEDARTOWN. The Georgia Power Company is making investigations for constructing lines to Cedartown.

BOWMAN. It is understood that options are being taken on the water powers adjacent to Bowman for the purpose of developing a system of water works and electric lights for the town and supplying electric power for the smaller industries throughout the section.

KENTUCKY.

LEXINGTON. It has recently been announced that the new power station to be erected by the Kentucky Traction and Terminal Station Company will be of a capacity of 4,750 K. W. Expenditure in connection with this station is placed at $800,000.

STURGIS. A water works system and plant is under consideration for the city.

LOUISIANA.

It is understood that the lighting system of this place will be changed from direct to alternating current and equipment installed in the power house to cost approximately $40,000. W. L. Eyres is superintendent of the light and water plant and can give other information.

MORGAN CITY. It is understood that a water works plant is to be established at this place and that X. A. Kramer, of Magnolia, Miss., has the plans. The plant will cost approximately $60,000.

SHREVEPORT. It is understood that the Caddo Window Glass Company, of Shreveport, La., is to install an isolated plant. Will require generator, engine and boiler.

VIVIAN. It is understood that the Vivian Ice, Light & Water Company was organized with a capital stock of $50,000 to construct an electric light plant. O. C. Jacobs is president and his address is Oklahoma City, Okla. J. C. Wilinston is secretary, Shreveport, La.

MISSISSIPPI.

BAY SPRINGS. The Bay Springs Electric Company has been incorporated with a capital stock of $10,000 by C. E. Burnham, L. L. Denson, E. A. Denson.

COFFEEVILLE. An electric light plant is being considered by P. M. Woodall.

CLARKSDALE. The city has voted $6,000 in bonds for an extension to the electric light system. The mayor can give other information.

HICKORY. It is understood that the city has under consideration plans for an electric light plant.

TUTWILER. According to reports a company is being organized for the purpose of installing an electric light plant. The plant as proposed will cost $10,000. W. D. Corley is interested.

TYLERTOWN. It is understood that Q. D. Sauls, of Tylertown, Miss., is in the market for a 50 K. W., 2,300 volt, 60 cycles generator and exciter.

NORTH CAROLINA.

GASTONIA. The Spencer Mountain Power Company's power plant located on the Catawba River about seven miles from Gastonia was destroyed by fire at a loss of $20,000. It is understood that the plant will be rebuilt at once.

RALEIGH. It is understood that S. O. Middleton, of Hallsville, N. C., is the chairman of a committee to decide upon the installation of an electric light plant at the state hospital.

SELMA. Plans are under way for the installation of a municipal electric light plant at Selma. J. A. Mitchell is mayor and can give other information.

WILMINGTON. An auxiliary steam plant is being considered by the Savannah River Power Company. Information can be obtained from H. McRae Company.

WINSTON-SALEM. The Mengel Box Company, of Louisville, Ky., has completed its plans for the erection of a new factory to be built at Winston-Salem, N. C. The plant will cost approximately $100,000 and will be equipped with electric drives. It is understood that electrical energy will be supplied by the local central station plant.

SOUTH CAROLINA.

GREENVILLE. It is understood that the Southern Power Company has contracted with the New Duncan and the Westervelt Mills, both of which are now under construction, for electrical power. Each mill will have 50,000 spindles and full accompaniment of looms and other machinery so that each will use about 1,500 horsepower.

HONEA PATH. It is understood that T. W. Cochran, of Greenville, S. C., has been engaged to prepare plans and superintend the construction of an electric light plant. J. S. Monroe can give other information.

ORANGEBURG. The Dixie Lumber Company desire a 15-horsepower and a 5-horsepower electric motor.

SELMA. It is understood that the city has plans for the installation of an electric light plant. The mayor can give other information.

TENNESSEE.

BRISTOL. It is understood that the Bristol Gas & Electric Company is invading the field of steam power in the section, and has secured a number of customers to use electric power. The electrical energy will be generated at the Watauga hydro-electric plant on the Watauga River.

SOUTH PITTSBURG. The South Pittsburg Electric Light & Power Company's plant owned by D. J. Alexander, of Nashville, and Charles Houston, of South Pittsburg, was destroyed by fire July 13. The total loss was approximately $14,000. The electric light plant will be rebuilt at once.

PERSONALS.

MR. GEORGE BELL, formerly with the Westinghouse Electric & Manufacturing Company, has become associated with the Duncan Electric Manufacturing Company, of LaFayette, Indiana, as Sales Manager. Mr. Bell prepared for college at Mercersburg Academy at Mercersburg, Pennsylvania, and took the Electrical Engineering course at LaFayette College, at Easton, Pennsylvania. Upon leaving college, he entered the apprenticeship course of the Westinghouse Electric & Manufacturing Company, and after spending a year and a half in their shops, entered the sales department, spending some time in the offices at East Pittsburg, and later joined the sales force in the Atlanta office. After spending eight months there, he was transferred to the Cincinnati office. In the fall of 1900, Mr. Bell was sent to Indianapolis to build up his Company's business in Indiana, and the following spring opened the Indianapolis office, where he remained in charge until he resigned his position in October, 1910, to get some experience in central station work. Mr. Bell was connected with the Westinghouse Company for almost ten years, and is well fitted for his new position. He has acquired an interest in the Duncan Electric Manufacturing Company, manufacturers of the Duncan Meters and Transformers.

MR. WILLIAM N. DRIVER, general manager of the Great Southern Hotel at Gulfport, Miss., at the recent convention of the Mississippi Electrical Association, with headquarters at that place, was conspicuous for his general acquaintance and popularity among the electrical men of the South. This acquaintance among electrical men, however,

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Some Engineering Methods of Today

In present day engineering, at the very time when our foremost text-book writers declare that electrical science has outgrown its infancy and historians proclaim this the age of inventions, there is much practice in the profession that is infantile and lacking genius in its method. Let us analyze a bit. In this country alone, there are over one-hundred schools maintaining regular electrical engineering courses, giving the profession yearly many hundred of intelligent, prospective engineers. These young men scattered over this country, with the ambitious idea of getting immediately into practical work, often lack completeness in their knowledge of the theory of subjects with which they are dealing, bringing such into disrepute under fire of their practical fellow workmen. They are jeered at and made fun of, because their theories are apparently exploded.

These occurrences discourage theory in the future engineer's mind and lead him to adopt the "cut and try" methods of his less-trained examples to the right and left. Thus matters continue, perhaps he progresses to the draughting room and here unconsciously he adjusts and tries, adjusts and tries his dividers rather than use the reliable methods taught him in his early secondary school days. These habits grow until they become almost fixed opinions. Our technical graduate has now, long since been doing engineering work under the head of "draughting," a term used by many campanies to obtain and retain good engineers at a "pen pushers" salary. At last, to still collect the revenue from the work of "one of the more successful" the employer is constrained to increase considerably the weekly earnings of the "lucky guesser" and along with this considerable increase comes the title of engineer, the ambition of the receiver.

The next step is to become well-known as an engineer. Clubs and banquets are the easiest means of becoming locally known, just like adjusting and trying was the easiest way of finding the radius of some particular arc. A jolly good fellow is always acceptable company in the society of club rooms, but is it the jolly good fellow that becomes the engineer? Is not his value his knowledge? What we may ask, has become of his text books? With the exception of a few handbooks it is safe to say that they have been forgotten. He is then to rely upon what? Experience, like the untrained man? He can do a little better than that, he can do like others have done, depend upon the experience of someone else. To do this he attempts to look over "the best American practice" which is not at all necessarily the best existing. He has forgotten all his German, French or whatever other foreign tongue he may have studied, and he can only keep up with the publications in English at the best. He uses the methods that look the best to him, taking a part of this plant and a part of that, puts them together, then wonders why they do not give perfect satisfaction for they were taken from "the best American practice." It is the same old "cut and try" proposition over again.

Did it ever occur to him that his methods might be investigated? If they were fully investigated in a scientific manner and reported upon favorably, would they not have operated successfully or more successfully than they were likely to by simply being put together? The most satisfactory method of producing a worthy product is not to simply put parts together and let the purchaser test the assemblage, but fully develop the product by scientific investigation before it is presented to the market.

Our engineers of today are prone to use the experience of a more or less successful predecessor rather than individually investigate within other fields for themselves. There must be a reason for this. Is our technical school at fault or has her alumnus misinterpreted and misapplied her instruction and training? Quite often we believe the latter. Of course it is necessary to keep up with the practice of the day. There is one good way of doing this and that is, subscribe to all the best electrical journals. Every engineer appreciates this, and usually subscribes to as many periodicals as pertain to his line of the profession. Many find that their reading is wholly confined to these journals, because their time is largely taken up with the practice of their profession. Thus the journal of today is the text-book of many an engineer. What is contained in the journal, later becomes his knowledge.

If the journal gives exclusively a series of examples, such as "the best American practice," then its influence is toward the "cut and try" engineer. To represent the greatest good in technical journalism, advanced theory and methods of scientific investigation must receive careful attention. Then the temptation is layed before the engineer and the chance is given him to investigate for himself. This also keeps the theory fresh in the minds of the theoretical.

In the State of New York a short time ago, there was agitated for introduction into the State Legislature, a bill requiring all practicing engineers to stand an examination and therewith procure a license. The A. I. E. E. and the engineers in general arose with both hands in the air and stamping with both feet on the ground yelled, "No!" When the general assembly asked, 'Why?" the only answer came, "Because it would do a great injustice." If the gentlemen were able to stand the examination, would there be any injustice? The answer should then have been, that there are many among us who have been out of school so long, that the theoretical elements have been forgotten and since the examination would consist largely of this, we fear that the younger men in the profession might stand a better examination than some of us who are the fossils of the profession. Why have we older men forgotten the elements of the science? Had the theoretical elements been retained in our minds, would we not have been able to secure the license now? And would the capable, therefore, the deserving of us not be separated financially as well as intellectually from the undeserving?

Beginning with this issue there will appear in this journal, at least one purely technical article, composed of new, first hand scientific matter, results of mathematical and laboratory investigation written exclusively for these columns. It is hoped that the effort will help to encourage individual investigation, the making of the successful man or engineer among our readers.

Final Arrangements for Convention of Georgia Section of N. E. L. A.

At the time this issue of SOUTHERN ELECTRICIAN goes to press, the date set for the convention of the Georgia Section of the N. E. L. A. is less than four weeks hence. While exact details of the plans laid have not yet reached such a stage as to permit publication, the general features have taken definite form, appearing elsewhere in this issue, and promise to make possible two days of real profit to all who come to Columbus, Ga., September 26 and 27. In accepting President Bleecker's invitation to make Columbus the meeting place for the first convention of the Section, it was with due recognition of the city as a point of interest for electrical men.

Columbus is the capital of Muscogee County, Georgia, situated on the east bank of the Chattahoochee River, on the border of Alabama, and at the head of navigation and the foot of the falls of the Chattahoochee. It is located in the heart of the great cotton belt, surrounded by rich agricultural lands, with ample rail and water transportation facilities. There are three dams constructed within two miles from the center of the city, each developing a large amount of power. Another large dam is now near completion. It is owned by the Columbus Power Company, and will prove a great addition to the marvelous water power already developed in the Chattahoochee River in and near Columbus.

The program committee has arranged for and secured a number of able engineers to present exhaustive papers on various phases of the central station industry. The application of power will be covered by a paper on "Supply of Electric Energy to Textile Mills," to be presented by Geo. K. Hutchins of the Columbus Power Co. The building up of a day load on lighting feeders by heating devices will be discussed through a paper entitled "Electric Heating Utensils" to be given by L. L. Warfield, engineering expert for the Westinghouse Electric and Manufacturing Company. The problem of making the small station pay during the period of light load will be taken up by a paper on "Ice Making as Associated With Central Stations," to be delivered by Burdett Loomis, of the Ware County Light and Power Company. Another important subject which will receive attention is the economy of manufacture by improved machinery. This topic will be ably treated in a paper entitled, "Low Pressure Turbines" to be presented by E. H. Ginn, an electrical engineer for the General Electric Company at the Atlanta office, who has made a special study of the conditions prevailing in Southern plants.

The social features of the convention are receiving special attention. Definite information, however, is lacking, further than the planning of a reception on the first night for the various delegates and their wives, and an inspection trip to the different power stations of the Columbus Railroad Company and the Columbus Power Company, including a trip to the new development at Goat Rock, where the large dam is in course of construction. It is safe to say, however, that further than these events there will be others of such a nature as to employ all spare time with profit and pleasure well balanced.

Producer Gas and Electrical Equipment of East St. Louis Drainage System

(Contributed Exclusively to Southern Electrician.)

BY HOWARD F. SMITH.

THE city of East St. Louis, Illinois, has a population of 60,000 and is located on low ground, surrounded on three sides by a levee. During periods of high water the greater portion of the area of the city is below the water line of the Mississippi river, and rainfall and seepage from the Bluffs, back of the city, remains on the surface of the low ground causing unsanitary and unhealthy conditions. A drainage and sewage system costing $742,000.00 has recently been designed to meet the city's requirements, consisting of approximately seven and one-half miles of concrete sewers, together with a net work of vitrified clay pipe sewers.

NATURE OF DRAINAGE SYSTEM.

At a point about one mile from the river, the system converges into a concrete intake flume, from which the water is pumped through a ten and a half foot reinforced concrete main to the river. The suction flume and discharge main are by passed by means of a ten and a half foot gate valve, so that during periods of low water the system will operate by gravity.

The territory drained comprises six square miles of city property, together with the underground seepage from three to four times this area. In explanation of this statement, the ground upon which the city is built consists of sand to the depth of from a few feet to 200 or more feet. This sand varies in size from coarse sand to a sand resembling dust in appearance when dry. A portion of the water from the bluffs back of the city, filters through this sand so that the water level throughout the year is at a variable depth, from a few inches to a few feet below the surface.

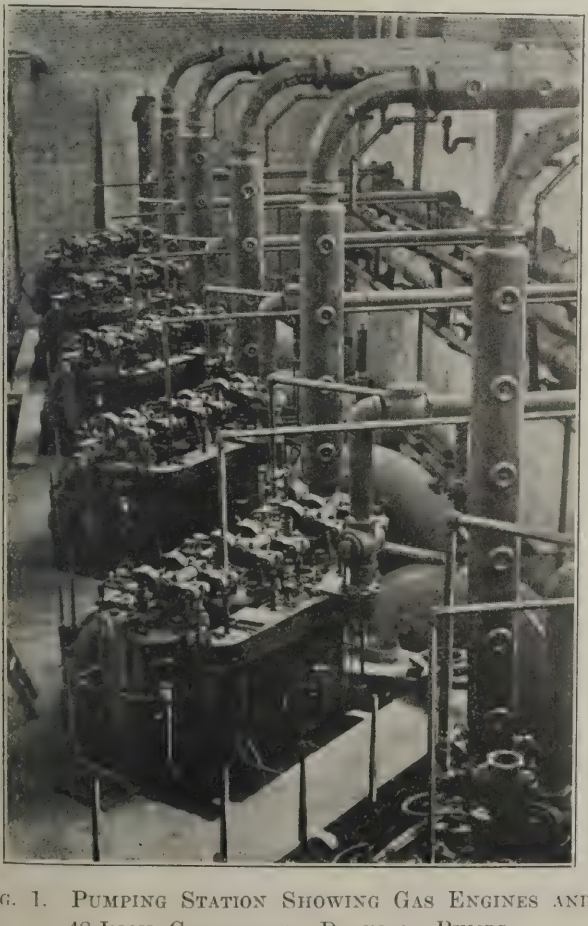


Fig. 1. Pumping Station Showing Gas Engines and 48-Inch Centrifugal Drainage Pumps.

Fig. 2. Pumping Station Building.

The design and selection of apparatus for the pumping plant is of special interest, and was first worked out by Mr. E. T. Adams, of Milwaukee, Wis. It was embodied in a city ordinance about seven years ago, and has since been remodeled and the apparatus installed under the personal supervision of Mr. Howard F. Smith, of the firm of Dixon-Smith Engineering Company, consulting engineers at St. Louis, to meet the present design of apparatus and modern improvements in the various classes of machinery. The plant will be idle about one-third of the year, but must be ready for immediate service at any time the river reaches a stage above ten feet. As no effective storage could be secured for the drainage water, the plant must handle the full amount of run off from a storm within a few minutes after the rain begins to fall. The static head to be pumped against varies from zero to a maximum of 25 feet, while the average condition under which the pumps will operate as indicated from a record of the past decade is nine feet.

All machinery is located on lines running 45 degrees with the center line of the building, which admits of a minimum foundation and building, but provides sufficient operating room. The foundations are in fact floating, resting on quick sand, and all pumping machinery is located below natural grade, giving the observer at first glance, the impression of the works of a huge watch. The electrical generators and switchboard are located on a concrete gallery, on a level with the operating platform of the engines, and the entire plant including the auxiliary apparatus and valves is controlled from this elevation. The vacuum pumps, compressor and other secondary apparatus are located under the switchboard gallery.

NATURE OF EQUIPMENT.

The apparatus selected consists of a gas producer, gas engines and centrifugal pumps, together with an electrical plant and auxiliaries. The producer is a modern type, manufactured by R. D. Wood, of Philadelphia, Pa., rated at 500 H. P., and designed primarily for anthracite coal, but provided with tar extractor and auxiliaries for operation with bituminous coal. The producer proper is ten and one-half feet in diameter by fifteen feet high of the suction type, the scrubber being six and one-half feet

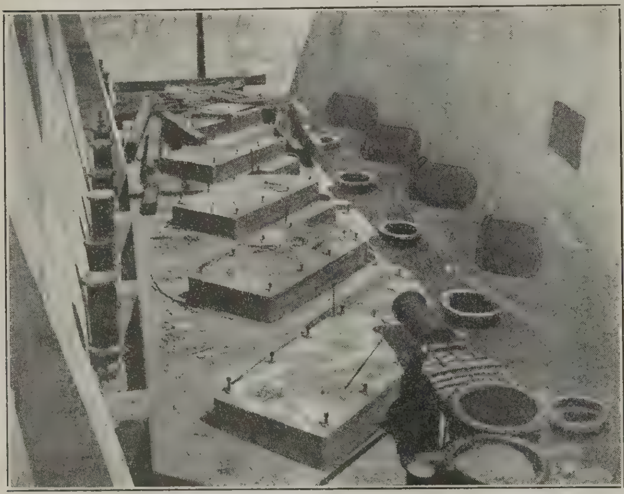


FIG. 3. ENGINE FOUNDATIONS, INTAKE AND DISCHARGE OUTLETS FOR CENTRIFUGAL PUMPS.

in diameter by eighteen feet high. A vertical boiler is provided for starting and cleaning purposes. The producer and auxiliaries are located at one end of the main building but separated from the pumping plant by a brick and concrete partition. A coal bunker adjoins the producer room and is situated so that coal may be unloaded directly from the car, and at the same elevation as the top of the producer.

Five large internal combustion type pumping engines, manufactured by the Rathbun-Jones Engineering Co., of Toledo, Ohio, are installed for drainage purposes. These engines are vertical, single acting 18½ x 20 inches, and designed with a hand operated controlling device to operate a variable speed, and having a rated capacity at full speed of 290 B. H. P. each when operated on city gas. The engines are so constructed that either producer gas or city

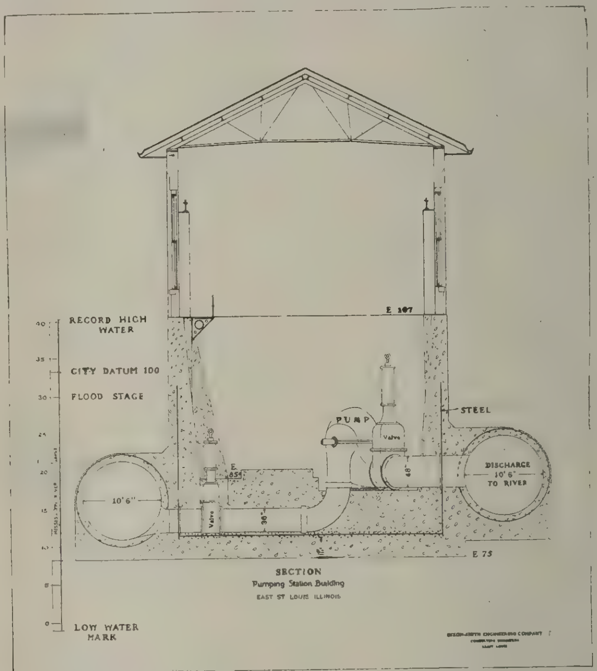


FIG. 5. SECTION THROUGH PUMPING STATION.

gas may be used which admits of an independent source of fuel in case of accident to the producer. It also provides for emergency operation in case of flood, without necessitating an abnormal outlay in producer equipment, which would be required only a limited number of weeks during the year.

Two pumping engines of similar design are installed for sewage pumping, being 15 x 16 inches and rated at 200

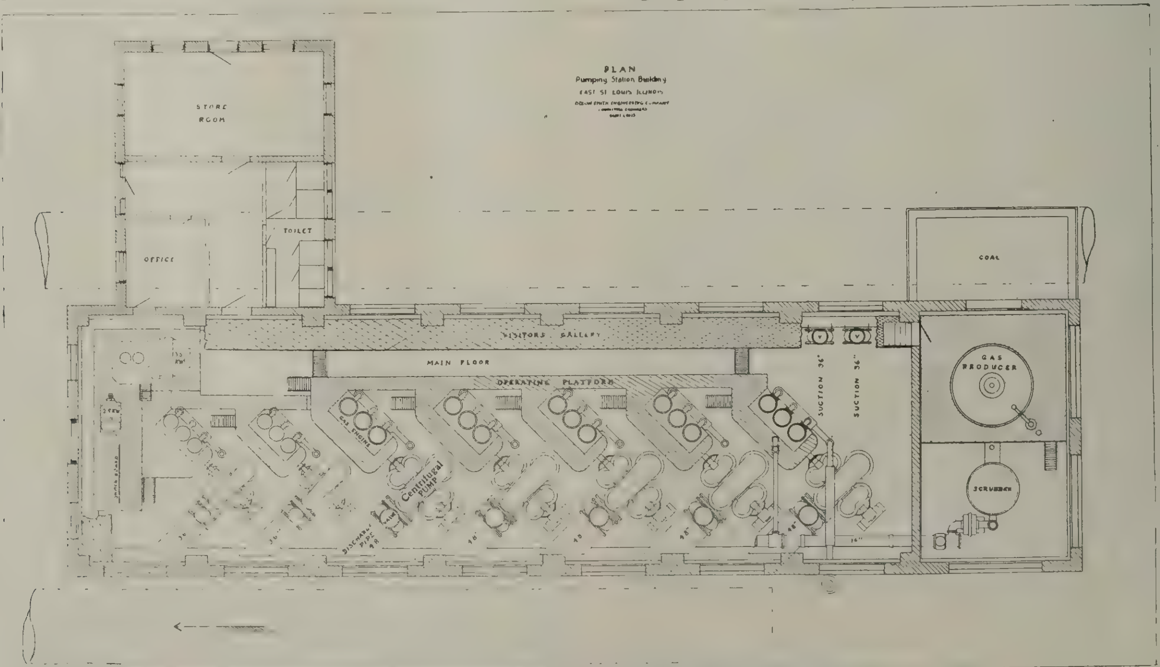


FIG. 4. PLAN OF PUMPING STATION BUILDING.

B. H. P. One engine for electrical power is a vertical two-cylinder 11 x 13 inches, rated at 75 B. H. P. Five 48-inch centrifugal Allis-Chalmers drainage pumps are direct connected to their respective engines, and designed to operate at a speed varying from 75 to 200 R. P. M. depending on the quantity of water to be handled and the head pumped against. The pumps are provided with two 36-inch suction lines and a single 48-inch discharge, and operate without the use of thrust bearings. The two 36-inch sewage pumps are similar to the above, and have 24-inch suctions and 36-inch discharge. The maximum total capacity of the pumps exceeds one-half billion gallons per day.

The engines are arranged to start with compressed air, with the pumps full of water and discharge valves closed. The pumps are primed by means of a vacuum pump. The auxiliary apparatus, excepting valves, is operated by electricity, a 120-240-volt, direct-current, three-wire system being selected for this purpose. The auxiliary power plant consists of a 35 K. W. direct-connected generator together with a 25 K. W. generator direct connected to a 40 H. P. motor, operated by an independent source of electricity. This plant furnishes light for the various buildings, together with power for operating the vacuum pumps, air compressors, main sluice gate, tar extractor, cranes, etc.

Lorimer & Gallagher Company were general contractors, and Mr. T. E. Richards, of Chicago, superintendent in charge of construction of the East St. Louis plant. All engineering work was done by the Dixon-Smith Engineering Co., of St. Louis.

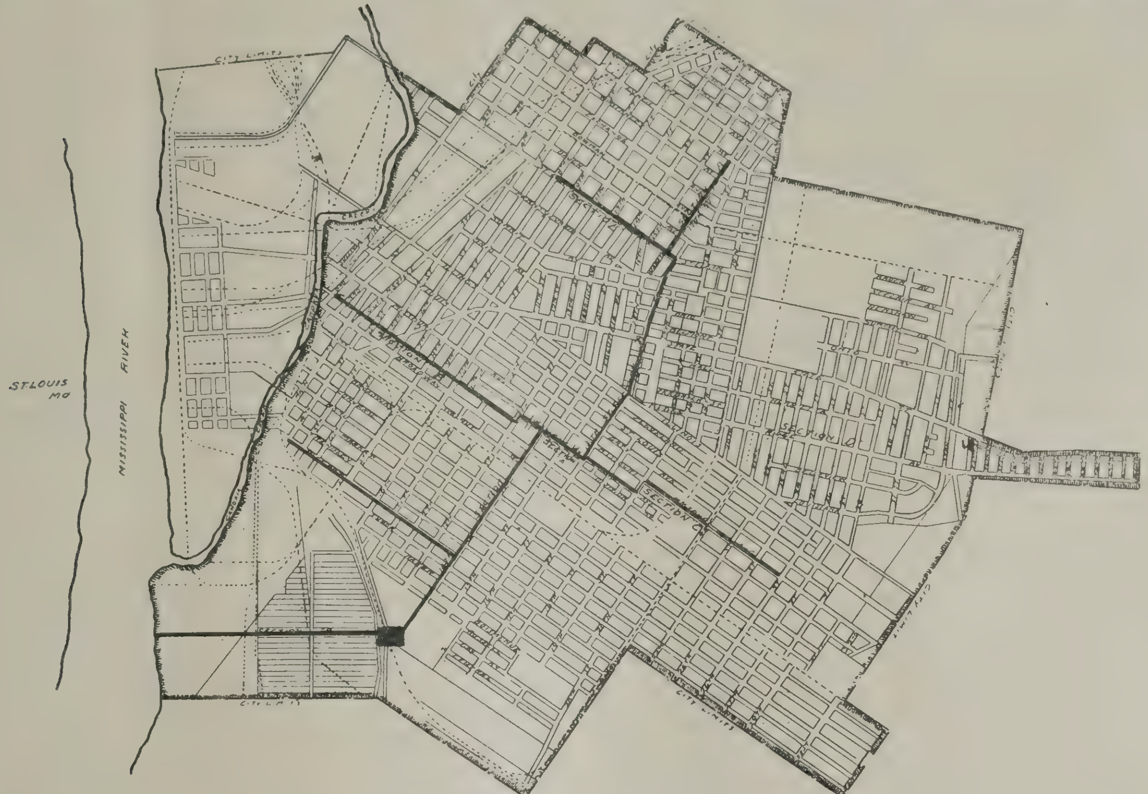


FIG. 6. MAP OF EAST ST. LOUIS, SHOWING DRAINAGE AREA.

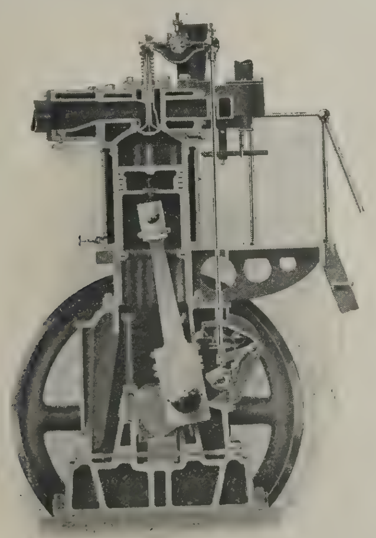


FIG. 7. RATHBUN-JONES GAS ENGINE.

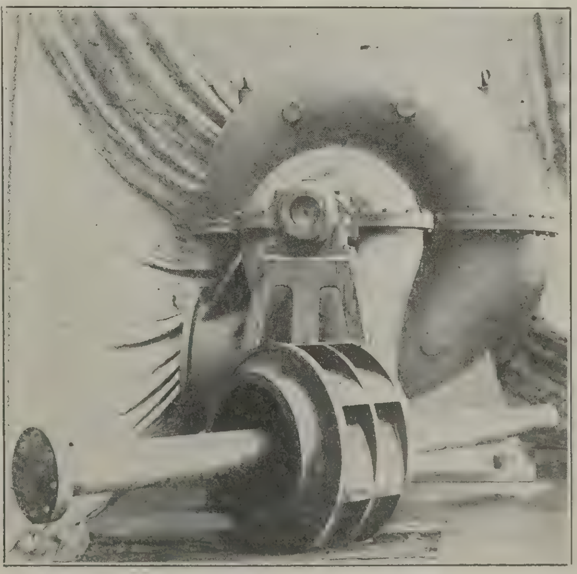


FIG. 8. TYPE OF DRAINAGE PUMP USED.

Principles of Illuminating Engineering

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN)
BY A. G. RAKESTRAW.

WHILE it has only been about four or five years since American made tungsten lamps have been on the market, yet their introduction has been remarkably rapid especially for commercial installations, as superior efficiency and quality proved them at once to be a good investment. It is in fact due altogether to the tungsten lamp that electric light has been able to compete successfully with the latest improved gas lamps. A good many tungsten lamps are also used in residences, especially for libraries, sitting rooms, and wherever there is much reading to be done.

The first tungsten lamps placed on the market were very fragile, were high in price, could not be burned satisfactorily in any but a vertical position, and were apt to blacken the bulb. All of these defects have been practically overcome. The blackening of the bulb, which greatly reduced the lighting value of the lamp, was caused by the contact of the tungsten filament with other metals at the points of contact with the leading in wires and anchors. The high temperature of the filament simply volatilized the steel or copper of the support which then was deposited on the inner surface of the globe. Fig. 10 shows why the lamps would burn out so quickly when burned on an angle. The dotted line shows the position of the filament when cold and the solid line when hot. This produced a bending at the point of connection every time the lamp was lighted or extinguished which soon caused a break at that point. Improved construction has largely done away with this trouble.

The fact that this lamp would not operate satisfactorily on an angle, while it caused some inconvenience and necessitated change of fixtures on the part of those who desired to avail themselves of its good qualities, yet it was really a blessing in disguise, as it forced the consideration of scientific fixture design for the use of high candle power lamps of high intrinsic brilliancy, together with properly designed reflectors. This of course would have come about in time, but the fact that a merchant in replacing carbon lamps with tungsten lamps had to put in new fixtures, in order to overcome this peculiarity, was the means of introducing scientific fixtures and glassware in his place of business sooner than he naturally would have done. Now that tungstens have been developed which will burn at any angle, the custom of installing the lamps vertically has become so universal that we seldom see a new installation put in any other way.

The fragility of the tungsten lamp has been practically overcome by the use of the new wire drawn filament. The first filaments were composed of the metal in a powdered state mixed with a binder and while plastic squirted through a die, thus producing an extremely hard and brittle filament. It is impossible to pick up a filament of this type between the thumb and finger without breaking it. The new filaments are not squirted, but drawn, and while still brittle as compared with the carbon filament, yet are stout enough to stand up quite well with ordinary care. The difference in the mounting of these two is shown in Figs. 8 and 9. It will be observed that the wire drawn filament has only two joints, being wound back and forth over the supports, while the old type has two joints for every loop.

We may mention here another effect of the introduction of the tungsten lamp, that is the raising of the standard of illumination. With the carbon filament lamp the majority of stores were not sufficiently illuminated, due to the cost of securing a really good light. Most of these merchants welcomed the new lamps as a means of securing the illumination that they felt they ought to have, without increased cost. Thus the revenue to the central station from this class of business was not greatly decreased, but the standard of illumination was raised until today brightly lighted stores are the rule. Furthermore, since the new lamp was not made in smaller than the 25 watt, 20 candle power size, for 110 volts, it cut out a good many 8 and 6 candle power which were in use. If the tungsten lamp had been made in these smaller sizes, no doubt a good many persons would have used them, but since it was 20 candle power or nothing, the effect was naturally to help to raise the general standard of illumination wherever they were used. The low voltage tungsten system, comprising a small transformer or "economy coil" with 27.5 volt lamps in 10 and 15 watt sizes, was devised to meet the demand for a tungsten lamp of small candle power, but has not met with much success, for the principal reason that as stated, the public are no longer satisfied with these small sizes, and are entirely content with a minimum unit of 20 candle power.

Other materials are used for filaments, such as osmium, helium, titanium, and perhaps many others, but these are all more or less in an experimental stage and not yet commercially introduced, at least not in this country. It would seem as if the limit of operating temperature had about been reached and further progress will likely be along other lines, such as the utilization of selectivity and luminosity, which is not possessed by these types of lamps, at least not to a great degree.

We have already spoken of variation of candle power with voltage. Fig. 11 shows curves from data published by the N. E. L. A. showing the variation both for the tungsten and the carbon lamp. From this it is seen that an increase of voltage over normal of only 5 per cent increases the candle power of a carbon lamp over 30 per cent and of a tungsten lamp about 20 per cent. This shows the necessity of maintaining close regulation on incandescent lighting circuits. Fig. 12 shows the variation of candle power

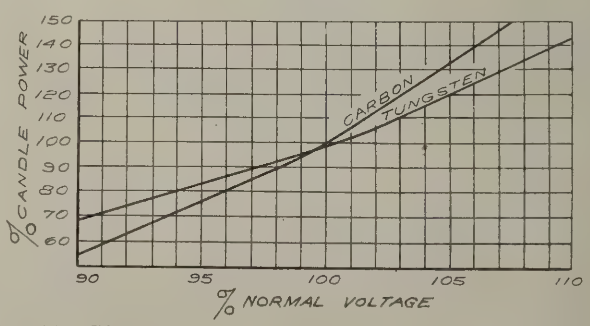


FIG. 11. VARIATION OF CANDLE POWER WITH VOLTAGE.

with life. It will be noted that it rises a few per cent above the initial value and then slowly decreases to about 90 per cent of rated value, having a much higher average value than carbon lamps, which fall from the initial rating to 80 per cent of that value.

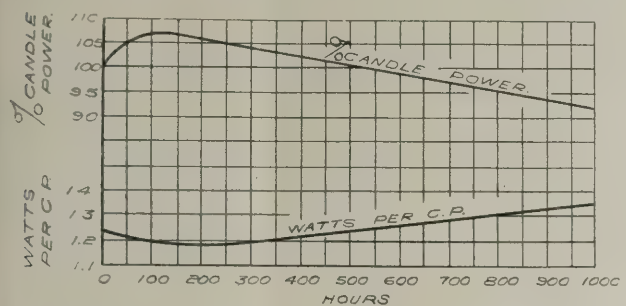


FIG. 12. VARIATION OF CANDLE POWER WITH LIFE.

The following table gives the mean horizontal candle power, the spherical candle power and the watts per candle power and lumens per watt of the filament type of lamps. Incandescent lamps have always been rated in mean horizontal candle power because their candle power was greatest in that direction. In recent comparisons of light sources it is common to use the mean spherical candle power, or what amounts to the same thing, the lumens or total light flux. Since a lumen is the amount of light flux required to illuminate a surface of one square foot with an intensity of one foot candle, it follows that a light with one mean spherical candle power will emit 12.56 lumens. It is also becoming more common to speak of lumens per watt rather than watts per candle. The ratio of the mean spherical candle power to the mean horizontal is called the spherical reduction factor, and is practically constant for a given shape of filament.

TABLE SHOWING LAMP RATINGS.

Lamp	Mean Hor. c. p.	Mean Sph. c.p.	Lumens	Watts	w.p.c. (Hor.)	w.p.c. (Sph.)	Lumens per watt.
Carbon 3.1 watt.	16	13.2	166	50	3.1	3.8	3.32
Gem 2.5 watt.	20	16.5	207	50	2.5	3.0	4.14
Tantalum	20	16	201	40	2.0	2.5	5.0
Tungsten	20	15.6	196	25	1.25	1.6	7.84

While lamps still go by the nominal rating of 16 candle power, etc., yet the candle power ratings are not usually given on the labels, but the watts and volts only, and instead of one voltage being given there are three. The explanation of this is as follows. If we burn a lamp at a certain voltage it will have a certain efficiency and also a certain life. If it is burned above that voltage it will give more light and be more efficient, but the lamp will not last as long. If we have the efficiency and the life given for each condition we can determine from the cost of current and lamps what is the most economical voltage to use. The following table gives this data for a 40-watt tungsten lamp, which we will say is labeled, 110 / 108 / 106 V

DATA FOR A 40-WATT TUNGSTEN LAMP.

Voltage	Mean Hor c. p.	Watts per c. p.	Hours Useful Life.
Top	32	1.25	1000
Middle	29.9	1.30	1300
Bottom	28.0	1.35	1700

In this case, 110 volts would be the "top voltage" and 106 volts the "bottom voltage." It is customary to burn lamps at the "top voltage" as in general the value of the current saved will more than compensate for the decreased life.

Electricity for Canadian Farms

The chairman of the Ontario Hydroelectric Commission recently made a tour of Europe in search of information for the Ontario government, so that the use of Niagara electricity on the farms of that part of Canada may be extended. From an interview in a Montreal paper the representative is quoted as follows: Some of the interesting features at the electrical exhibition at Munich were a model farm fully equipped with electricity, and a practical demonstration of electric plowing, where from 25 to 30 acres were being plowed with one plow per day. While at the International Exhibition of Manufactures at Turin we also had an opportunity of investigating heavier electric apparatus, such as large motors suitable for railways, street cars, etc. We found that in practically all European countries electricity is largely and extensively used on farms of 25 to 1,000 acres for both light and power purposes, such as thrashing, cleaning grain, chopping, root cutting, sawing wood, pumping water, milking, cream separating and butter making, ironing, lighting houses, stables, and yards.

At the municipal farm at Berlin over 400 horsepower is used. While we found that the cost of supplying power and light was higher on the whole than it will be with us, the cost of distribution of electricity to the farmer is less, as they do not live on their farms as in Ontario, but are grouped in villages. Electricity from an economic standpoint should be of greater value to our farmers, as wages are from 50 per cent to 100 per cent higher, and even at that, farm labor is difficult to procure. We also found motors and other apparatus in use, and guaranteed by the manufacturers, which should be of great value to the municipalities, especially in Toronto, where the city engineers are considering the coversion of alternating current to direct current and storage batteries for the purpose of supplying the industries in the center of the city at a cost of several hundred thousand dollars. Electric ovens were another feature which we found largely and successfully used in Continental bakeries, while the electric ozone system was also being used with great success for schools, hospitals and public buildings.

The city of Berlin has also adopted electricity as a motive power for their fire department, four stations being already fully equipped, horses and gasoline motors being dispensed with. Among the many advantages of the systems was a saving of over half the cost where horses had been used, also a wonderful saving of time, it taking but 12 seconds from the time an alarm was sounded until the department was fully under way on the street. Safety and simplicity of operation were also fully demonstrated. Another very useful application of electricity was with motor outfits for street watering, and these we found used in many municipalities. In fact we gathered a great deal of information in Great Britain, Germany, Switzerland, and Austria which will be of great value in assisting the hydroelectric commission in preparing the rules and regulations authorized by the Ontario government for street wiring and the wiring of houses, factories, mines, etc. Hydraulic accumulator stations were seen in practical operation in Turin and Bergamo, Italy, and they showed the great value of electric storage by this wonderful system. The projectors of the scheme have furnished us with all details and plans, which will be of great service to the commission in dealing with the question of establishing a similar accumulator station.

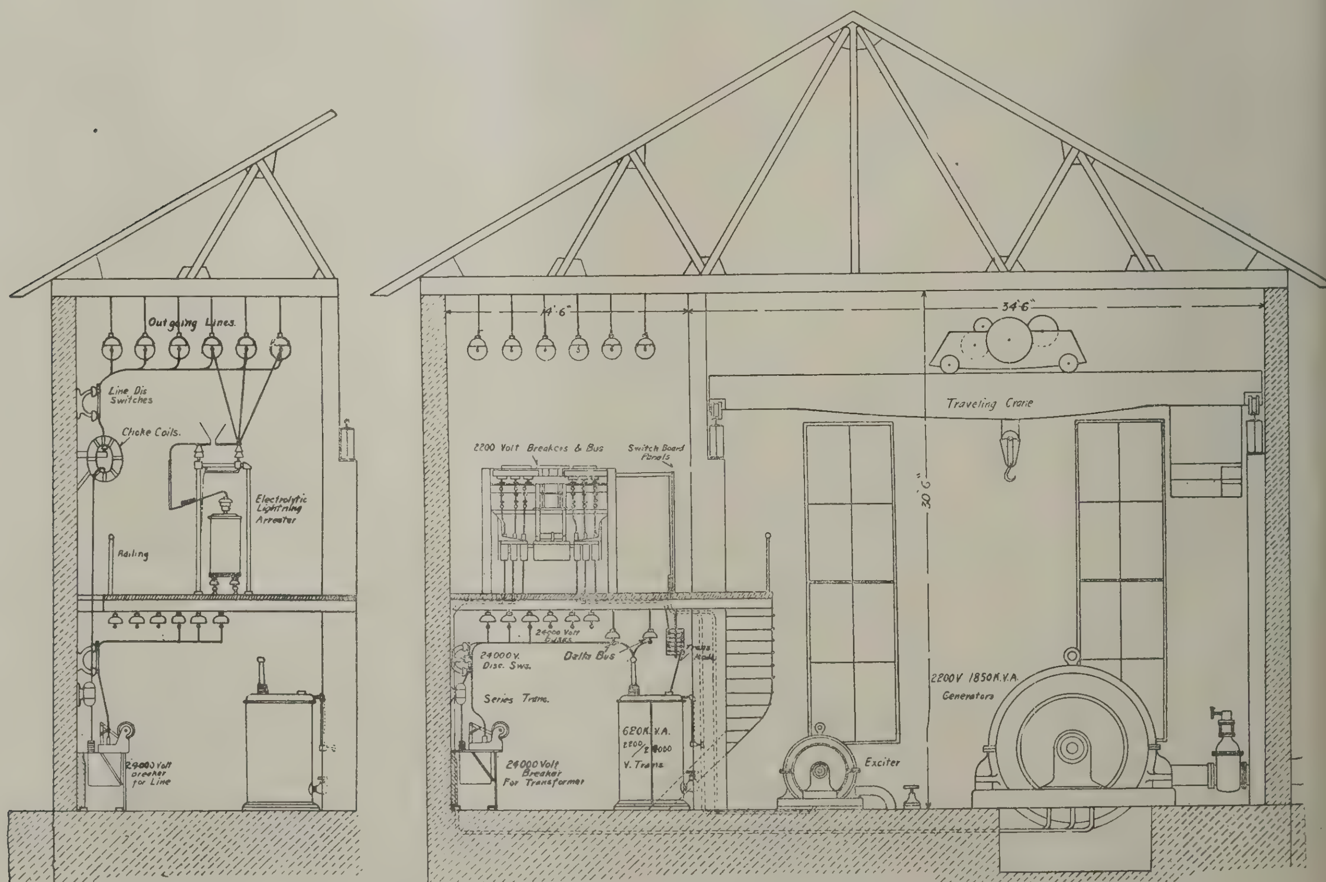
American Switch Gear Structures and Distant Control Apparatus

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)
BY STEPHEN Q. HAYES.

ALL of the illustrations of the previous article in the July issue, indicated the use of top connected or back connected circuit breakers in the low tension and high tension circuits. In connection with the low tension breakers, fireproof masonry compartments have been supplied in practically all of the large capacity stations and the switching equipment is arranged in these masonry compartments in such a manner that leads of opposite polarity are separated by soapstone, concrete, brick or similar material. These fireproof walls, barriers, etc., prevent an arc forming in one place and communicating to adjacent conductors. The amount of current available momentarily at the point of trouble in large stations of 13,200 volts or less where the generators are connected to a bus, is something enormous and every precaution must be taken to prevent trouble from spreading. For such voltages the question of suitable insulation distances between the live metal parts and the masonry structure is comparatively simple.

Where the generators connect through separate transformers giving voltages from 22,000 to 135,000 or even higher, the question of enclosing the busbars and wiring for the high tension circuits becomes an entirely different proposition. Some engineers are of the opinion that the cellular construction should be used for large capacity circuits of any voltage, and bottom connected breakers have been designed that work in well with the enclosed busbar construction for high voltage plants.

The writer is of the opinion that the open system of wiring is preferable for any voltage higher than that for which generators can be conveniently wound, basing same on the following reasons: (1) The violence of an arc and the destructive effect of short circuits depend on the amount of current available at that point and are inversely proportional to the voltage for the same amount of power. While fire-proof barriers and cellular constructions are required on large capacity plants of comparatively low voltage, they are unnecessary for higher voltage plants of the same or even larger capacity. (2) The distance from wire to ground has to be greatly reduced over what could be obtained with open wiring in the same space as the fireproof barrier offers a more or less perfect ground for high voltage circuits and the higher the voltage the more perfect the ground. (3) A more expensive building and costly construction are usually needed for enclosed busbars and



SECTION ON LINE BB SECTION ON LINE AA

FIG. 9. SECTION THROUGH A 22,000 VOLT STATION.

wiring than are required for open wiring. (4) Inspection and repairs are more difficult for busbars, wiring, disconnecting switches and similar appliances that are boxed in masonry compartments, and are only visible and accessible by the removal of doors, than if everything was in plain sight. Inspection will be more frequent and thorough and incipient trouble will be noticed far sooner with open wiring than with enclosed, as the station attendant in a few minutes walk can see everything and will not have to remove many doors and visit two or three floors to examine the condition of the apparatus.

In all the previous illustrations the outgoing feeders are supplied with current at the generator voltage, while with the subsequent illustrations the generator voltage is stepped up to some higher pressure for transmission. Fig. 9 shows a section through a proposed generating station which is to contain four 1850 Kva, 2,200 volt, three-phase generators, four banks each of three 620 Kva transformers stepping up from 2,200 to 24,000 volts and four 24,000 volt feeder circuits. A complete ring busbar arrangement is provided both for the 2,200 volt circuit and also for the 2,400 volt circuit. In this station a panel board is supplied and back of this panel board is located the structural iron frame work for the 2,200 volt circuit breakers, busbars, and disconnecting switches.

The plan view of the same station is shown in Fig. 10 and the relative location of the switchboard panels and the low tension structure is clearly shown in the gallery. The generator leads are brought to the four circuit breakers in the back of the structure, while the leads to the transformers are taken from these breakers in the front portion of the structure, and are run underneath the galleries. The leads from the high tension side of the step-up transformers are carried overhead to the solenoid operated breakers placed next the outside wall, and from these breakers the leads are taken through disconnecting switches to the 24,000 volt ring bus that is suspended below the ceiling.

As shown on the right hand side of Fig. 9 the leads from the ring bus pass through disconnecting switches and oil circuit breakers to the outgoing line circuit, choke coils and lightning arresters for the outgoing line circuit being provided in the upper gallery. It might be stated that two lines leave each end of the building and these lines are sectioned by means of knife switches in such a manner that there are practically four outgoing feeder circuits from this station.

In Fig. 11 a section is shown through the 2,200 volt and 33,000 volt circuit breaker galleries of the plant for the Huronian Company in Canada, which plant contains four 2,000 Kva 2,200 volt, three-phase generators, four banks of step-up transformers, and two 33,000 volt lines. The control desk and instrument posts are located on a gallery overlooking the generator room and back of the

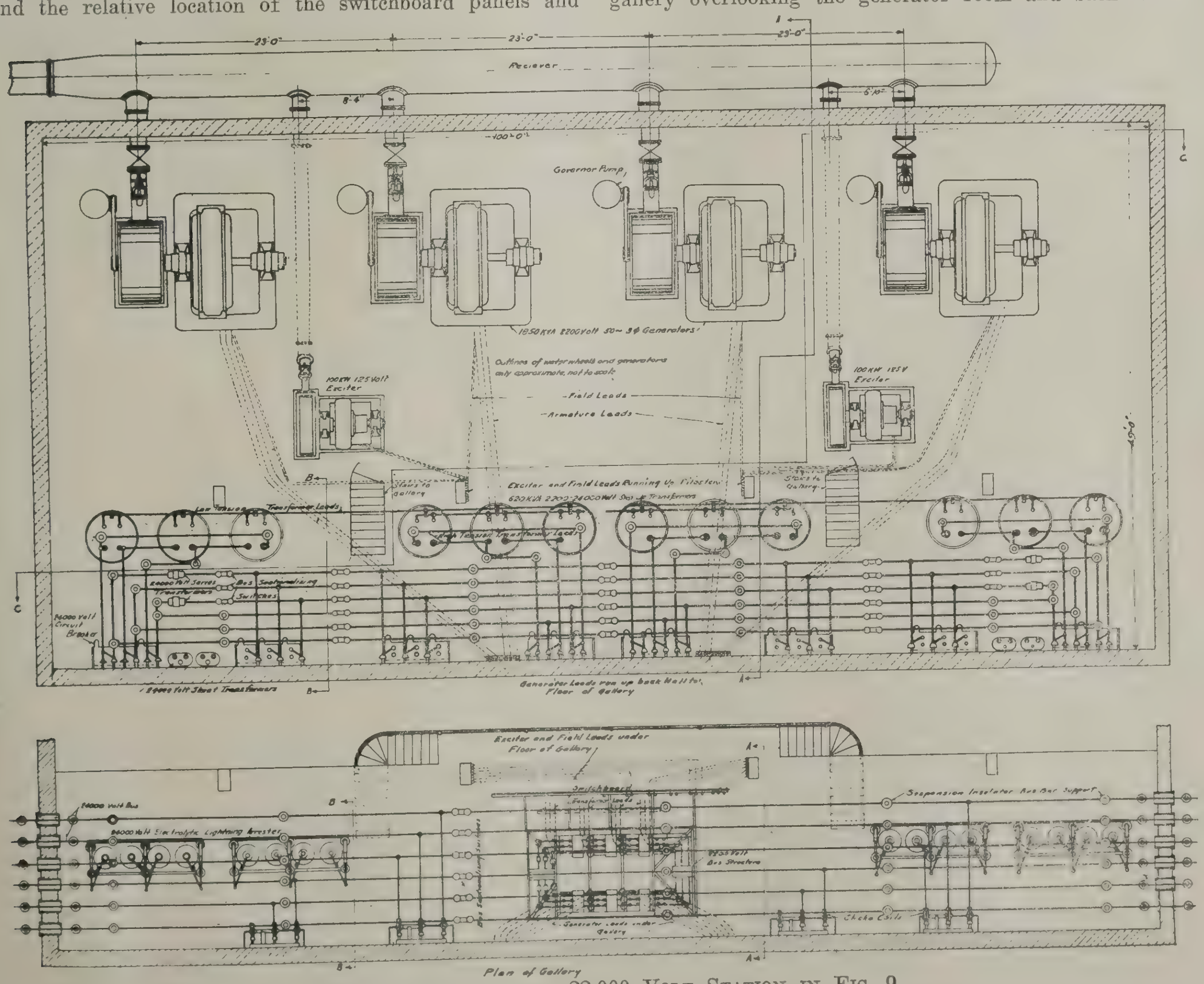


FIG. 10. PLAN OF THE 22,000 VOLT STATION IN FIG. 9.

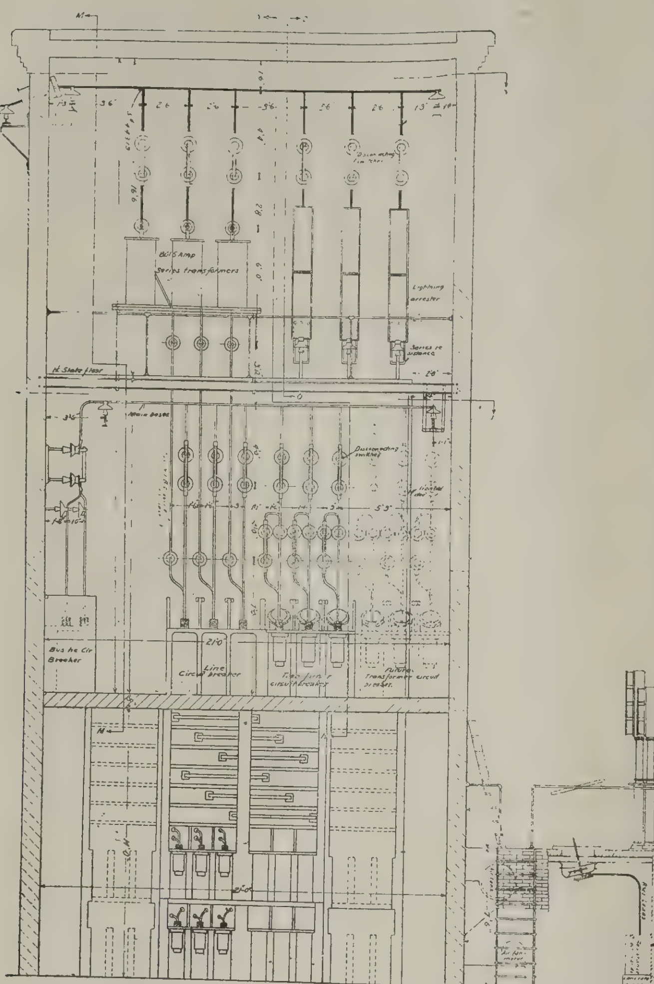


Fig. 11. Section Through 33,000 Volt Station of Huronian Co.

gallery is a wire tower containing all of the switching devices, busbars, etc. This tower forms the outside wall of the middle portion of the building, and on each side of it are located the compartments of the step-up transformers. The high tension leads from the transformers to the oil circuit breakers pass through 12-inch diameter tiles in the wall of the wire tower.

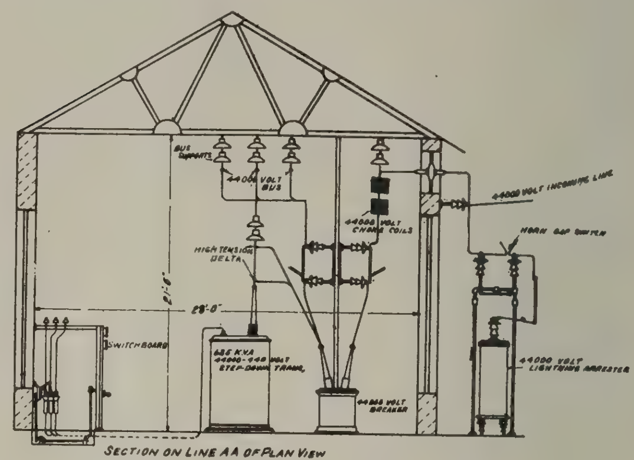


Fig. 13. Section of Station in Fig. 12.

Although the space available in the tower was extremely limited, the low tension room being 16 feet 2 inches wide, 21 feet deep and 14 feet high, provision was made in that room for sixteen 600 ampere and one 1,200 ampere, 2,200 volt three-pole breakers, so wired that any of the four generators or four transformer banks could be connected to either of two sets of busbars. This was accomplished by two rows of busbars arranged in a double deck manner as indicated. The lower deck of busbars in the two rooms was solidly connected together while the upper deck was tied together by a 1,200 ampere, 2,200 volt, three-pole electrically operated breaker. Disconnecting switches mounted in the back of the structure were supplied for isolating the

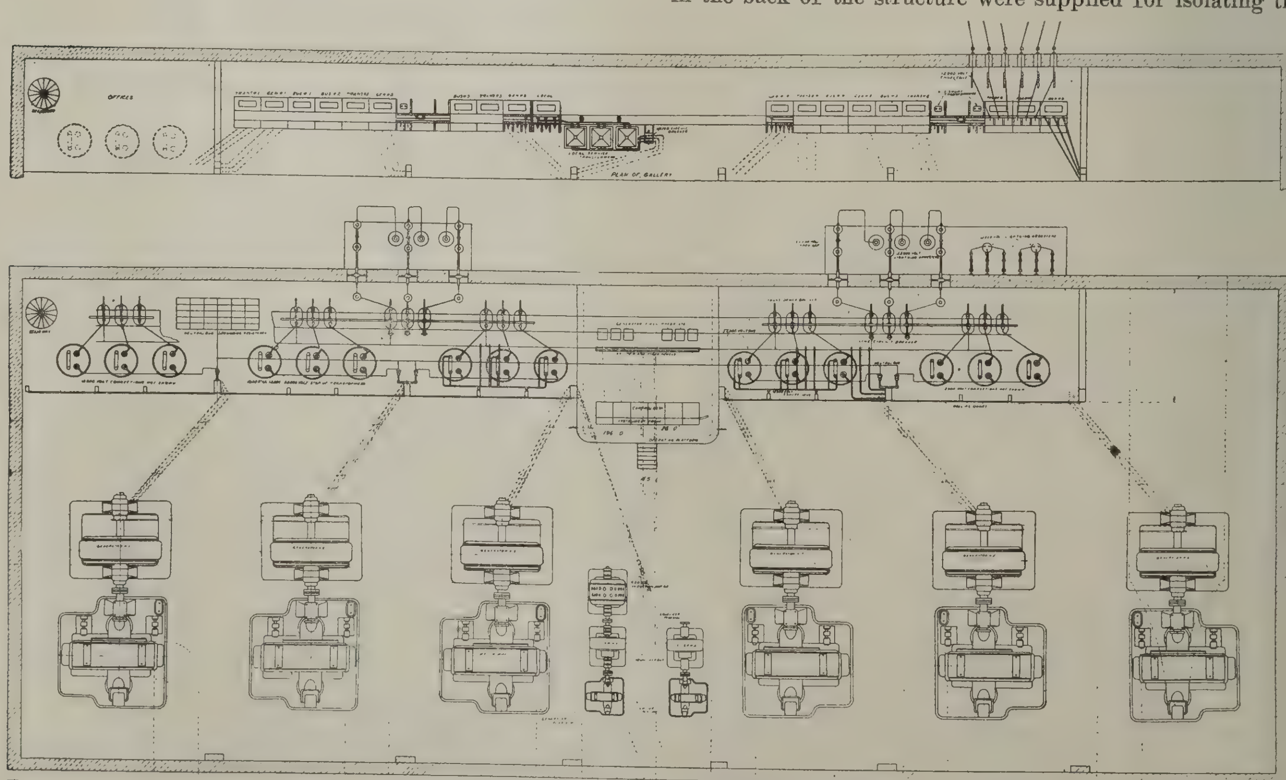


Fig. 12. Plan of a 44,000 Volt Station.

various oil circuit breakers. The entire structure for the breakers and busbars including the horizontal shelves were made out of concrete without any re-inforcement. The concrete for the shelves was made of one part Portland cement and two parts sand, no gravel, and the finished product closely resembled soapstone in its appearance and characteristics.

The high tension compartment, 16 feet 2 inches wide, 21 feet deep, by 32 feet 6 inches high, was arranged to contain seven 100 ampere 33,000 volt, three-pole solenoid operated breakers with disconnecting switches, lightning arresters, etc., with two banks of transformers, and two 33,000 volt lines. The leads from the transformers enter the wire tower through the 12-inch tile duct previously referred to, and pass through disconnecting switches to the transformer breakers, and then through other disconnecting switches to the 33,000 volt busbars. Normally two banks of transformers would supply power to each of two sets of busbars used for the two outgoing feeders, and these two sets of busbars could be connected together through a tie breaker. Disconnecting switches located as shown were used for isolating the various breakers, lightning arresters, etc. The busbars and wiring were all arranged on the open system and to guard against accidental contact all of the busbars, leads, etc., were heavily insulated with oiled cambric until they reached a point where it would be impossible for the attendant to touch them unintentionally.

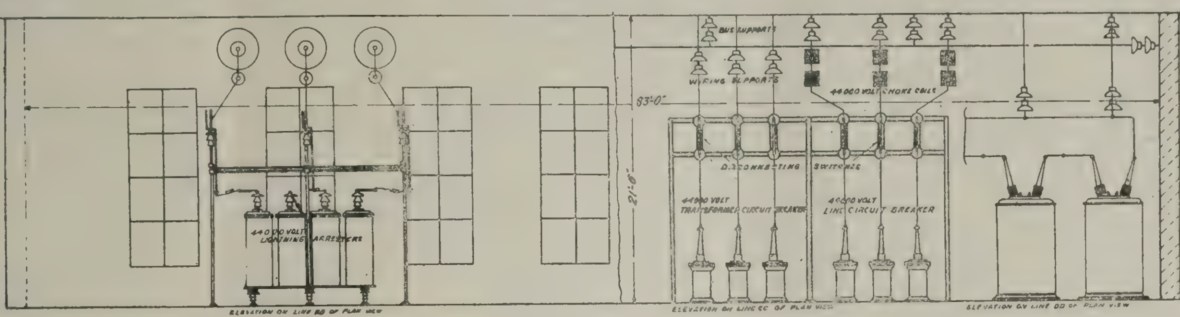


FIG. 14. PLAN OF A 55,000 VOLT STATION.

In Fig. 12 is shown the plan view, section and elevation of a proposed transformer station for the control of two 44,000 volt, three-phase incoming lines, four banks each of three 625 Kva single-phase step-down transformers, and a number of 6,600 volt feeder circuits. It may be noted from this drawing that it is the intention to locate the 44,000 volt lightning arresters with their horn gap disconnecting switches out of doors, while the circuit breakers, transformers, disconnecting switches, and busses are located indoors in the manner shown.

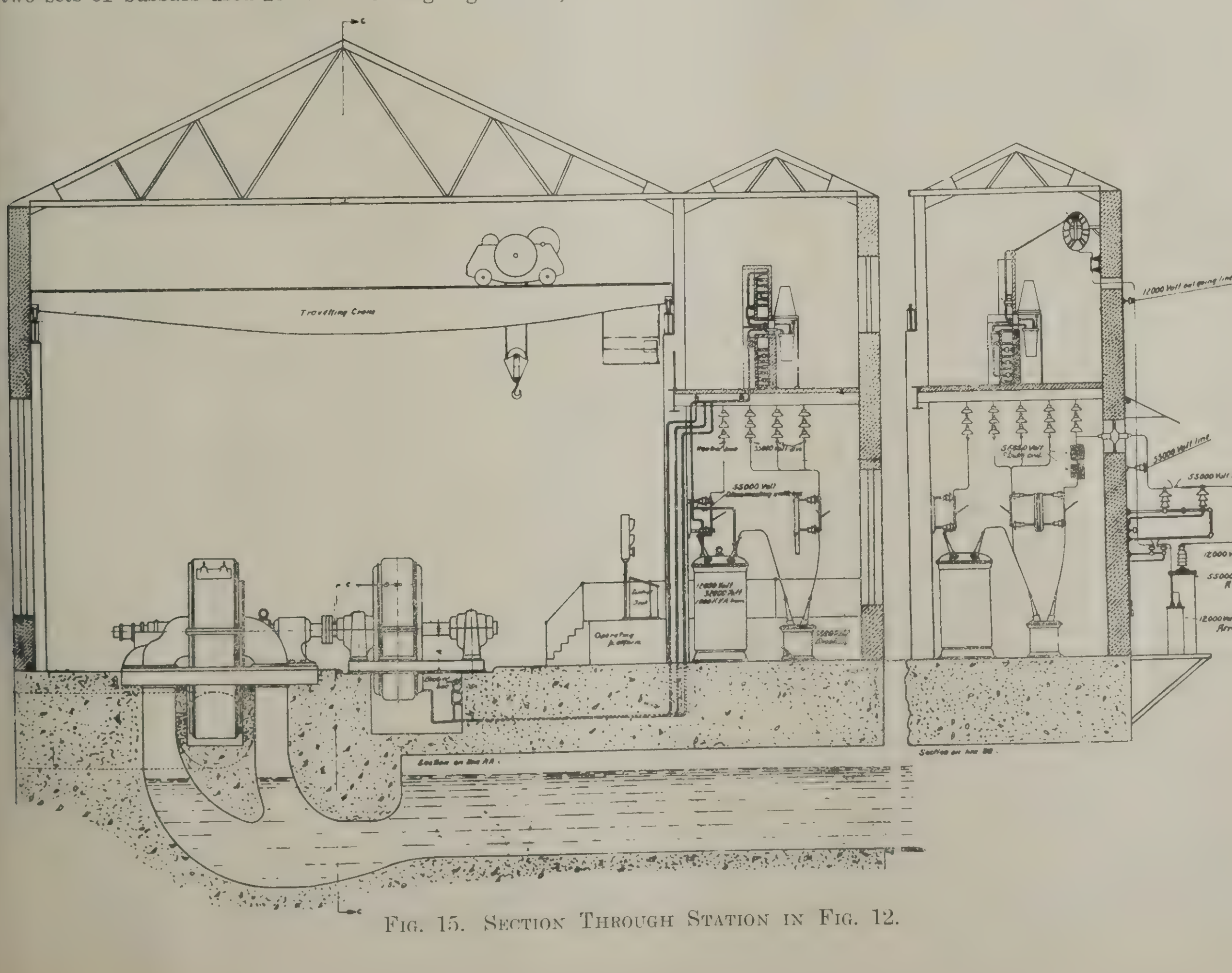


FIG. 15. SECTION THROUGH STATION IN FIG. 12.

The incoming leads pass through porcelain bushings in the walls to the choke coils and through disconnecting switches to the 44,000 volt breakers. From these breakers the current passes through other disconnecting switches to the 44,000 volt bus that is hung from the ceiling by means of suspension insulators. From this bus the current passes through other disconnecting switches to the circuit breakers, and thence to the high tension side of the step-down transformers. The panel board next the wall contains the handles for the distant mechanical control circuit breakers for the 6,600 volt circuit and also contains the controlling devices for the electrically operated bréakers in the 44,000 volt circuit. Owing to the advisability of using direct current for the electrically operated breakers, a small motor generator set and storage battery is installed.

In Figs. 13 and 14 are shown respectively the plan view and the sectional elevation of a proposed generating station that is to contain six 5,400 Kva, 12,000 volt, three-phase generators, five banks each of three 1,800 Kva step-up transformers, two 55,000 volt three-phase feeders and two 12,000 volt three-phase feeders. Each of the first five generators with its transformer bank is supplied with three electrically operated breakers so that while normally each generator will supply its own transformer bank, any generator or transformer bank can be connected to the 12,000 volt busbar.

As may be noted, the step-up transformers with the high tension breakers and busbar are all located on the same floor, the busbars being hung from suspension insulators in the manner indicated. The 12,000 volt circuit breakers with their busbars and connections are placed in a gallery above the high tension room. The lightning arresters for the 12,000 volt feeders and for the 55,000 volt feeders are placed outside of the building, while the choke coils are located inside.

Considerations of Modern Central Station Loads and Equipment

BY F. D. NEWBURY.

DUE to the varied problems presented to the central station manager and to the manufacturers of elecerical apparatus by the rapidly increasing field for application of central station energy, the conditions on such systems are always a subject for study. The paper on this subject presented at the recent convention of the National Electric Light Association at New York City, by the above author, takes up so many interesting details that we publish an abstract of it as follows:

Many of the early and, to some extent, present troubles which have been encountered in alternating-current systems have been due to lack of knowledge of the requirements of the various kinds of load, leading to a choice of unsuitable generating equipment. If some of these danger points can be indicated so that they may be avoided to an increasing extent in the future, the object of this paper will have been fully attained. The range of apparatus and applications to be met with by the central station requires a similar range in experience on the part of the central-station management if the station is to properly provide this diversified service. This experience must be gained both in connection with the proper application of the apparatus with respect to the station equipment and circuit conditions, and with respect to the conditions of service required by the customer. In order to cover these various phases of the subject, the question of the modern load will be dealt with under two main headings: (1) The effect of the load on the station equipment. (2) The application of the station equipment to meet the requirements of the modern load.

EFFECT OF THE LOAD ON THE STATION EQUIPMENT.

In the alternating-current system the characteristic that has led to more trouble in the generating equipment than any other one thing is the effect of loads of low power-factor. A simple way of considering this question is to assume that the actual load can be divided into two components, one equivalent to the energy load, and another equivalent to the combined leading and lagging wattless load. The energy components, in turn, can be divided into the revenue-producing load and the losses, or non-revenue-producing load. The wattless component represents no energy whatever, and is, consequently, a non-revenue-producing load. It is even worse than this, for it not only takes the place of a paying load by loading up the generator and transmission lines, but it actually increases the non-paying energy loss in the station equipment and transmission circuits, and is a more difficult load, ampere for ampere, for the generators to handle.

The wattless component of the load may be a demagnetizing component, such as required by induction motors and inductive loads in general; or it may be a magnetizing wattless load which is supplied by over-excited synchronous motors or static condensers. A distinction should be made between raising power-factor by increasing the energy load and by decreasing the wattless load. While the former is desirable the latter is more desirable, since low power-factor is a positive detriment only when the load is a maximum and station capacity is at a premium, while a decrease in the wattless load is always of advantage, since it means an increase in operating efficiency.

Practically all loads to be supplied by central stations have larger or smaller (and usually larger) demagnetizing components. In laying out a station for a proposed system it is, of course, impossible to exactly predict the power-factor that will result when the entire system is in operation. It is possible, however, to very closely approximate the operating power-factor from experience with existing plants offering similar service.

The following general statements regarding probable power-factors have been abundantly proven by experience:

(1) Operating power-factors above 95 per cent. will be obtained only when practically all of the load is synchronous motors or rotary converters which may be operated at practically unity power-factor; that is, without any wattless

component. Even with this character of load, the generators should be capable of operating satisfactorily at 95 per cent. power-factor to provide for unforeseen contingencies. (2) Power factors of 90 to 95 per cent. can be safely predicted only when the load is entirely incandescent lighting or heating, or if a large non-inductive load, such as synchronous motors or rotary converters, is used with a smaller proportion of inductive power load. (3) For the average central-station load, consisting of lighting and power, a power-factor of 80 per cent. should be assumed. (4) A power-factor of 70 per cent. should be assumed for a plant having a large proportion of induction motors, arc lighting, electric furnaces or electric welding load.

In the above statements, the figures given are conservative from the standpoint of the generating equipment, and, while there probably are stations in which the operating power-factor is higher than stated, it is a part of wisdom in laying out a new plant to estimate on a low, rather than high power-factor, since it does not greatly increase the first cost and will prevent serious trouble.

The determination of the probable power-factor leads up to the question of relative ratings of prime mover and generator. The maximum generator rating in kw. should be equivalent to the maximum engine rating in kw. Since the size of the generator is determined from kva. rating, rather than the kw. rating, the size of the generator for a given engine will depend on the operating power-factor. As an example of the proper method of comparison, assume a generator having a normal rating of 1000 kva. and a maximum continuous rating of 1250 kva. at 80 per cent. power-factor. This is 1000 kw., and the maximum continuous engine rating should be proportioned to 1000 kw. To select the prime mover of a generator on the basis of normal 100 per cent. power-factor always results in an engine or water wheel too large for the generator. The generator can be dangerously overloaded or the engine is operating at partial load, and poor economy and the central station has uselessly increased its investment charges.

KIND OF LOAD.	APPROXIMATE POWER-FACTOR.
Incandescent Lighting with Small Lowering Transformers.	90% to 95%.
A. C. Enclosed Arc Lamps with Constant-Current Transformers.	From 60% to 75%, depending upon whether the Transformers are carrying their rated number of lamps. An average figure would be 70%.
D. C. Metalic Arc Lamps with Rectifiers.	From 55% to 70%, depending upon whether the rectifiers are carrying their rated number of lamps. An average figure would be 65%.
Induction Motors, Squirrel-Cage Rotor, Single Phase, 1/20 HP. to 1 HP.	55% to 75%, average 68%, at rated load.
Induction Motors, Squirrel Cage Rotor, Single Phase, 1 HP. to 10 HP.	75% to 86%, average 82%, at rated load.
Induction Motors, Polyphase, Squirrel Cage, 1 to 10 HP.	75% to 91%, average 85%, at rated load.
Induction Motors, Squirrel-Cage, Polyphase, 10 to 50 HP.	85% to 92%, average 89%, at rated load.
Induction Motors, Polyphase, Phase-Wound Rotors, 5 to 20 HP.	80% to 89%, average 86%, at rated load.
Induction Motors, Polyphase, Phase-Wound Rotors, 20 to 100 HP.	82% to 90%, average 87%, at rated load.
Induction Motor Loads in General.	From 60% to 85%, depending on whether motors are carrying their rated loads.
Rotary Converters, Compound Wound.	At full load the power-factor can be adjusted to practically 100%. At light loads it will be lagging, and at overloads slightly leading.
Rotary Converters, Shunt Wound.	The power-factor can be adjusted to any desired value, and will be fairly constant at all loads with the same field rheostat adjustment. Rotary converters, however, should not be operated below 95% power-factor leading, or lagging, at full load or overload.
Small Heating Apparatus.	This load has the same characteristics as an incandescent lighting load. The power-factor of the load unit is practically unity, but the distributing transformers will lower it to some extent.
Arc Furnaces.	80% to 90%.
Induction Furnaces.	60% to 70%.
Electric Welding Transformers.	50% to 70%.
Synchronous Motors.	Adjustment between practically zero power-factor leading, to zero power-factor lagging.

From the above table it will be seen that the only kind of load which affords any control over power-factor is the synchronous motor. This fact has led to an increasing use of synchronous motors by central stations in order to improve the power-factor of the system. Unfortunately, the complication of a separate exciting source and the ability to start only under comparatively small load, limits the synchronous motor largely to installation at the power station where exciting current and skilled attendance are available and to applications such as motor-generator sets requiring small starting torque. The field of application for the synchronous motor is, however, broadening, and synchronous motors are used to an increasing extent for driving slow-speed air compressors and plunger pumps and high-speed fans and centrifugal pumps.

In cases of low power-factor, where no mechanical or D. C. load is required, synchronous motors have been installed running without energy load, in which case they have been called synchronous condensers or rotary condensers, from the fact that they cause a leading current to circulate as would a static condenser. It is, however, more economical to utilize a synchronous motor for energy load as well as for wattless magnetizing current, since the required capacity of the motor is determined by the geometrical sum of the components (which are at right angles) and not by the direct arithmetical sum. An illustration will explain this. Assume a synchronous motor with 1000 kva. rating at zero power-factor. It can supply, then, 1000, kva. in leading current when operating without energy load except its losses. Without exceeding 1000 kva. total load it can supply 707 kw. energy load (including its losses) and 707 kva. in leading current, which is the equivalent of 1414 kva. capacity if the energy and wattless loads were handled by seperate machines. Under the above conditions the motor would be operating at 70.7 per cent. power-factor. This proposition of enegry and wattless load results in the maximum kva., but the proportions can be greatly changed without materially affecting the arithmetical sum of the two competent loads. For example, at 80 per cent. power-factor, the energy would be 800 kw. and the wattless component 600 kva., or a sum of 1400 kva.; and at 60 per cent. power-factor, the sum will also be 1400 kva. with a range of power-factor of the motor imput of 40 to 90 per cent, the arithmetical sum of the two component loads will vary less than 7 per cent. of the maximum. The statement that such synchronous motors should always be operated at 70 per cent. power-factor has for some reason, gained considerable publicity; but, from the above figures, it is evident that the argument is a little bit strained.

Numerous methods for determining the proper size synchronous motor to effect a certain improvement in power-factor have been proposed, but they are all based on these four propositions:

(1) The actual load on the station can be divided into two right angle components as proviously described. (2) The total energy component of the station load is equal to the sum of all the individual energy components in the sys-

tem. (3) The total wattless component of the station load is equal to the sum of all the individual wattless components in the system, proper attention being given to the kind of wattless component existing. The magnetizing, or the leading, components should be substracted from the demagntizing, or lagging, components. In other words they neutralize each other, and an ideal condition is obtained with regard to power factor when the magnetizing components in the system are sufficient to completely neutralize the damagnetizing components. (4) Since the power-factor is the ratio of the energy component to the total load, the energy component can be determined directly by multiplying the total load in kva. by the power factor. The wattless component can be determined from the relation existing between the three sides of a right-angle triangle when two sides are known.

An example will explain the method of working such problems: Assume that a station has a load of 1200 kilowatts, by wattmeter reading, at a power-factor of 70 per cent. A motor-generator set is to be installed which will have a direct current load of 200 kilowatts, and it is decided to use a synchronous motor, as part of the motor-generator set, of such size that it can raise the power-factor of the combined load to 90 per cent. in addition to carrying the 200 kw. energy load. It is desired to know the required rating of the synchronous motor.

First, consider the exisiting load. With 1200 kilowatts energy and a power-factor of 70 per cent., the total kilovolt-amperes is 1710 (1200 divided by .70). The wattless kilovolt-amperes, as the third side of the triangle, is 1220. Now, consider the combined load. The total energy component will be the sum of 1200 kilowatts for the existing load and 240 kilowatts for the motor-generator set, including its losses, or 1440 kilowatts. This load is to have a power-factor of 90 per cent., in which event the total kilovolt-amperes will be 1600 (1440 divided by .90). This means a lagging wattless component of 698 kilovolt-amperes (the third side of the triangle). It is necessary, then, for the synchronous motor to supply a leading wattless component equal to the difference between the wattless component of the exisiting load, 1220 kilovolt-amperes, and of the combined load, 698 kilovolt-amperes, or 522 kilovolt-amperes. The required capacity of the synchronous motor is, then, the resultant of the energy load (240 kilowatts, and the wattless load, 522 kilovolt-amperes), or 575 kilovolt-amperes. The power-factor of the synchronous motor itself, it will be noted, is the ratio of 240 to 575, or 41.8 per cent. leading. If it were desired to raise the power-factor to 100 per cent instead of 90 per cent., the synchronous motor would have to supply a leading wattless component equal to the total lagging component to the existing load. or 1220 kilovolt-amperes. To raise the power-factor to 100 per cent., the synchronous motor would then have a capacity of 1243 kilovolt-amperes.

It is interesting to note the large increase in capacity of the synchronous motor to raise the power-factor above 90 per cent. In general, it will not be found worth while to raise a station power-factor above 90 per cent., since the investment necessary is seldom warranted by the improvement in operation.

(To be Continued.)

Alternating Current Engineering

(Contributed Exclusively to SOUTHERN ELECTRICIAN)

BY W. R. BOWKER.

IN LAST issue, theoretical considerations of alternating current machines were taken up. More practical forms of motors, as regards the electrical system, are shown in Figs. 48 and 49, in which it will be noticed that the generator armature core and motor stator core are wholly covered by the conductors. In Fig. 48 is shown an outline diagram of the electrical connections to produce a rotary magnetic field by the generation and utilization of a two-phase current, in quadrature.

Three phase currents are likewise employed to produce a rotary magnetic field, and referring to outline diagram Fig. 49, there is shown the electrical connections of the combined system, that is generation, transmission system and motor. If the three-phase alternating currents generated and differing in phase by one-third of a period (120°), be delivered to the motor stator, which is analagous to the primary receiving circuit of a three-phase transformer, and led in through connections at one third circumferential positions of the stator winding, we have a three-phase motor stator circuit, and at a definite particular instant of time, the current flows in at X and out by Y Z circuits. At the next instant it will flow in at Y and out by way of Z X, and at the third instant will flow in at Z and out by YX and so on; this action occurring and repeating at regular successive time interval periods. The number of changes depend upon the frequency or periodicity of the current.

These periodic changes in direction, in combination with the phase difference, will produce a rotary magnetic field. In the two-phase, the only difference is that in one case two-phase currents are utilized while in the other, three-phase currents are employed.

If masses of metal or conductors suitably assembled and free to rotate, are placed within the influence of this rotating magnetic field, they will by induction revolve and be self starting, realizing the condition of an induction motor. The rotors when so constructed are in reality a revolving field magnet, the currents induced in the rotor windings being analagous to the currents induced in the secondary circuit of a two or three-phase transformer. There is this difference however, that whereas in the secondary circuit of a stationary transformer, the result is elec-

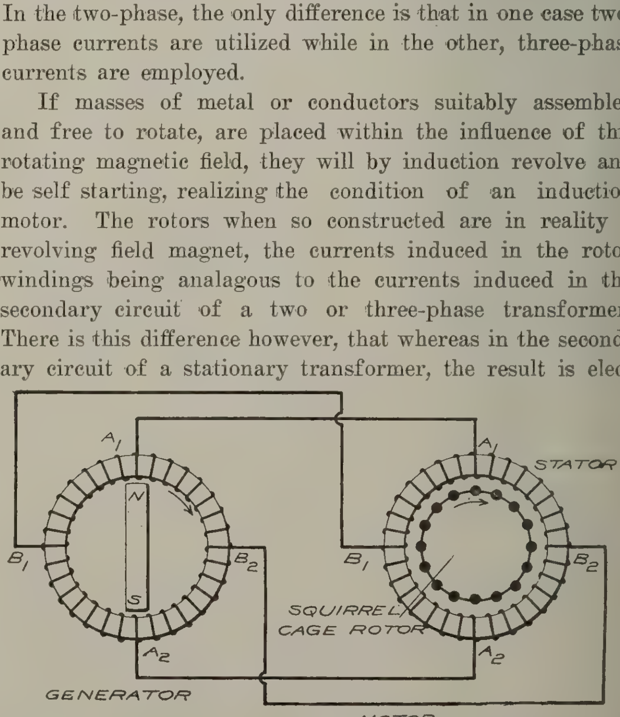


FIG. 48. PRINCIPLES OF TWO-PHASE TRANSMISSION WITH INDUCTION MOTORS.

trical in so far as the induced current and voltage is electrically utilized, in the rotor of a motor the resulting effect is mechanical for the reason that the secondary currents induced therein by the mutual induction of the primary stator currents react upon the primary stator circuit, so as to produce a magnetic drag causing the revolution of the rotor which is capable of doing mechanical work.

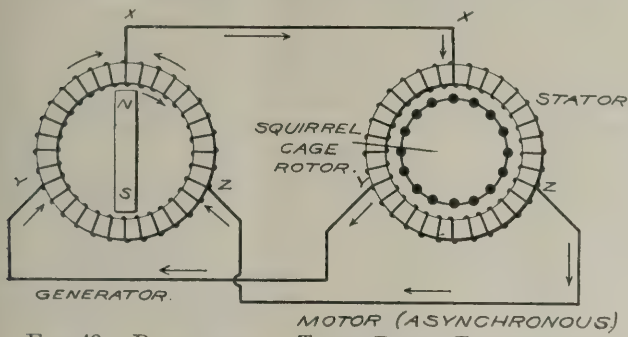


FIG. 49. PRINCIPLES OF THREE-PHASE TRANSMISSION.

The strength of the secondary current induced in the rotor depends upon the relative speed of the rotary magnetic field in the primary stator circuit and the rotor. If the rotor was to revolve at a speed equal to that of the stator field there would be only a very slight or weak current induced in the secondary rotor windings, resulting in a slight magnetic drag and no mechanical torque of a sufficient magnitude to perform useful work. The difference in speed between the stator field and rotor is known as the slip and it is this latter condition that results in the mechanical torque, so essential for practical utilization. If there was no magnetic slip there would be no mechanical torque.

The rotors as shown in Figs. 48 and 49; are practically constructed by embedding or assembling copper rods or bars in slots or holes located around the periphery of a cylindrical core built up of thin iron discs, forming what is known as a squirrel cage rotor (approximating a revolving field magnet). The conductors of this rotor are short circuited both at front and back by a copper tape or other suitable means of connecting the ends of the bars or rods electrically, forming a completely short circuited rotor. The copper rods or bars are of course separately insulated from the iron core discs that support them. The short circuited currents in the rotor produced by the mutual inductive action of the currents flowing in the stator primary circuits or rotating magnetic field, in turn magnetize the iron core in which they are assembled, producing what is to all intents and purposes a field magnet, which by the mutual action between itself and the stator results in a rotation of the free to revolve rotor.

Previous mention has been made that if there was no magnetic slip there would be no mechanical torque. The theory of action will clearly explain this. When the rotor is at rest it is obvious that the magnetic field of the stator as it rotates (consider now the rotating magnetic field) cuts the rotor conductor at right angles and also at the maximum speed. That is the relative maximum speed or rate of cutting is when the rotor is at rest and the primary stator current is flowing with its resulting rotating field. This is the condition for the maximum currents to be induced. The currents induced in the rotor conductors by this action, flow in such a direction as to stop the motor which produces them, according to Lenz's Law of motion due to electromagnetic induction. The magnitude of this is greatest when the current strength is at a maximum and it has just been shown that the current induced is at a maximum when the rotor is at rest, but the stator rotating magnetic field continues to revolve and exerts a magnetic pull or drag on the rotor field, the rotor magnetic field being produced by the induced currents flowing in the rotor conductors. This magnetic pull is greatest when the currents are greatest, therefore it is obvious that the mechanical torque exerted by an induction motor is greatest when the rotor is at rest, for the reason that the magnitude of the mechanical torque exerted by the rotor shaft, depends upon the magnitude of the magnetic drag. The mechanical torque is the effect of a magnetic drag, this latter being the cause and the former the effect.

This action of a maximum mechanical torque just at starting, is in practice the desirable and essential condition required, but it results in a momentary heavy current flowing in the stator as well as the rotor windings. It is evident that as the rotor gradually speeds up, the rate at which the rotating magnetic field cuts the rotor conductors is gradually diminishing. This is on account of the fact that the stator magnetic field and rotor are revolving in the same direction with the result that the current in the rotor windings is diminishing in strength and likewise the magnetic drag and mechanical torque and when the speed of the rotor very closely approximates the speed of the rotating (stator) field, the mechanical torque which the rotor shaft is capable of exerting becomes practically of no value. This is because there is only a very slight current flowing in the rotor windings, in fact when running light, under no load, only a sufficient amount to overcome frictional resistance of the bearings and wind resistance of the moving rotor mass, this slight current being the result of no cutting of the magnetic field by the conductors, therefore when there is no difference in speed between the rotating stator field and revolving rotor that is no magnetic slip, there is no mechanical torque.

This property is a very valuable feature which the induction motor possesses, that is the exerting of its greatest mechanical torque or turning effect at starting and the fact that the torque is increased whenever the rotor speed is reduced by throwing on the load. It is evident that for the rotor to perform mechanical work, it must always revolve at a less speed than the rotating magnetic field of the stator, for if the speeds were equal, there would be no cutting of magnetic lines of force by the rotor conductors, no resulting currents and no magnetic pull or mechanical torque. The magnetic slip varies from 2 to 5 per cent. under general normal conditions of service requirements for large motors, but goes as high as 30 or 40 per cent. in the case of small sizes.

The mechanical torque or turning moment of an induction motor decreases as the square of the impressed voltage, and advantage is taken of this by utilizing auto-transformers for controlling the speed of these motors. This subject will be dealt with in a thorough manner as this article progresses.

There are single-phase induction (asynchronous) motors in practical service which work when supplied with single-phase alternating current. When starting up however, it is necessary to supply them with a two-phase alternating current, this condition being attained by dividing the circuit in each part of which is inserted suitable reactances possessing different properties.

Mechanical Integration by Means of the Planimeter

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

BY MONTFORD MORRISON.

THERE are many methods of mechanical integration and many instruments have been designed to perform the work. All of these instruments are too expensive for the individual student or worker, where such work as integration is only an occasional occurrence. A special mechanical means is therefore more a luxury than a necessity. The following method has been worked out and found successful, using the planimeter as the mechanical means.

Since there seems to be a confusion of names—or rather too much liberty sometimes taken with the flexibility of terms relating to calculating instruments depending upon the area of curves—a brief description of the four most important ones will be given for the purpose of defining them. The planimeter, sometimes called planeometer or platometer, the integrater, the integraph and the wave analyser will be taken up.

PLANIMETERS.

Planimeters are designed for ascertaining by a simple mechanical operation the area of any plane surface represented by a figure drawn to any scale, such as profiles, sections, curves, etc. They are classed as, polar planimeters and rolling planimeters. The polar planimeter, designed by Prof. Amsler in 1856, consists of two principal parts; the tracer arm, carrying the tracing point and the carriage with the measuring wheel, and the pole arm. At the end of this pole arm is fixed the pole, around which the instrument revolves. The area of any figure is readily and accurately obtained by tracing the boundary line with the tracing point, the result is then indicated by the graduated measuring wheel. This original design of the polar planimeter has in the course of time been greatly improved and perfected, and its accuracy, utility and range have been greatly increased. As all the polar planimeters revolve around a fixed point, their scope is limited by the length of the arms of the instrument, which necessitates measuring large figures in sections. The rolling planimeter measures by one operation figures of any length and up to a width equal to the length of the tracer arm. It moves in a straight line on broad, heavy rollers and is specially adapted for measuring the area of long narrow plane surfaces.

The planeometer is intended for the same purpose as the planimeter but primarily designed, it is believed, to do in steps the work of a stereometer, an instrument for measuring the volume of solids. The platometer is also intended for the purpose of obtaining the superficial contents of a surface, but is scarce in America. It was designed in 1851 by John Lang, five years prior to the design of the planimeter, according to records. However, the planimeter, the planeometer and the platometer may be regarded as the same class of instruments, the difference being thought of as a matter of design. The preference of name to use is given to planimeter, the generally accepted term now for all instruments designed for the sole purpose of obtaining the area of surfaces.

INTEGRATERS.

Instruments known as integraters[1] do not come into the discussion in this paper, but to distinguish them from other instruments they will be briefly reviewed. They are somewhat similar to rolling planimeters, but have two and three recording mechanisms, giving area and moment, area, moment and moment of inertia, depending upon the number of recording mechanisms. Electro-motive-force integraters are not considered here[2]. Integraters are usually equipped with two gauges for adjusting the instrument to the axis of moments and are provided with two tracing points for large and small figures. The one nearer the center of rotation of the instrument effects a greater travel of the measuring wheel; consequently the area value of the wheel unit is more accurate. Large figures can be measured in sections. Area and moment of any figure drawn to scale can be easily obtained by means of a formula. The integrater plots the integral curve point by point, like the planimeter method about to be explained, and therefore has no points of preference over the planimeter within its common range of area and integration. Prof. Amsler was the designer of the integrater as well as of the planimeter.

INTREGRAPHS.

Planimeters in German silver cost from fifteen to ninety-five dollars and integraphs of the same material from one hundred and fifteen to two hundred and eighty dollars.

There are several designs of integraphs, which enables one to compute the different moments, curves of stability, etc., the same as with the integrater. In one way, however, they are superior to the latter. While it is necessary with the integrater to compute the several curves point by point and construct them by the computed points, the integraph directly draws the curves on paper, thus giving a graphical representation of the integration. The operator traces the outline of the figure, that is, the differential curve, and the pen or pencil point automatically draws the integral curve. The value of the ordinate of this integral curve can be measured off on the paper or read on a finely graduated bar. This value multiplied by a constant gives the area of the figure. By regarding the new curve and tracing it in the same manner in which the first was traced, the integral curve of the next higher order is drawn, the ordinate of which multiplied by a constant gives the moment of the original diagram. By repeating this operation, the moment of inertia, moments of the fourth, fifth, etc., order can be readily found.

WAVE ANALYSERS.

Wave analysers[3] are somewhat numerous now, seven distinct designs being known to the writer. They are designed for the purpose of determining the harmonic components of periodic motions or motions treated as periodic, either by drawing directly the components on paper or finding their individual altitudes and phase displacement, or determining the co-efficients for a sine series equation, either applied to a motion, an electro-motive-force or to a graph. Some of these instruments have integrating elements, others are combined analysers and *synthesisers,* and may be made to construct the integral of any differential curve by taking the whole or sections and regarding them as periodic. The next step is then to formulate them by the analyser function of the instrument, then integrate them mathematically, and by the synthesiser construct the integral curve.

Because of the integrating functions of these instruments, they are sometimes termed integraters. The designer of a splendid integraph refers to his instrument as a "planimeter." The instrument does compute the area and it therefore might seem that the name "planimeter" in its generally accepted meaning should apply. But the instrument was designed primarily to integrate and all integraphs as well as integraters give the area. Such free use of terms which have come within accepted limits of meaning are misnomers and should be discouraged, as it leads the novice into confusion.

POLAR PLANIMETER.

The following treats the theory of the polar planimeter, the instrument of most interest in this paper. There are several somewhat complete mathematical discussions on the reasons why the planimeter registers the area of any

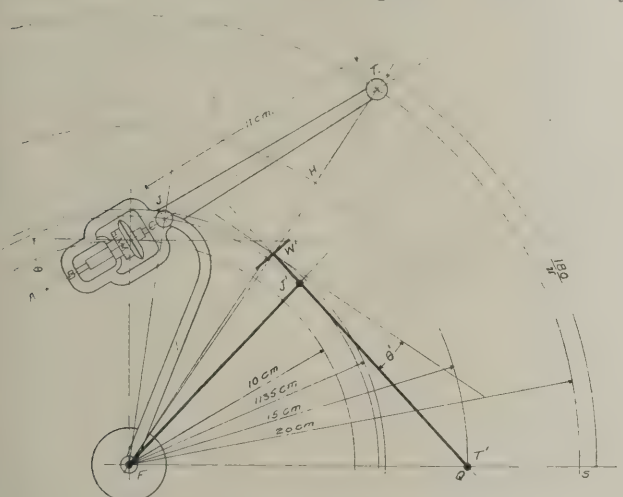


FIG. 1. DIAGRAM SHOWING PROGRESS OF PLANIMETER READING.

plane figure within its range and we shall take a simple case and by following the steps of the theory see it really compute the area in practice. While mathematics may be considered as absolute, because it treats of relative and quantitative values, a graphic demonstration is usually more convincing to the average practical engineer.

In Fig. 1 is shown a type of the polar planimeter with some of its totaling mechanism removed. *J F* is the pole arm, which rotates around the fixed fulcrum *F* and is pivoted at *J* to the tracing arm *A T,* which is thus able to revolve around the fixed point *F* and at the same time receive a circular motion around its axis *J.* The wheel *W* revolves on an axle parallel to the tracing arm bearing in the two ends of the carriage *B* and *C.*

It can be shown that the area of any plane figure within the limits of a planimeter is equal to the area of a rectangle the base of which is equal to length of the tracing arm from the joint *J* to the tracing point *T* and an altitude equal to the length of arc rolled off by the circumference *c* of the wheel during *w* units[4].

A = [(J-T).c.w]/100

Taking *c* equal to 10 and from the dimensions on the drawing,

[(J-T).c.w]/1000 = [110.100.w]/1000 = 11w

It will be necessary to regard Fig. 2, which is an enlargement of the registering wheel *W.* Fancy this wheel held in a fixed axis y_1 y, but free to revolve about this axis. Let any plane surface that moves parallel to the surface of the paper be tangent to the cylindrical surface l m_1, the line of contact being that portion of the y y_1 axis that lies between the limits of the cylinder l and m. Let a point on the tangent movable surface begin at the intersection of P_1 P and l l_1 and move in a direction P P_1 until it falls on the line m m_1. The periphery of the cylinder will have moved through twice the distance between the intersection of y_1 y and m m_1, and the position where the moving point fell on the m m_1 line, or the distance moved by the point multiplied by the sine of Θ. Assuming as before for simplicity, the circumference of the cylinder l m_1 to be 10 centimeters, let the periphery of the smaller cylinder be divided into tenths. Then let it roll on any smooth surface in any direction P P_1, P_1 P or both, the value read from the wheel *W* divided by the sine of Θ will then give the distance or the algebraic sum of the distances traveled.

The problem is to compute the area *T H Q S* in Fig. 2, the dimensions are on the drawing. The first position of the instrument is shown with the tracing point at *T.* The

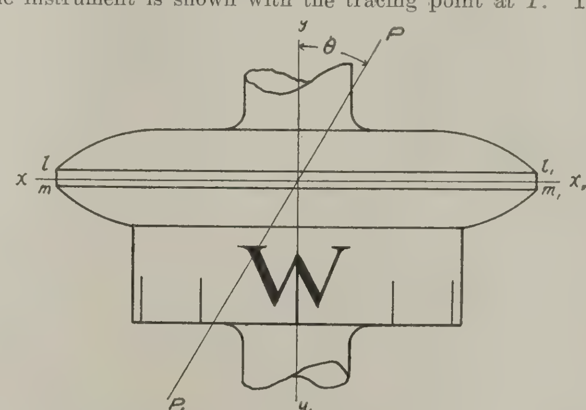


FIG. 2. ENLARGEMENT OF PLANIMETER UNIT WHEEL.

relation of the several members are such that, in this position, the angle Θ in Fig. 1 is 32 degrees. Now if the tracing point *T* be moved along the arc *T S,* the wheel will travel 10 centimeters and the reading will be 10 multiplied by the sine of 32°, equals 5.3 nearly. The distances *H T* and *Q S* are equal and have the same angular positions with the wheel axis when traced, but opposite directions. Their algebraic sum will be zero, hence jointly these two straight lines will have no effect on the wheel. From that we shall not trace these lines, but place the tracing point at *Q* with the 5.3 reading. The planimeter is theoretically represented in its new position by the heavy lines, the prime letters representing the parts as described in its original position. The radius of the circle that the wheel is to roll on when the point T' traces the 30 centimeter-radius arc, was found to be 11.35 centimeters about, and the angle Θ', 13° 35′, approximately.

Viewing the wheel W from the tracing point T, it will be noticed that when the point T is drawn along the arc $T\ S$, the wheel W will revolve in a clockwise direction. Also, the angle Θ is at the right of the wheel-axis, in the plus direction we shall call it, and the angle Θ' (or in fact the angle opposite Θ') is then negative, and therefore if the point T' be moved along the arc $Q\ H$ in a direction opposite to the original movement $T\ S$, the wheel will again move clockwise. The reading of the wheel when the tracing point arrives at H will be 5.3 plus 11.35 multiplied by the sine of 13° 35′, or equals 7.9, equals w. And from equation (a), the area is 11 centimeters multiplied by 7.9 (height by base) equals 86.9 square centimeters, the answer.

It will be appreciated that the numerical values are only approximate as they were taken by comparison from the figure drawn to scale as best we could. The actual average planimeter reading on the figure was 87. The calculated area is one half of $(20)^2$ minus $(15)^2$ equals 87.5, by the formula for area of polar diagrams. The calculated areas being about one-half of one per cent. too large. A precision planimeter was used and at the time of this calculation its mean error was 0000, that is, it was accurate to the last reading. The error in the 87 reading was personal, the error in 86.9 was both mechanical and personal, due to the use and means of the measuring instruments and the 87.5 is absolute, not for the drawing, however, but for the area, the number we attempted to get.

THE THEORY OF THE METHOD.

Integrating by this method depends upon the following proposition: *The integral of the points on a curve are directly proportional to the algebraic sum of the areas between the ordinates at the points and any fixed limits.*

Rather than work out a complete mathematical proof of this theorem, we shall formulate the work and then show it graphically. Probably the most interesting way of working out this method will be with the aid of Fourier's Law and a Sine Series. In any periodic curve resolvable into odd harmonics only, let,

I = integral curve
2π = its period
o = ordinates of the given curve
u = number of radians in $\sin^{-1} y$.
Then

$$I = -\int o\,du \qquad (1)$$

if we resolve the curve into a sine series. Now, integrate this equation between any angular value and that value plus π, as

$$I_{u+\pi} - I_u = -\int_u^{u+\pi} o\,du \qquad (2)$$

Since only odd harmonics are present

$$I_{u+\pi} = -I_u$$

$$\text{and, } -2I_u = -\int_u^{u+\pi} o\,du$$

$$\text{therefore, } I_u = \tfrac{1}{2}\int_u^{u+\pi} o\,du \qquad (3)$$

or the points on the integral curve are numerically equal to one-half the algebraic sum of the areas included between a set of limits, at a distance of one-half the period, on the differential curve, having a period of 2π and resolvable into odd harmonic components only.

Also if the π member of the superior limit be increased by n, n being an odd number, thus,

$$I_u = \tfrac{1}{2}\int_u^{u+n\pi} o\,du \qquad (4)$$

the expression is still an equation, that is, the I_u is the correct relative value for the left hand member and we may express it in this way. The integral for any points on an odd harmonic curve is numerically equal to ½ the sum of the area between limits separated by any odd multiple of π, equation (2).

These equations can also be shown graphically. In the beginning it will be necessary to use the sine and its integral. Let, $y = \sin u$ and $y_1 = \cos u$. And

$$\int \sin u\,du = -\cos u \qquad (5)$$

$$\int \cos u\,du = \sin u \qquad (6)$$

In Fig. 3 is traced the curves, $y = \sin u$ and its integral curve from (5),

$$\int \sin u\,du = -\cos u.$$

Take any point u on the abscissa of the given sine curve and another point $(u + \pi)$. Now, goniometry shows that, $\sin u = -\sin (u + \pi)$ and $-\sin (u + \pi) = \sin (\pi - u)$.

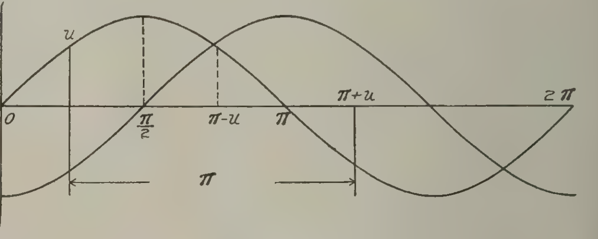


FIG. 3. RELATION OF AREAS TO ORDINATES OF LINE CURVES.

The area between the limits o and u equals that included between $(\pi - u)$ and π. And the area between the limits u and $(\pi - u)$ is the algebraic sum of the area for the half period. We have already shown graphically that the integral of the sine is minus the cosine and it is not necessary to show by a graph that the cosine is numerically equal to one half the area included between u and $(\pi - u)$ or $\pi/2$ and $(\pi - u)$. It is not believed that anything would be gained by treating the areas graphically for the proof is discussed fully in explaining the theory of definite integrals. The symbols representing this theory will be used instead.

Let $(\pi - u) = \pi/n$ a variable, and find the area between the limits $\pi/2$ and π/n.

$$A = \int_{\pi/2}^{\pi/n} \sin u\,du$$

$$= -\Big|\cos u\Big|_{\pi/2}^{\pi/n} = \cos \pi/n \qquad (9)$$

which shows that the integral for any point on a sine curve is numerically equal to the area included between the point and the $\pi/2$ limit. The area included between the ordinates u and $\pi/2$ equals that included between the $\pi/2$ and $(\pi - u)$ ordinates, and the area between ordinates u and $(\pi - u)$ equal twice the numerical value of the integral for either u or $(\pi - u)$. Also that the area between u and $(\pi - u)$ equals the algebraic sum of the area between the ordinate at u and the fixed limits o and π. This is the fundamental principle upon which we shall depend and it will be expanded to give an idea of its limits. The fixed limits mentioned in this paragraph will be discussed later.

Fig. 4 represents a curve of the equation $y_{11} = \sin nu$, where n is any odd number, here n equals 3. It is evident that, if u is always odd, then,

$$\int_u^{u+\pi/n} \sin nu\, du = \int_u^{u+\pi} \sin nu\, du \text{ ---------- } (10)$$

that is, if the inferior limit is constant while the π member of the superior limit is divided by n, (10) is an equation. The cause is this,

$$\left| \frac{\cos nu}{n} \right|_o^{2\pi} = 1/n(\sin 2n\pi - \cos 0) = 0$$

that is, if the value of the superior limit equals that of the inferior, the result is zero. It will be noticed that the cosine of zero equals the cosine of any even multiple of π,

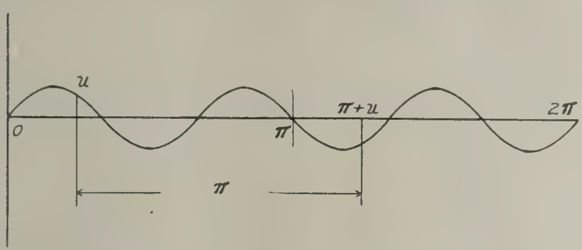


FIG. 4. RELATION OF CERTAIN AREAS OF ODD HARMONICS TO THEIR ORDINATES.

or $n2\pi$. Since one of the multipliers of π is even, the product in terms of π will always be even. This merely means that whole cycles reduce to zero, regardless of the number. We have before (10) shown that the integral for any point on a sine curve is numerically equal to one-half the algebraic sum of the areas between the ordinates and the fixed limits o and π. By integrating the right hand members of (10)

$$\left| \frac{\cos nu}{n} \right|_u^{u+\pi/n} = 1/n[\cos n(u+\pi/n) - \cos nu] \text{ -- } (10\text{-l.h.m})$$

$$= \left| \frac{\cos nu}{n} \right|_u^{u+\pi} = 1/n[\cos n(u+\pi) - \cos nu] \text{ -- } (10\text{-r.h.m})$$

Equation (10—l. h. m.) shows that the integral for any point on the sine $n\,u$ curve has the same relation to the area of its half period that the sine curve has. Equation (10—r. h. m.) shows that the same relation holds true for n half periods of the sine nu, that is, $n.\pi/n$ which equals a half period of the sine curve.

The next interesting point is the comparison of the two equations,

$$I_u = \tfrac{1}{2} \int_u^{u+\pi} o\, du \text{ ---------------------- } (4)$$

and

$$I_t = \tfrac{1}{2} \int_t^{t+T/2} o\, du \text{ ---------------------- } (11)$$

which will show the range of the equation (4). Attention must be called to the fact that one does not often find a sine curve in its original proportions drawn to scale outside of a text-book on mathematics, that is, with an altitude of 1 and the base 3.14159+, approximately, of course.

$$A = \int_o^{\pi} \sin u\, du = 2 \text{ -------------- } (12)$$

Now, if the base is not equal to πh, then the height is not unity and the area is not 2 in terms of the altitude. In a great many books treating electricity, the sine curves are either plotted in the sexagesimal system or their amplitude is increased without mentioning anything about it. If only a diagramatic sketch is desired, this allows the time of the curve to be shortened (or lengthened) which is somewhat of an advantage when the space is limited or when it is desired to call particular attention to certain effects on the curve. If the base equals πh and h the unit, then from equation (12) A equals 2, but if the base equals $2h$, then A equals $2/\pi.2$, which is twice the numerical value of the mean altitude of the curve of unity value or $4/\pi$ equals 1.274. And if the base equals h, which is the case in most oscillograms of alternating current, then $A = 1/\pi.2$, or just the numerical value of the mean ordinate of the unity curve, all in terms of the altitude. It will be noticed that whatever the base length may be the mean ordinate is always $0.637h$. Then base line may be altered without changing the average value. If it is desirable to use the circular system and retain π with its numerical value in some system of units, h may be altered to suit the case. If h equals π then h equals 3.14159+ and the area is $0.637\pi.\pi$, but 0.637 equals $2/\pi$ and therefore the area is $(2/\pi)\ \pi.\pi$ equals 2π, which is numerically equal to the number of radians in the circle. However, if a sine curve be drawn with an amplitude of one centimeter and a base of the same length, we may make π units equal one centimeter. Now if the base were π centimeters long the area would be 2 centimeters, but since it is only π units the area is 0.637 centimeters or 2π units. The units of π may be of any length and if we substitute T for 2π and t for time in place of number of radians (u), we get (11).

According to Fourier's Theorem, any periodic motion admits of resolution into a fundamental, or prime harmonic motion and harmonics having frequencies represented by exact multiples of the prime. Take any curve $Y\ X$, Fig. 5, between any limits $x_1 \cdot x_2$, and consider x_1 $P^1\ P^{11}\ x_2$ as a half period and trace another curve $x_2\ P_{11}\ P_1$ x_3 geometrically similar, but with its sign reversed. Hence with the symmetry shown by the dotted lines, this curve $x_1\ P^1\ P^{11}\ P_{11}\ P_1\ x_3$ is resolvable into harmonic components, being periodic. Curves of this kind of symmetry have only odd harmonics present. Then if the distance between x_1 and x_3 equals T, the integral for any point on the curve $Y\ X$ is:

$$\tfrac{1}{2}b_1 \int_{x_1}^{T/n} \sin\frac{2\pi t}{T}dt + b_3 \int_{x_1}^{T/n} \sin\frac{6\pi t}{T}dt + b_5 \int_{x_1}^{T/n} \sin\frac{10\pi t}{T}dt \text{ ---- }$$
$$+ b_n \int_{x_1}^{T/n} \sin\frac{2n\pi t}{T}dt - b_1 \int_{T/n}^{T/2} \sin\frac{2\pi t}{T}dt - b_3 \int_{T/n}^{T/2} \sin\frac{6\pi t}{T}dt$$
$$- b_5 \int_{T/n}^{T/2} \sin\frac{10\pi t}{T}dt \text{ ---- } - b_n \int_{T/n}^{T/2} \sin\frac{2n\pi t}{T}dt \text{ ---------- } (12)$$

It has been shown already that if we fancy a sine curve plotted in the sexagesimal system, that is, if we take any distance whatsoever along the abscissa, and let its length represent 180° and plot a sine curve using these values, the altitude of the curve being always unity, the average height will always be 0.636+ regardless of the base length.

This fact enters largely into the general application of this method of integration by means of the planimeter. It must be well understood and always considered. In the case of electro-motive-force integraters, there is found a

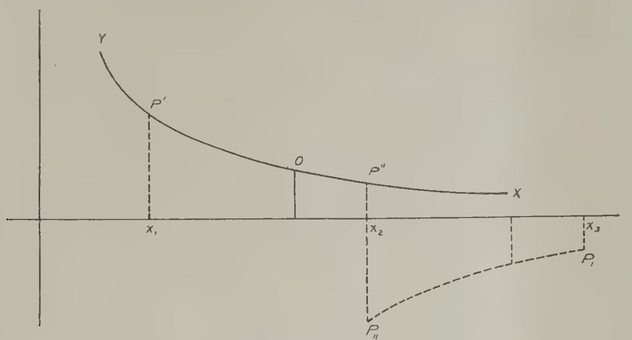


FIG. 5. DIAGRAM SHOWING INTEGRATION OF ANY CURVE.

point of convenience of which we might take advantage in this planimeter method. Since a change in the base length does not effect the average height of a curve, the frequency of the alternating current is not taken into consideration from a mathematical standpoint in methods of integration that are applied directly to an electro-motive-force or to its graphic representation, if the methods depend upon the average heights. Therefore if it is found to be a convenience we may take the algebraic average height of the areas instead of their algebraic sum and the readings will be directly proportional. Algebraic average height may be measured by setting a mean height planimeter to the base of the diagram and tracing a surface clockwise for plus values and counter clockwise for negative values. We then obtain algebraic average height readings in centimeters (most planimeters are so calibrated) and by dividing the reading by 0.4 we get the result expressed in inches. In integrating curves of various base length, care should be taken in evaluating the units in the ordinates of the differential curve.

Attention is directed toward this: The majority of equations representing irregular or broken periodic curves are very inaccurate approximations and should not be confused with (12). In the evaluation of the co-efficients of a sine series equation, by the methods usually taken into consideration only selected points on the curve, n in number and the calculated curve is expected to intersect the given curve at these points. If, however, n were increased indefinitely, there would be an infinite number of points of intersection on the curve and they would coincide absolutely[5]. Also, we shall often find that the adoption of two different methods of integration will give us a different result for the same function. If, however, the work has been correct, it will invariably be found, on examination, that the two curves represented by the two results are exactly the same shape and are exactly alike in every particular except that one is higher than the other by a definite and constant quantity all along its length, and that the one algebraical expression for value of y can be expressed as the sum of the other and a constant. For different values of the constant we should get different curves, but all of exactly the same shape. After the integration has been performed by this planimeter method, it is evident that the axis of abscissas and ordinates may be transformed to agree with conditions or for convenience.

[1]See Barker: Graphical Calculus, Appendix (London, Longmans).

[2]Regarding Electro-Motive-Force Integraters see:
Davenport: Southern Electrician, 42,238 (1911).
Lloyd and Fisher. Bulletin Bureau of Standards, Vol. 4, No. 4, May (1908).
Lyle: Phil. May 6, 549 (1903).
Sahulka: Zeitschrift fuer Elektrotechnik, 16, Seite 4 (1898).
Townsend: Trans. American Inst. Elec. Eng. 17, page 5 (1900).
———: Southern Electrician 43, 60 (1911).

[3]For the mathematical theory of the Planimeter, see:
Nichols and Franklin: Elements of Physics, Vol. 1, pages 7 and 8 (New York, McMillan, 1908).
Osgood: Differential and Integral Calculus, pages 409 to 412 (New York, McMillan, 1907).
For Planimeter settings and calculations see:
Cox: Polar Planimeter (New York, Keuffel and Esser Co).
Wheatley: The Polar Planimeter and its use in Engineering Calculations.

[4]See: "Harmonic Analysis by means of the Planimeter."

[5]Byerly: Fouriers series and Spherical Harmonics, Chap. III. (Boston Ginn & Co.,) 1893.

Motor Vehicles in United Kingdom.

In a recent report by Consul Albert Halstead, of Birmingham, England, it is stated that motor vehicles are used for every kind of commercial purpose in the United Kingdom. For instance, for carrying travelers' samples, the drummer touring the country with a motor vehicle, so as to reach the small towns instead of going by train; as delivery wagons for breweries, railways, bakeries, department stores, fish and poultry stores, hardware, flour and seed merchants, grocers, coal and coke delivery, and for express-parcels service; by the postoffice department for carrying mails not only in cities but between large towns; for road work, one machine being fitted not only as a road roller but as a sprinkler at the same time; railways employ them for carrying traffic and freight from stations at distances in the country, there being parts, for instance, in Cornwall and Devon where a great deal of railway service is done by motors on the roads; for sewage purposes, with a vacuum tank attached; as watering carts; for tower wagons for repairing trolley wires; for fire engine purposes; one manufacturer makes a motor car to which is attached a train of wagons four in number; for omnibuses; pleasure vehicles to carry large numbers of people; for a tipping wagon to carry coal, sand, or gravel; as oil wagons; for the carrying of heavy machinery; with three wheels for quick delivery purposes; for heavy freight from docks and railway stations and elsewhere; in Australia for hauling wool; for agricultural purposes, such as for mowing and plowing, and for almost every conceivable commercial use for which heretofore horses have been employed.

Some of the power is steam, but in most cases gasoline engines are used. Some of the heavier wagons have a carrying capacity as high as five long tons. The tendency throughout the United Kingdom seems to be to use motor propulsion for commercial purposes to a greater and greater degree, and to extend the purposes for which it is thus employed.

There is at present only one electrically driven motor car in use in Liverpool. The fact that there is but one recharging station, which is under municipal control, and the additional reason that the cost of electric propulsion works out in excess of the use of gasoline, account for the practical non-existence of the electric vehicle in Liverpool; and as conditions now are it is improbable that efforts of American manufacturers would be followed by their introduction.

Engineering Features Governing Use of Storage Batteries In Central Stations

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

BY A. N. BENTLEY.

IN THE July issue of SOUTHERN ELECTRICIAN on page 32, appeared an inquiry, taking up the engineering features upon which the choice and use of a storage battery is based for central station service. In view of the fact that this is a question of general interest but little understood in its details, the writer will present in the following remarks, information drawn from his own experience in storage battery engineering and from data gathered as operating results of equipments installed. In order that readers may be familiar with the conditions set forth in the inquiry, it is given herewith as it appeared in the issue referred to: I would like to see a discussion on the advisability of purchasing, installing and operating a storage battery in conection with the necessary generating equipment of a central electric lighting and power or railway station of four or five thousand kilowatt capacity or greater. (1) What conditions would make a storage battery desirable? (2) What would be the advantages to be gained by its installation and use? (3) Would not its high first cost more than counterbalance the advantages gained by its use? (4) Will nit its first cist prohibit the installation of a battery whose ampers hour capacity is greater than the stations largest generating unit? Thus say in a station of 4,000 kilowatt capacity whose generating capacity whose generating units were of the following sizes, three 500 kilowatt, two 750 kilowatt and one 1,000 kilowatt, would it be advisable to install a storage battery of a greater ampere hour capacity than the full load ampere capacity of the 1,000 kilowatt unit? (5) Assuming the battery to have been installed, what if anything besides assistance in the regulation of the voltage is to be gained by allowing the battery to float upon the station bus-bars during times of non-use or during times when it is neither charged nor discharged? (6) Would the regulation of the voltage afforded by floating the battery on the station bus-bars be equivalent to the regulation afforded by the installation of automatic field regulators or rheostats on the generators? (7) What can be said in favor of the installation of a storage battery at a remote point, say 5 or 6 miles from the central station on a railway feeder which is supplying a short suburban or interurban railway line.

The use of storage batteries in central electric lighting and power or railway stations can be divided into two general classes, as follows: (1). Batteries for regulating a station load which is subjected to frequent and extreme variations. (2). Batteries for emergency service of which there are two general classes: (a) Emergency, or "Stand-By" batteries used in connection with Edison three-wire distributing systems. (b) Exciter batteries, used to insure against a failure of exciting current from any cause whatever.

REGULATING BATTERIES.

The conditions which make a regulating battery desirable are, in general, an extremely variable load such as a railway or a manufacturing plant using heavy, motor-driven machine tools and cranes. Also where a plant carries such a variable load and, at the same time, furnishes lighting service from the same generators, the battery is especially desirable. The value of a storage battery under these conditions can best be illustrated by observing the results obtained in an existing installation. Figures 1 and 2 show the load on a large manufacturing company's power plant. It will be observed that the average day load was 1,800 amperes, or 470 K. W. with a maximum of 3,600 amperes, or 935 K. W. The average night load was 2,650 amperes, 690 K. W., with a maximum of 4,500 amperes, 1,170 K. W. The powerhouse equipment consisted of three 550 K. W. and one 200 K. W. 260-volt, direct-current generators, supplying light as well as power. Wattmeter readings, taken before the installation of the battery, showed an average load during the day of 520 K. W. and during the night of 830 K. W., the increase at night being due to the lighting load. To carry these average loads, on account of the heavy fluctuations, it was necessary to operate two 550 K. W. units during the day and three during the night; the load factors being 47 per cent. and 50 per cent., respectively. It was, moreover, impossible to maintain a steady voltage as the sudden fluc-

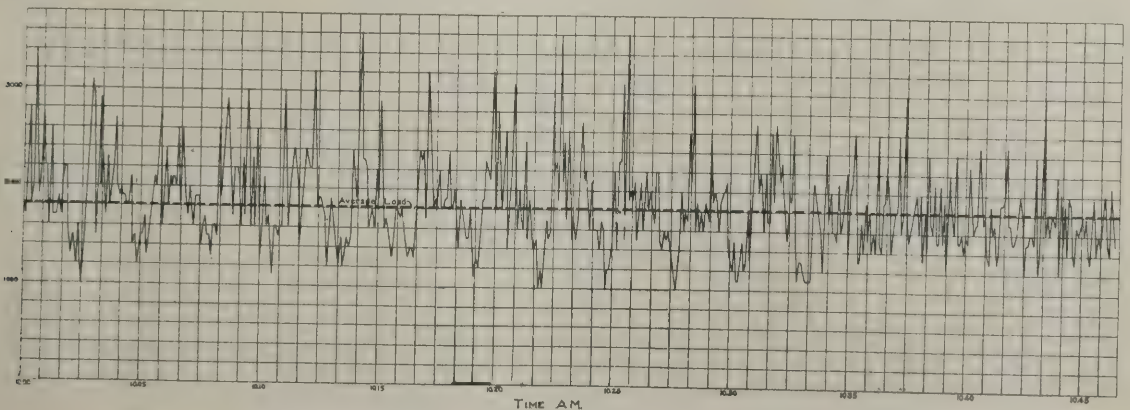


FIG. 1. AVERAGE MORNING LOAD CURVE ON A MANUFACTURING COMPANY'S PLANT.

tuations would slow down the engines before their governors could operate. The conditions under which the engines were operating are well illustrated by the engine indicator diagram, Fig. 3, which shows the variation in load during a period of five minutes.

At the time the battery was installed the company was making additions to its works which, it was estimated, would increase the average load on the station by 500 K. W. As the power plant could not furnish this increase and have sufficient apparatus in reserve, it was necessary to increase the station capacity, which was done by installing a storage battery. Figure 4 shows the load after the addition to the plant has been completed. It will be observed that the load varied between 2,100 amperes and 5,900 amperes while the variation on the generators was between 3,350 amperes and 3,850 amperes, the battery taking the difference. Fig. 5 shows the effect on the engines of the regulating work done by the battery.

In this instance, therefore, the battery took the place of an additional 550 K. W. unit and, with an addition of 500 K. W. to the average load, there is still the same generator capacity in reserve as before. Moreover, in case of a break-down of one of the larger units, the battery has sufficient capacity not only to take the fluctuations in load but to supply the current that had been furnished by this unit until a reserve unit could be put in service. In this manner reliability of service was assured. It is then clear that the advantages gained by an installation of this character are as follows: (1) A greatly improved load factor resulting in a saving in fuel of from 20 to 33⅓ per cent. (2) A proportional saving in oil, waste and depreciation of generating apparatus due to the operation of the engines at a steady load. (3) The elimination of shut-downs due both to the reserve capacity of the battery and to the greatly decreased wear and tear on the engines and generators. (4) The elimination of fluctuations in voltage on the lighting circuits.

In regard to the first cost of a battery installation of this character counter-balancing the advantages gained by its use, such is not usually the case. The cost of the battery in the instance cited above was no greater than would have been the cost of the additional engine, generator and boiler equipment which it would have been necessary to install if the battery installation had not been made. A conservative estimate of the saving in fuel alone effected by this installation is over $7,000.00 per year and the oil and waste used at present, in spite of an increase of 75 per cent, in the average load, is actually 25 per cent. less than it was before the additional load was taken on.

Whether or not a storage battery will prove to be a profitable investment depends largely on local conditions effecting the particular power plant in question. The larger battery manufacturers employ engineers, expert in their line of work, who will make a thorough study of con-

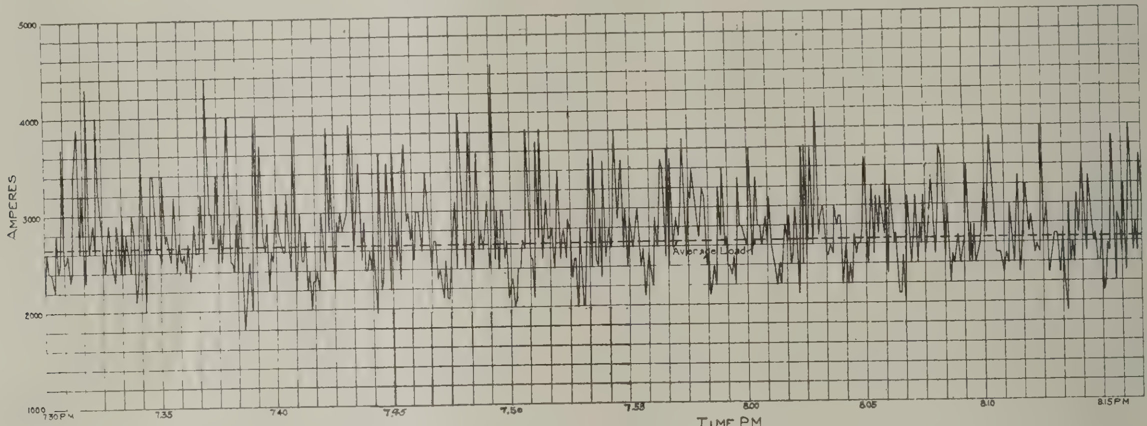


FIG. 2. AVERAGE EVENING LOAD CURVE ON SAME PLANT AS FIG. 1.

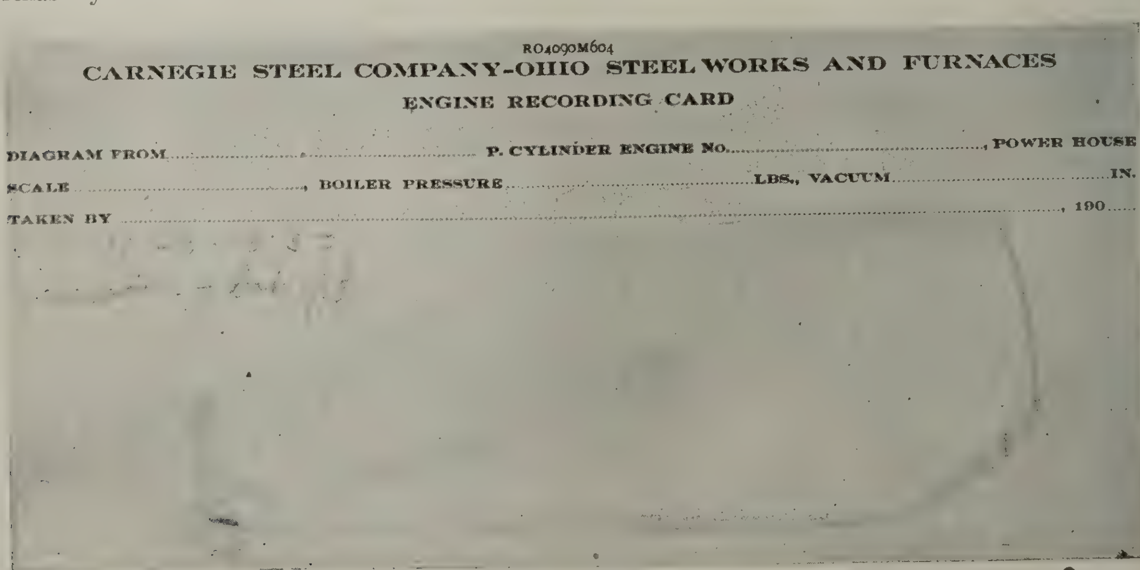


FIG. 3. INDICATOR DIAGRAM FOR ENGINE OF PLANT IN FIG. 1, SHOWING LOAD VARIATION FOR FIVE MINUTES.

ditions and submit a report on the results which can be accomplished. If a battery would not be a good investment, the battery engineers will not recommend it on account of the effect which an unprofitable installation would have on their future business.

The questions numbers 4, 5 and 6 evidently do not refer to a regulating battery as the ampere-hour capacity of a battery of this type is fixed, not by the capacity of the station units, but by the difference in amperes between the average load and the maximum fluctuations. In this class of service, batteries usually work at from two to two and one-half times their one hour discharge rate as given in the manufacturer's catalogues.

FIG. 4. LOAD CURVE OF SAME PLANT AFTER AN ADDITION INCREASING LOAD BY 500 K. W. AND AFTER THE INSTALLATION OF A STORAGE BATTERY.

EMERGENCY BATTERIES.

The conditions which make an emergency or "Stand-By" battery desirable arise in stations having an Edison three-wire D. C. system of distribution through the business section of the city which they serve. The writer is not aware of any battery installation in which the battery is used as an emergency source of power on an alternating current distributing system. To operate a battery on such a system would necessitate the use of motor-generators or rotaries of K. W. capacity practically equal to the maximum load on the generating station or, at least, to that portion serving the business district.

To obtain and hold its business in the business districts of the large cities, a central station must be in a position to give absolutely uninterrupted service and steady voltage. One or two failures on the mains supplying the large retail stores, office buildings, theaters, and others, would immediately result in the installation of private isolated plants and the loss of income to the station might be sufficient to seriously embarrass the company financially. The largest central station companies have found from experience that the best method of distribution for the congested business section of the large cities is the Edison, three-wire, D. C. system. Usually, sub-stations are located at points near the centers of distribution, these sub-stations being supplied with alternating current from the main power house, the alternating current being converted to direct current by rotary converters. The residence sections are supplied with alternating current only. The possible causes of failure of these sub-stations are: An accident to the rotaries; failure of the A. C. supply; grounds and short-circuits on the D. C. feeders; sudden increase in load at a rate too great to allow sufficient time for starting spare units.

As a provision against failure from any of these causes, storage batteries are installed in each sub-station, the batteries being constantly connected to the bus bars, ready to take up the load instantly in case of necessity. The batteries are usually designed to carry the maximum load to which the station is ever subjected for a period of about fifteen minutes. Owing to the fact that there is practically no limit to the ampere discharge capacity of a storage battery up to a dead short-circuit, these batteries are designed for very high discharge rates for short periods of time. Their capacity is sufficient to carry the entire sub-station load for a period sufficient to enable the station operator to start up his spare units or make temporary repairs in practically any case of emergency. They will quickly burn out any ordinary short-circuit or ground on the distributing system and will take up any rapid increases or decreases in load, thus holding the voltage of the station constant.

On account of the exceedingly high discharge rates of such batteries, their cost is low per unit of K. W. output. The battery should be designed to carry the maximum load on the station and not simply the full load of one or more

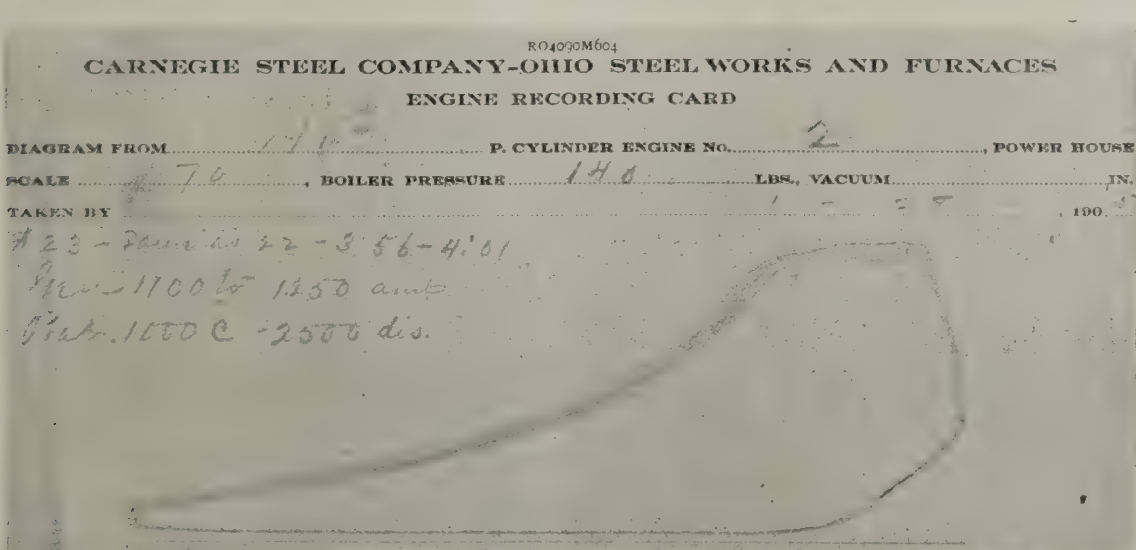


FIG. 5. REGULATION OF THE BATTERY AS SHOWN AT THE ENGINE FOR SAME PERIOD AS IN FIG. 3.

of the generating units. The question of whether or not an installation of this character would pay depends entirely upon the value which the central station places on uninterrupted service. The president of one of the largest central station companies in this country once made the remark, on the occasion of a temporary failure of one of his main generating stations, that his batteries had paid for themselves in twenty minutes.

EXCITER BATTERIES.

The exciter battery is installed to insure against failure of excitation current. This type of battery is usually quite small and consequently, inexpensive. When installed in a station not using automatic voltage regulators, the battery is connected directly across the exciter bus, a number of end cells being provided to enable the station operator to raise or lower the number of battery cells in circuit with changes in the exciter bus voltage. In stations using automatic voltage regulators, a "booster" is connected in series with the battery so as to automatically adjust the battery voltage with changes in the bus voltage and prevent the battery from charging or discharging. Automatic voltage regulation can also be obtained by means of the battery booster and certain auxiliary apparatus. This type of installation, like the "Stand-By" battery depends for its value on the attitude of the central station toward failure of power.

LINE BATTERIES.

In answering question number 7, let us again refer to an existing installation. A road operates from A to B, a distance of fifteen miles. The average voltage over the system is 500 and the average current is 200 amperes. The power house contains two 250 K. W., 500-volt generators. The grades on this road are heavy and the current taken by the cars in starting made it necessary to operate both generators, although the average load was only 100 K. W. This meant a low load factor and no spare unit.

The drop in voltage over the trolley and feeders when a car started near the B end of the line was so great that schedule speed could not be maintained and the slow speed of the motors increased the current consumption and made matters worse. A battery was installed eight miles from the power house and 3½ miles from B. The capacity of this battery was only 50 amperes for 8 hours, but it will supply 600 amperes for short periods. The battery voltage is 500. It is connected directly across the trolley and track, without any attendant, and does its work as follows: When a car starts at B, the current, instead of coming over 11½ miles of copper from the power house, comes from the battery, 3½ miles away. The drop in voltage at B is, therefore, only one-third as great as before. As the car leaves B, the voltage improves until it passes the battery. Between the battery and the power house the voltage is never as low as it was at B, because the current is divided between the battery and the power house. After the car passes the half-way point, the voltage at the battery rises and current flows in, charging the battery for the next car.

The installation of this battery has resulted in shutting down one generator, thus giving a spare unit and improving the load factor. The battery is also used to supply power for shifting cars at night, the power house being shut down. The saving in coal for nine months after installing the battery, over the same period of the previous year, was $1,590.30. The road also has had 50 per cent. less armature and field trouble and a noticeable reduction in lamp renewals. Under normal conditions, this road operates three cars, but since the battery was installed, they have on several occasions operated excursions of fifteen to twenty cars and have had excellent voltage over the entire line.

Maintenance of Telephone Exchanges

BY C. P. GRIFFIN.

ONE of the papers presented at the Annual Convention of Telephone District Superintendents, at Halifax, Nova Scotia, contains so much practical routine information in connection with telephone exchange upkeep, that we publish the following abstract:

In order to have and keep a perfect mechanism of any kind, it is essential that each and every element be kept in such condition that its particular part in the whole scheme is correctly performed, for one jarring unit will disrupt what would otherwise be, when applied to the case in hand, a perfect service.

Taking first the central office with its complex common battery equipment, a volume could be written on this alone and be instructive and pleasing throughout. It is intended, however, to touch but lightly a few points concerning the method of caring for this part of the plant not only in eliminating faults that have become self-evident, but also with the idea of forestalling those that are liable to occur.

The wire chief comes on duty at seven o'clock a. m., and at once makes a voltmeter test of all long distance lines before the day's business has fairly started, the readings, condition of switches, etc., being noted and filed away at the end of the month for reference. In addition, we keep a record of all long distance troubles much in the form of a diary, each circuit being alloted a page on which we note all troubles occurring on that circuit, time out of service, nature of trouble, when and where found, when and by whom cleared and cost of clearing.

This has a decided advantage as a record inasmuch as each individual circuit having its allotted space in the book, its record can be had at a glance for months past as to how much loss of time we have had, and the cost of repairing. I might add in passing, that this record has proven its value in securing two corrections, the total time long distance lines were out of order during the past few months. In view of the fact that we had such an excellent paper on long distance maintenance at our last meeting, it was not my intention to touch on it at all, but as the foregoing forms a part of our daily routine it has been included.

Following the above a test is made of all local troubles reported during the night, or that have indicated their existence so that, when the lineman is prepared to take up the work he can tell by a glance at the trouble ticket what he is required to do, and form a good idea of what material he will need to put faulty lines in good condition again. In order to keep posted on the insulation of the exchange, we make a voltmeter test of the entire local board once a week, and in that way find many times, faults that, while not heavy enough to actuate the line signal, are still pronounced enough to materially affect the service. These are at once followed up and in many cases we find that in so doing we have disclosed a condition that if not rectified at once, would have had consequences of a serious nature and I think that very often faulty transmission on long haul connections are due to these defects in local terminals.

The interior plant does not as a rule, give very much trouble, cord troubles, adjustment of signals and occasionally a defective ringing key, but in the small plant, unless it happens that some accident has befallen such as a cross with high tension, a very limited amount of time will clear up the central office derangements. In my opinion there is no part of the plant that should be more carefully cared for than the power room, inasmuch as the entire system depends wholly upon the effectiveness of the source of energy.

In our own case a careful inspection of the apparatus is made daily. Our ringing machines are tested to assure ourselves that they are up to standard and performing properly, the storage batteries are inspected not only on charging days but every day at some time each cell is thoroughly examined, not alone to learn the specific gravity and voltage readings, but to guard against shortcircuiting, or buckling of plates, or other defects creeping in. The power board and charging motor are carefully gone over after each charge, parts burnished, etc., and in fact to sum it all up we aim to keep this room which should be the principal care of the wire chief neat and clean and the apparatus fit for the closest scrutiny at any time.

Too much cannot be said in favor of a premises well kept, particularly those affording a public service. There are always those among our patrons who appreciate a look through our plant, and what more likely or natural than they should place the quality of service rendered on a par with the conditions as they see them. It is customary with us to invite the public to look through the plant, and I feel safe in saying that a little courtesy and a desire to get them in closer touch with the practical end of the business will send them away with an altogether new idea of what it means to give telephone service, well pleased with their call, and feeling that we are interested in them over and above the total yearly rental.

Just a few words in passing in reference to the stock and method of keeping it. While it is essentially the wire chief's duty to look after this end of the business, it is not possible for him to be in touch with it at all times, assuming as he does his share of repairing, installing, and in fact anything that requires attention. We therefore keep a book in the stock room in which each man enters whatever stock he takes out or returns, specifying to what it is to be charged or credited, and from this each day the wire chief transfers it to a form, which in turn is handed in weekly and entered in the stock ledger. While this may involve a slight increase in clerical work, it is far more than offset by the facility and accuracy with which we can check up our stock at any time.

There is no public utility that, in my opinion, has so few allowances made for breaks in the continuity of the service, which in the natural order of things must occur, as the telephone. The water supply may be shut off, light and power be intermittent, and there is little or no complaint, such things evidently being taken much as a matter of course, but let the telephone communication to the office of the business man or, in fact to any subscriber, be interrupted for even a very brief time and at once an emphatic protest is in order. I choose to consider this as proof positive of the fact that, of all mechanical appliances of modern times, the telephone is the most indispensable to the business man, rather than any desire on the part of patrons to make fewer allowances for the troubles incident to the making and furnishing of telephone service.

In view of the foregoing it is of the utmost necessity that prompt and thorough attention be paid to the most trivial complaint, and to so rectify a fault that it will not be repeating itself at intervals, for nothing is more annoying to both subscriber and management than repeaters among trouble complaints. We have made it a rule to call and inspect instruments in the case of each and every complaint originating with a subscriber, even though morally sure that there is nothing wrong. This may seem at first glance a trifle extreme, but the fact of going and examining the telephone is ample proof to the subscriber that we are anxious to render him the best we have in the way of service, whereas a simple calling up test signifies to the subscriber anything but a real anxiety to make the service right. To my mind, the only safe way is to assume that there is trouble, until you have proven positively that it does not exist, in each case referred for test to the wire chief. Something must have occurred or existed to cause the defect complained of, and a close study of this part of the work in the past has convinced me that the number of complaints originating with subscribers, which after a diligent search for the trouble have proved to be groundless, is so small as to be not worthy of notice.

If subscribers have been used to a good or superior service they will be quick to notice any deterioration from it, and it is well to concede that they know what they are talking about when they complain, and to so treat them when calling to attend to the faulty instrument that they will feel their particular case is the only care you have in the world. Talk to them, ask them to explain just what was the nature of the trouble, if it has been more noticeable with any particular party with whom they may have been connected, for very often by a few such questions the disturbing element may be found at some distance from the complaining party. In this connection I have in mind a lineman who upon being given a "Can't hear" complaint took up the wire on trouble cord and called the party, asking him if he heard him all right. On being answered in the affirmative, he replied that he was just testing and that the phone with whom subscriber had been connected must have been in trouble, and hung up his receiver. Now it can readily be seen that this is all wrong. In the first place, the lineman knowing the complaint to be "can't hear" would naturally do his best to make himself heard; and second, to admit that the other phone must have been in trouble and making no inquiry as to whose and where it was, showed anything but a desire to furnish good service.

It cannot be supposed that this party was as well satisfied as if the lineman had gone to and thoroughly inspected his telephone.

The theory of clearing up trouble in common battery sub-stations can be mastered with a very little study and thought. Take a drawing of any of the several types in use and it can at once be seen how readily each and every part can be tried out with nothing but a receiver, and without calling in for a test at all. Of course defects are found, as some linemen find them, by first changing this and then another part of the instrument until finally the affected part is reached, but how much more satisfactory to know, before starting to cut first this and then that wire, just what is wrong and then proceed to rectify it intelligently.

This, it seems to me, should be a source of keen satisfaction as against the practice of changing entire instruments having someone else clear up the trouble, thus building up the expense, having on hand an over supply of second-hand instruments; and the man who cannot or will not be taught to clear trouble in this way is not nor ever will be a telephone man.

The same course of procedure can be applied to sub scriber's lines; that is, the lineman can test his own trouble. Using as we do a grounded battery it is the simplest thing imaginable to pick up with a receiver an escape either to a ground or a short circuit that would by no means actuate the line signal, run them down and call the office only to report the circuit O. K.

Too much emphasis cannot be placed on the necessity of making repairs thorough. Temporary work in this connection is practically inexcusable, and will surely come back at you some decidedly disagreeable day and you must perforce go and rectify that which should have been properly repaired at first. This method of doing work implies not only gross negligence, but also absolute lack of interest in the company's plant, and the quality of service rendered the subscriber, and it is very probable that the lineman who looks after his employer's interests in this way will frequently be heard expressing wonder why some other man gets a higher salary than he. Be it understood that this is not a criticism of any particular man or exchange, but I venture to say that we all find at times just such conditions in our plant, and I think we realize how much more difficult and unsatisfactory it is to bolster up a poorly constructed piece of work than to do it properly in the first place.

In conclusion I would like to suggest that we cannot take too much pains in the instruction of the boys turned over to us for training. We can easily fit them for greater responsibility by practical talks and demonstrations at convenient times, and further, if they meet with obstacles they cannot overcome, take them in hand and with a timely suggestion here and there, they will, if they are the right kind of stuff find their way out of the difficulty and will not readily forget the lesson. It seems to me that if we do this to the best of our ability, when the way opens for a step higher up the man will not be wanting.

Modern Street Lighting in Warren, Ohio.

Adequate street lighting is growing more and more in favor in American cities. This is demonstrated by the efforts many municipalities are putting forth to secure better lighted streets, a notable example being furnished by Warren, Ohio, a city of about 12,000 inhabitants. For two years the Board of Public Service has been busy with the problem of giving Warren an efficient and effective street lighting system. The old arcs so long in use, have at last been discarded, the streets now illuminated by a complete installation of Mazda street series incandescent lamps. The installation is unique from the fact that no other city has yet adopted this style of lighting, to the exclusion of all others.

On the downtown streets and around the spacious park an ornamental lighting system employing standards has been installed. The majority of these support three lamps enclosed in large white globes and the artistic features of the complete standard add much to the attractive appearance of Warren's business streets. The lighting system in the residential streets, though not so spectacular as that just mentioned, is characterized by neatness and utility. Ample light is now available throughout all parts of the city which hitherto could boast of but meagre illumination.

The official inauguration of the recently completed system took place on the night of June 7th. The business section presented a very stirring scene when from fifteen to eighteen thousand people witnessed the turning on of the lights. For ten days previous, preparations had been under way for a big carnival. Many visitors from a distance showed their interest in the new lighting system by being present to join in the celebration and the neighboring towns were represented. Immediately after their evening meal the citizens turned out en masse to witness the evening's entertainment. Shortly after seven o'clock the programme was officially opened by the Mayor who from an elevated platform, introduced Hon. J. J. Sullivan of Cleveland, to those in the immediate vicinity that were able to hear above the din of the revellers. In his brief address, Mr. Sullivan reviewed many of the developments that had taken place in Warren during the past thirty years and commended the citizens on the public spirit they displayed in having achieved such magnificent results in the matter of night illumination of their streets.

At the close of the address, Mayor Craver threw the switch at the rear of the platform which turned on the new Mazda lighting system and the streets were flooded with a blaze of light. The transition from gloomy to brilliantly illuminated streets was greeted by a general exclamation of approval on the part of the pleased citizens who realized that the old conditions of inadequate street lighting had finally passed away and that they had a lighting system of which they might well be proud.

Market Street at Night, Warren, Ohio.

Southern N. E. L. A. News.

Georgia Section N. E. L. A. Convention

Although definite information is not available covering all the details in connection with the convention to be held at Columbus, Ga., September 26 to 27, the important events have been settled. President Bleecker advises as follows in regard to plans as they now stand:

The convention headquarters will be at the Muscogee Club, 1219 Broad St., with the regular meetings held in the north lodge room of the Masonic Temple, situated on the corner of 12th Street and 1st Ave. During the convention the registration bureau will be found in the first room to the right of the entrance of the Muscogee Club, and all members with their guests should register immediately on arrival. The hotel committee will have headquarters at 1151 Broad Street, and will take pleasure in arranging accommodations for those planning to attend the convention when so advised by letter. Such advice should be sent the committee early for convenience of all concerned. There will be no general exhibition in connection with the convention, however members and guests are cordially invited to visit the show rooms of the Columbus Railroad Company at 1151 Broad Street.

The program for the convention will be substantially as follows: On Tuesday morning, September 26, at 11 o'clock the convention will be called to order and the address of welcome delivered by Mayor Rhodes Browne, of Columbus. The address by the president will then follow, together with reports by the committees on membership and finance and a paper entitled "Advantages of Co-Operative Effort by Central Stations With Insurance Inspections," by A. M. Schoen, chief engineer, Southeastern Underwriters' Association, of Atlanta. The afternoon session on Tuesday will be called at 2:30 o'clock and the following papers presented. "Low Pressure Turbines," by E. H. Ginn; and "Supply of Electric Energy to Textile Mills," by G. K. Hutchins. Both these papers will be open to written and oral discussions. During Tuesday evening from 8:30 to 10:30 o'clock an informal reception will be held at the Muscogee Club. There will also be an executive committee meeting during the evening.

On Wednesday, at the morning session the following papers will be presented: "Ice Making as Associated with Central Stations," by Burdett Loomis, Jr.; and "Electric Heating Utensils," by L. L. Warfield. These papers will be discussed. Following the reading of these papers and the discussion, the members will go into executive session, considering reports of the various committees, including that of the nominating committee, after which the election of officers for 1911-12 will take place. After adjournment from executive session at 12:30, a special train will take all delegates and guests to Goat Rock. A picnic lunch will be served on the train and an opportunity offered to see the construction going on at the new dam. During this trip the members and guests of the convention will be guests of Stone and Webster Engineering Corporation.

All registered members and guests will be provided with a badge, the color of which will designate the class of membership as follows: Officers and Executive Committee, Red; Class A members, Purple; Class B, Rose; Class D, Golden Brown; Class E, Dark Brown; Guests, Light Blue; Press, Light Green; Hotel Committee, Lavender. Special committees have charge of the papers, general arrangements, hotel accommodations, badges, publicity, registration, and entertainment. A special transportation committee for Atlanta has been appointed with W. R. Collier, of the Georgia Railway and Electric Co., of Atlanta, as chairman. Information can be obtained from him by those in that district.

During the convention the office of President J. S. Bleecker will be at the Transfer Station and that of Secretary T. W. Peters at 1151 Broad Street and Muscogee Club.

The hearty co-operation of the Board of Trade of Columbus, which boasts of having the Electric City of the South, has been offered, and delegates are invited to drop in at their headquarters, 15 11th Street, during the stay in the city and make the acquaintance of Mr. C. B. Woodruff, Secretary, who will gladly furnish general information about the city and surrounding territory.

National Electrical Contractors Assoc.

The eleventh annual convention of the National Electrical Contractors Association was held under most favorable circumstances July 19 to 21, at Niagara Falls, N. Y. As an expression summing up the work of the convention and its success, we quote from a letter by the president published in the official organ of the Association. "The Convention was the most interesting gathering that the National Association has ever held. Papers that were read at the opening meeting were among the most interesting and instructive that we have ever had and there was never a meeting when the members went so thoroughly into discussion of the subjects presented." The attendance represented branches of the industry throughout the United States and Canada and numbered approximately 200.

The papers presented at the various sessions are as follows. "Relation between the Central Station and the Contractor" by Arthur Williams of New York; "Credit Protection" by Franz Neilson of New York; "The Proper Lamp for the Circuit" by C. F. Bauder of the National Electric Lamp Association, Cleveland, Ohio; "The National Fire Protective Association" by E. E. Cabots of Boston; "The Contractor as a Merchant" by C. E. Whitehorne of New York; "Co-operation in the Electrical Industry" by P. S. Dodd of the National Electric Lamp Association of Cleveland. Besides these matters discussed in open sessions, were other topics of a practical and economical nature relating to the contracting business, discussed in closed sessions.

The usual entertainment features were well taken care of, trips being made to Niagara Falls and other places of interest. The Sons of Jove held a successful rejuvenation, initiating a class of 22 candidates. About 150 members of the Jovian order were present and all enjoying a banquet on the evening of the rejuvenation.

The officers elected for the year 1911-12 are as follows: President, M. L. Barns, Troy, N. Y.; vice-president, Ernest Freeman of Chicago, Ill.; 2nd vice-president, H. S. Porter of Boston; 3rd vice-president, J. C. Hatzel of New York City; treasurer, J. R. Galloway, Washington, D. C.; Secretary, W. H. Morton, of Utica, N. Y. The next meeting place selected is Denver, Colo.

Ohio Electric Light Association

The annual convention of the Ohio Electric Light Association was held this year at Cedar Point, Ohio, July 25 to 28, with a total registration of about 400 members and guests. This seventeenth annual convention gave the body not only just claim for position well toward the head of the list of the large state organizations but for activity in central station affairs ranking equally as high. The new arrangement of holding sessions worked very well, giving plenty of time to take up all matters thoroughly. With the exception of the first session held on Tuesday afternoon, all work was done during the forenoon, the remainder of the day being given to recreation.

The program for the entire occasion was substantially as follows: The first session was held Tuesday afternoon July 25 at 2 o'clock, when the president's address was delivered and a response by Major C. B. Wilcox, Sandusky Gas & Electric Company, Sandusky, Ohio. The secretary next presented his annual report and the following papers were read: "Why the Central Stations Should Take Over the Isolated Plant," by Waldo Weaver, Chief Engineer D. and T. Power Station, Tippecanoe City, Ohio; "Systematic Central Station Records," by O. B. Reemelin, Dayton Lighting Company, Dayton, Ohio.

The second session was held Wednesday at 9:30 and the following papers read: "Limiting Energy Demand of Voltage Variations of a Circuit by Floating the Fly Wheel General on the Line" by A. M. Seeger, Toronto Railway & Light Company, Toronto, Ohio; "Ornamental Street Lighting" by G. A. Doeller, Dayton Lighting Co., Dayton, Ohio; "Advantageous Use to Which Mercury Arc Rectifiers May Be Put on Central Station Lines" by J. T. Kermode, Cleveland Electric Illuminating Company, Cleveland, Ohio.

The third session was called on Thursday morning at 9:30, and t he papers presented are the following: "Report of Insurance Rates Charged Electric Light Companies in Ohio" by the Secretary; "The Report of Committee on Meters" by J. G. Gilmartin, Toledo Railway & Light Company, Toledo, Ohio; "The Utility Law and Its Application to Electric Light Companies," by D. L. Gaskill, Greenville Electric Light & Power Company, Greenville, Ohio; "Pumping Water for Municipalities and for Irrigation by Electricity," by G. H. Gardnes, Dayton Lighting Company, Dayton, Ohio.

At the fourth session Friday morning the following papers were presented "Motor Driven Refrigeration" by W. C. Anderson, Canton Electric Company, Conton, Ohio; "The Use of Tungsten Lamps in Sign and Outline Lighting" by W. B. Gaudy, East Liverpool Traction and Light Company, East Liverpool, Ohio; "Progress of Electric Cooking in Small Towns" by P. L. Miles, Cleveland Electric Illuminating Company, Cleveland, Ohio; report of committee on motor applications and report of committee on electric transmission.

At the Friday session the report of the Nominating Committee was presented and the following officers and committees elected: President, W. C. Anderson; vice-president, J. C. Martin; secretary, D. L. Gaskill. Executive Committee: E. H. Beil, W. S. Towndsend, W. E. Richards, O. H. Hutchings and L. G. White. Advisory Board: S. Scovil, F. M. Tait, and D. L. Gaskill.

The exhibit features in connection with the convention were well carried out, the following electrical and manufacturing companies being represented: Acme Electric Heater Company, Detroit, Mich.; Adams-Bagnall Electric Co., Cleveland, Ohio; Allis Chalmers Co., Milwaukee, Wis.; American Electrical Heater Co., Detroit, Mich.; Canton Electric Sign Co., Canton, Ohio; Comet Electric Stove Co., Detroit, Mich.; Crocker-Wheeler Co., Ampere, N. J.; Dover Mfg. Co., Canal Dover, O.; Eclipse Electric Mfg. Co., Chicago; Electric Power Maintenance Co., Toledo, Ohio.; Enterprise Electric Co., Warren, O.; F. Bissell Co., Toledo, Ohio; Fort Wayne Electric Works of the G. E. Co., Fort Wayne, Ind.; Hart Mfg. Co., Hartford, Conn.; Hoover Suction Sweeper Co., New Berlin, O.; Hughes Electric Heating Co., Chicago, Ill.; Hurley Washing Machine Co., Chicago, Ill.; Machado & Roller, New York, N. Y.; Mica Electrical Sign Co., Cincinnati, Ohio; Kimball Electric Co., Chicago, Ill.; North Western Electric Equipment Co., Brooklyn, N. Y.; Packard Electric Co., Warren, Ohio; Sangamo Electric Co., Springfield, Ill.; Sterling Electrical Mfg. Co., Warren Ohio; Thompson Bros., Cincinnati, Ohio; Wagner Electric Mfg. Co., St. Louis, Mo.; Western Electric Co., Chicago, Ill.; Westinghouse Electric and Mfg. Co., Pittsburg, Pa.; W. N. Matthews & Bro., St. Louis, Mo.

All Together, All the Time, For Everything Electrical in the Electrical Capitol of the South

On Tuesday, July 25th, the order of Rejuvenated Sons of Jove, of Atlanta, under the direction of their able Statesman, Mr. L. S. Montgomery, District Manager for the National Metal Molding Company, established a precedent in number of initiates at a rejuvenation. At this time forty-five of the South's most representative and influential electrical men were taken into the order. It has been generally recognized by those familiar with the growth of the order in other sections of the country that there was lacking in Atlanta that life and spirit in connection with Jovianism which is characteristic of the city in all other matters concerning its general welfare, whatever it may be. That this spirit as regards the Jovians and the electrical industry was only lying dormant and needed the energy of a true Jovian to awaken it, is amply proven by the forty-five representative electrical men who made known their willingness to lend their support and influence to a good and common cause.

The Rejuvenation ceremonies were conducted in the collossal Atlanta Auditorium-Armory. Aside from those to be initiated and Atlanta Jovians, a number of visiting Jovians from near and distant points attended, all of whom expressed themselves as greatly pleased with the number and caliber of men that were given the Jovian oath and assumed the slogan of "All together, All the time, For everything Electrical." The object of the order is a splendid moral by which all men in and affiliated with the electrical development of this great country should be governed and there is no order which is receiving more if as much support from men interested in a common cause. A perusal of the fields of activity represented by the initiates will reveal the diversity of electrical interests in Atlanta, there being public service, manufacturing, engineering and contracting companies aside from manufacturers agents and various other representatives in the personnel.

Following the rejuvenation, a joviation and banquet was tendered at the Transportation Club's Roof Garden which was presided over by Mr. Walter M. Stearns, of the General Electric Company as Toastmaster. Those responding were Messrs. Oscar C. Turner, Past Junior of the Order and President of the Southern-Wesco Supply Company, of Birmingham; W. T. Gentry, President of the Southern Bell Telephone & Telegraph Company, Atlanta; A. F. Giles, District Manager of the General Electric Company, Atlanta; Victor L. Crawford, Eastern Manager for W. N. Matthews & Bro., New York City; W. H. Adkins, General Contract Agent of the Southern Bell Telephone & Telegraph Company, Atlanta; T. J. McGill, District Manager of the Westinghouse Electric & Manufacturing Company, Atlanta; Wm. Rawson Collier, General Contract Agent for the Georgia Railway & Electric Company; M. O. Jackson, Assistant General Manager Southern Bell Telephone & Telegraph Company, Atlanta; Robert Clayton, Superintendent of Electrical Affairs City of Atlanta, and L. S. Montgomery, Statesman of the Order and District Manager of the National Metal Molding Company, Atlanta.

The next National Convention of the order will be held in Denver in October. At that time it is expected that there will be a total enrollment of over 5,000 members.

Candidates at Atlanta Rejuvenation of Sons of Jove.

First row (left to right): F. V. L. Smith, Manufacturers Agent, Atlanta; Oscar C. Turner, President Southern-Wesco Supply Co., Birmingham, Ala.; F. H. Hill, Manager Atlanta office Sprague Electric Works of the G. E. Co.; Victor L. Crawford, Manager New York Office W. N. Matthews & Bro.; L. S. Montgomery, Manager Southern Office, National Metal Molding Co., Atlanta; T. A. Burke, Sales Manager, Western Electric Co., Atlanta; Walter M. Stearns, Manager Supply Sales, General Electric Co., Atlanta; Geo. F. Schoen, Manufacturers Agent, Atlanta; M. O. Jackson, Asst. Gen. Mgr,, Southern Bell Tel. & Tel. Co., Atlanta.

Second row from bottom. W. L. Bailey, Supt. Electric Construction Co., Atlanta; F. H. Cantrell, Sec.-Treas. Terrell-Hedges Co., Chattanooga, Tenn.; L. L. Chivers, Vice-Pres. and Mgr., W. E. Carter Electric Co., Atlanta; Albert Mayer, Philadelphia; W. T. Gentry, President Southern Bell Tel. & Tel. Co., Atlanta; W. H. Adkins, General Contract Agent Southern Bell Tel. & Tel. Co.; J. W. Gibson, Supt. of Supplies, Southern Bell Tel. & Tel. Co.; Kendall Weisiger, Southern Bell Tel. & Tel. Co.; Evelyn Harris, Publicity Manager Southern Bell Tel. &Tel.Co.; W. B. Carter, Manufacturers Agent, Atlanta; C. E. Burgoon, Partner Burgoon-Matthews Electric Co., Atlanta; R. L. Saxon, Sales Agent, New York & Ohio Company, Atlanta; W. M. Gregory, Vice-Pres. Electric Construction Co., Atlanta.

Third row: D. H. Braymer, Editor Southern Electrician, Atlanta; Joseph Egee, Representative Electric Construction Co., Atlanta; H. Clay Moore, Manufacturers Agent, Atlanta; Wm. Rawson Collier, Contract Agent Georgia Railway & Electric Co., Atlanta; A. F. Giles, District Manager General Electric Co., Atlanta; H. J. Cates, Supt. Electric Construction Co., Atlanta; H. B. Thrash, Chief Clerk Electric Construction Co., Atlanta; W. C. Hicks, So. Agent Franklin Elec. Mfg. Co., Atlanta; T. H. McKinney, Peters-McKinney Electric Co., Atlanta; T. M. Early, Georgia Public Service Co., Marietta; T. J. McGill, District Manager Westinghouse Elec. & Mfg. Co., Atlanta; C. S. McMahan, Sec.-Treas. Southern Electrician, Atlanta; T. B. Livingston, Livingston-Yonge & Co., Jacksonville, Fla.

Fourth row: T. J. Fleisher, Representative, Crouse-Hinds Co., Cincinnati, Ohio; A. N. Bentley, District Manager, Electric Storage Battery Co., Atlanta; Gadsden E. Russell, Russell-Nichols Electric Co., Atlanta; H. W. Matthews, Burgoon-Matthews Electric Co., Atlanta; R. C. Turner, Supt. Electrical Affairs, City of Atlanta, Atlanta; C. D. Cabinass, Representative Western Electric Co., Atlanta; G. T. Marchmont, Representative Western Electric Co., Atlanta; J. T. Holland, Service Dept. Western Electric Co., Atlanta; Joseph Paulson, Representative Western Electric Co., Atlanta; A. Brill, Brill Electric Co., Augusta; H. A. Coles, Sales Engineer Westinghouse Elec. & Mfg. Co., Atlanta; W. W. Henry, Chief Clerk to Chief Engr. Georgia Railway & Elec. Co., Atlanta; W. H. Smaw, Purchasing Agent Georgia Railway & Elec. Co., Atlanta.

Fifth row: C. B. McGaughey, C. B. McGaughey Electric Co., Atlanta; S. C. Johnson, Business Mgr. Southern Electrician, Atlanta; Dan W. Bowie, Asst. Supt. Elec. Affairs, City of Atlanta, Atlanta; F. C. Severin, Birmingham, Ala.; J. P. Coyne, Electric Construction Co., Atlanta; A. E. Salling, Estimator & Pub. Agent Electric Construction Co., Atlanta; R. H. Park, Gen. Supt. Electric Construction Co., Atlanta; V. Livingston, Representative Atlanta Office Fort Wayne Elec. Wks. of G. E. Co.; M. J. Lide, Consulting Engineer, Birmingham, Ala.; Roland B. Hall, District Manager Harrisburg Foundry & Machine Co., Atlanta; H. W. Karstens, Representative Holophane Co., Atlanta; Frank M. Byrne, Manufacturers Agent, Atlanta; Chas. B. Rogers, Wheat-Rogers Electric Co., Atlanta. Those given the Oath of the Order who are not shown in the picture are: Preston S. Arkwright, President of the Georgia Railway & Electric Company, Atlanta; George W. Brine, Vice-Pres. & General Manager of the Georgia Railway & Electric Co.; George A. Miller, "Great White Way" promoter; J. Lea Watson, District Manager of the Allis-Chalmers Company; E. J. Wallis, District Manager of the Western Electric Company, Atlanta; Patrick Calhoun Gilham, Sales Engineer, Western Electric Company, Atlanta; T. L. Ingram, General Plant Supt. Southern Bell Telephone & Telegraph Company, Atlanta.

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.

LOADING TRANSFORMERS.

Editor Southern Electrician:

(240) I have three single-phase transformers connected in multiple both primary and secondary. All three transformers are of the same make and same primary and secondary voltage. At a 50 kilowatt secondary load what load will each transformer take, also at 100 kilowatt and at full capacity of 175 kilowatt? Will they regulate the load between the three according to the capacity of each? Will a 25 kilowatt transformer take only its full load or equal load with the larger ones. That is will the 3 transformers, one of which is a 25 kilowatt give an output of over 175 kilowatts without endangering the 25 kilowatt transformer. Q. T. B.

ELECTRICAL STORM AND BROKEN FILAMENTS.

Editor Southern Electrician:

(241) I submit herewith an electrical proposition that I would be glad to receive information on. Last month we had a violent electrical storm, during which the filaments of the lamps in the outlets marked × of the diagram were shattered, being found in the bottom of the globes which were not broken. What is the explanation for the broken filaments? The main switch and all other switches were open. Why were not all the filaments of all the lamps shattered? I may add that the filament of a 60 watt lamp in the basement directly under to 5 light cluster was also shattered. The diagram herewith is that of a church circuit where the filaments were broken. R. C. Havenhill.

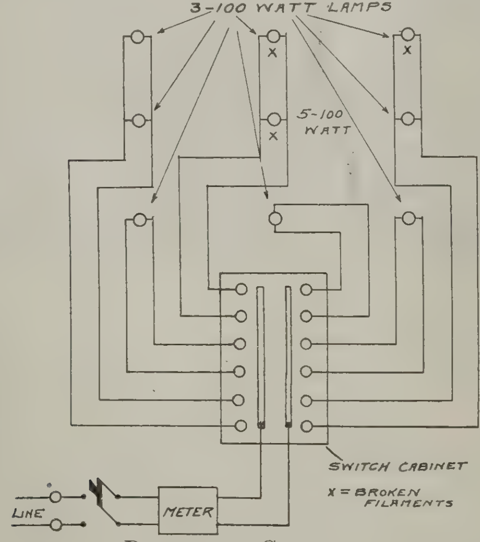


Diagram of Circuits.

GENERATOR EXCITATION FAILS.

Editor Southern Electrician:

(242) I have a problem which I would like your readers to explain. We are running 24 hours per day with a lighting load at night and a motor load during the day. Power is obtained from two Pelton water-wheels governed by hand. The load is very steady until about 8:30 o'clock when it starts to drop off. The load at night ranges from 12 to 34 amperes. From 7:30 p. m. to 8:45 p. m. the load ranges from 27 to 34 amperes, while during the day it is only 6 to 8 amperes. The voltage at the switchboard is 125.

At three or four different times the generator has stopped generating. It acts just as it would if the power were shut off quickly. When the water is nearly cut off, the generator begins to pick up again. Just about as it would if started up slowly with all switches in. The commutator and rings are in good shape and do not spark or heat. We use good compound on the commutator and boil the brushes in vaseline.

In the case of failure referred to, when the voltage starts down the water wheels speed up, then when the wheels are nearly shut down, the generator picks up and runs all right with the same load. When this happened once we were carrying 27 amperes and at two other times 31 to 32 amperes. The failure does not take place every night for the machine will run for a week or two satisfactorily. Loose connections have been looked for but everything seems to be tight. I will appreciate information explaining this trouble and how to remedy it.

Name Plate Data: General Electric A. C. generator; type A. T. B.; class 8—100—900; Form P.; amp. 25; speed 900; volts full load 2300. General Electric Continuous Current Generator (Exciter) type M. F., 6—3—900; Form A; amp. 24; speed 900; volts full load 125. W. I. N.

ELECTRICAL UNITS.

Editor Southern Electrician:

(243) I would like answers to the following questions: What is meant by the six electrical units, give definitions? If a generator is operating at 300 revolutions per minute and gives 110 volts, what will the voltage be if the speed is increased to 600 revolutions per minute, and all the other conditions held unchanged? S. V. E.

HARMONIC ANALYSIS.

Editor Southern Electrician:

(244) In your recent issues I have read with interest the articles on the Harmonic Instrument. Heretofore I have thought that I had a clear conception of harmonic analysis. A point has been brought up in the discussion to which I have given much thought, yet it appears as queer as ever. This is, how a wave composed of even and odd harmonics can be resolved into odd harmonics only. I can conceive of the components of the original wave having both even and odd harmonics but after the function of the Harmonic Instrument is completed, I cannot see what becomes of the even harmonics. Probably some of your readers can explain this phenomenon in the question and answer columns. A. T. M.

A LOUD SPEAKING TELEPHONE RECEIVER.

Editor Southern Electrician:

(245) In connection with the article appearing in the August issue on the Telephone Substation by L. O. Surles, which I have read with interest, I would like to ask for additional information. I would like to know if in the development of the telephone there has been devised any device for amplyfying the sound in the receiver so that it can be heard clearly several feet away? If so, what is the principle upon which this effect is brought about? I have noticed occasionally that the sound of a receiver can be heard distinctly across the room, this was only intermittently however, when a person with a very heavy voice was talking at the other end. Whatever may be the cause of the intermittent condition, no doubt it can be taken advantage of to create the same thing permanently. There are instances where a loud receiver would be well suited, such as in a power station. I would appreciate any information on this subject. C. C. D.

METERS REQUIRED FOR TESTS.

Editor Southern Electrician:

(246). I would be glad to know the number, types, and sizes of meters which will be required to carry on the necessary tests about our plant. We have a 750 K. W. power station supplying electrical power to several nearby shops and industrial plants. Induction motors are used on voltages of 220, 440, and 2,200. The sizes range from about 2 H. P. to 50 H. P. A 300 K. W. rotary converter supplies D. C. power for elevators, cranes and hoists at 250 volts. The A. C. generators are 3 phase, 60 cycle, 2,200 volt. We desire to make periodic tests for plant economy, efficiency of motor systems and power factor checks, as well as determine the actual cost per motor horsepower of operating. D. A. B.

Discussion of Ans. to Ques. No. 218.

Editor Southern Electrician:

Referring to Mr. Rakestraw's Answer to No. 218, permit me to say that while his conclusion is one to which anyone would naturally arrive upon first consideration, a certain fact in the case makes it incorrect. This is, that with a given adjustment of the engine, or other prime mover governors, it is impossible to machines must operate at the same speed (frequency) when in parallel. If we change the field adjustment of one of a parallel set of D. C. machines there will be a change of the relative loads accompanied with a slowing down of the heavily loaded one and a corresponding speeding up of the other. This change of speeds is necessary to allow the governers to adjust the steam supply to the changed loads.

Since the A. C. machines must run at the same speed, the only way to change the relative loads is to change the relative governor adjustments. See Electrical Engineering by Steinmetz, pages 152-9. It is of interest to note that if the governers are of different degrees of sensitiveness, the loads will be equal at only one value of the total load. Above this load the one with closer regulation (most sensitive) will take the largest share and below it the other one will. This is due to the fact that while the machines keep the same speed yet this speed varies with the total load and the sensitive governor is affected more by the variation than the other one is. Thus we see that the division of load depends only on the regulation of the prime mover. The only effect of changing the field adjustment is to cause wattless current to circulate between the two machines, leading with respect to the one with the weaker field and lagging with respect to the other.

It can be shown that the variations of the meter readings is due to this wattless current combined with a wrong connection of the wattmeters. Considering first Mr. McCoy's connection, we found that if we neglect to reverse the secondary of one of the potential transformers the voltage of the potential coil will be equal to the line voltage and $(90° - \Phi)$ out of phase with the current. Therefore since the meter reading equals VI cos $(90° - \Phi)$ it will be increased by an increase of either I or Φ. The values of both I and Φ will be increased in the machine giving lagging current (the over excited one) and decreased in the other which gives leading current. This will then cause one meter to go up and the other down.

With the proper connection, the voltage is $\sqrt{3}$ V or (1.732 V) and is Φ degrees out of phase with the current. The reading is then $\sqrt{3}$ VI cos Φ. Comparing this reading with the other, which is [VI cos $(90° - \Phi)$], and remembering that the cosine of an angle increases as the angle becomes less than 90°, we will see why the increase of Φ makes one reading go up [VI cos $(90 - \Phi)$] and the other ($\sqrt{3}$ VI cos Φ) go down. This increase of [VI cos $(90 - \Phi)$] is made still greater by the increase of I, but the decrease of ($\sqrt{3}$ VI cos Φ) is made less by it. In fact the increase of I just balances the increase of Φ so that the product ($\sqrt{3}$ VI cos Φ) remains constant and is not affected by the change of the wattless current. Since I cos Φ is the power component it is evidently not affected by the change of Φ, but since [I cos $(90° - \Phi)$] equals I sin Φ, we see that with the wrong connection, we are really reading the wattless component thus: Reading = VI cos $(90° - \Phi)$ = VI sin Φ.

This same reasoning would apply to a single meter connected as Mr. Hayward suggests for two. The reading would then be either [VI cos $(30° - \Phi)$] or [VI cos $(30° + \Phi)$] and the effect might not be so noticeable if we happened to connect so as to get the last one. With either of these wrong connections it is obvious that the meter readings are worthless so far as indicating power is concerned. I would suggest that H. A. S. send the question and answer department a sketch showing his meter connections with full description of same. If he has Mr. McCoy's connection of the transformer secondaries. T. G. Seidell.

[It will be noted that the answer to question 205 on page 79 of the August issue were not signed. Credit should have been given Mr. Seidell for this material.—Ed.]

House Circuits Ans. Ques. No. 220

Editor Southern Electrician:

Referring to Fig. 1, the energy in this circuit either A. C. or D. C. will be proportional to the current in wire A × 110 volts + current in wire B × 110 volts, correcting

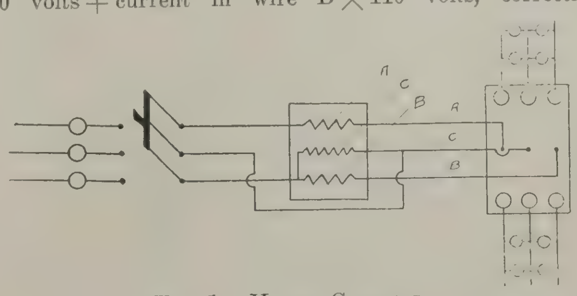


Fig. 1. House Circuits.

for power factor, which is done automatically in the meter. This meter then will have two series coils A and B, so placed that the effect of the two is added and one shunt coil C giving the voltage on one side. It will give the power in the circuit whether it is balanced or not. The fuse block shown is a double branch three wire cut-out, and will accommodate two three-wire circuits, as shown. I would prefer to use a three-wire panel board as shown in Fig. 2, which could be used for four two-wire circuits, making a simpler job of wiring.

As regards the iron, the fact that a ten ampere fuse blows when the iron is put in circuit is proof that it is

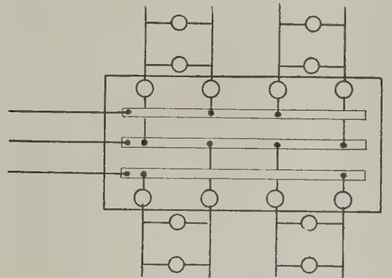


FIG. 2. PANEL BOARD.

taking far more than its rated current, and is very likely short circuited in part or all of its winding. If you will put this iron in series with an ordinary 16 candle power 110 volt lamp on a 110 volt circuit and measure the drop across it with a voltmeter you should get about 33 volts. If the reading is less it indicates that there is a short circuit.

Suggestion on Plant Equipment, Ans. Ques. No. 227.

Simply in the way of general remarks on this question, I would say that the first problem to settle would be the source of power. There is no doubt that an isolated plant could be made to pay if properly managed, but if there is a central station in the vicinity that is at all alive to its opportunities, it can furnish power cheaper than it can be made on the premises, when everything is taken into account. If a plant is installed it would probably be of 3-100 or 125 K. W. units, and run two-phase throughout. Lighting and power should be run separate from the busbars in this case, to secure better voltage regulation on the lights.

A. G. RAKESTRAW.

A. C. Distribution System, Answer Question No. 221

Editor Southern Electrician:

In answer to question 221, the accompanying diagram shows the circuits of a three-wire A. C. distribution system. The high voltage street circuit is assumed to be 2,200 volts and is usually run on the top cross arm, to which circuit the primary coil of the transformer is connected through 2,200-volt fuse blocks. The secondary coil of the transformer is connected to the three-wire secondary street circuit, which is usually run on the lower cross arm, is 110 volts between either outside wires and the center wire and 220 volts between the two outside wires, to which is connected the service lines leading to the buildings. On entering the building the service wires first connect to a three-wire fused switch which should be placed inside the building as near to where the service wires enter as possible. The circuit then leads to the meter and from thence to the distribution panel or switchboard, which it enters through another three-wire fused switch connecting to the busbars, which are in turn connected to the distributing circuits through fused switches. The distribution circuits should be so arranged that the load is practically equal on both outside busbars. By so doing a better voltage regulation is obtained, the line and transformer losses are reduced and the capacity of the whole system increased.

H. M. BEAL.

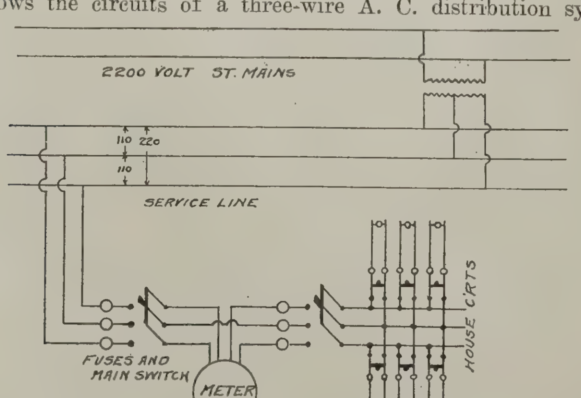


DIAGRAM OF DISTRIBUTION SYSTEM FOR LIGHTING.

Cooper-Hewitt Lamp, Answers Question No. 222

Editor Southern Electrician:

Perhaps the following explanation of the production of light by a mercury-vapor tube lamp will be of interest to C. C. P., on Question 222 in the June issue.

The light is produced by an arc thru a tube containing vapor of mercury, which acts as a conductor and is heated to incandescence by the current. The tube hangs normally in an inclined position, the lower end called the cathode end and containing liquid mercury. The upper or anade end is usually a piece of iron, resistances, inductances and current regulating ballast is contained in some sort of canopy above the lamp. In starting such a lamp the current is switched on and the lamp tilted in some types by hand and in others automatically, until the mercury flows along the tube and comes in contact with the anade. This forms a metallic conducting path for the current, which breaks when the tube returns to its normal position, thus starting the arc. Enough of the mercury is vaporized by the heat to keep the tube filled. LEROY SCOTT.

Cooper-Hewitt Lamp, Answer to Question No 222

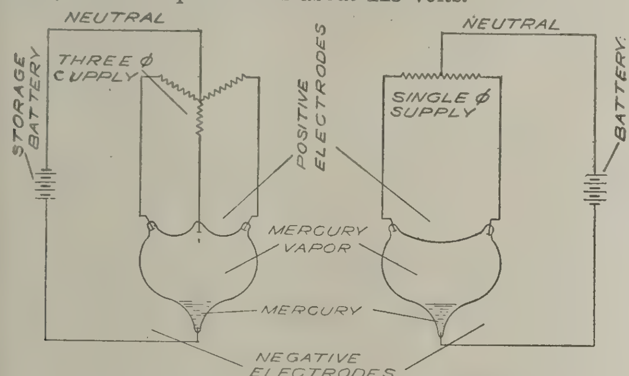
Editor Southern Electrician:

The only claim that can be offered to include this class of lamp in the list of incandescent electric lamps, is that the light is obtained by the incandescence of the remanent gas or mercurial vapour during its ionization. Strictly speaking, it can be more correctly classed as an arc lamp, the arc having a mercury cathode that is negative pole, and passing through a low-tension mercury vapour. The light probably results from the electro-luminescence of the mercury vapour, or from its ionization and not from any high vapour temperature or anode (positive pole) or cathode (negative pole) high temperature.

The lamp consists simply of a bulb or tube of a convenient shape and size to fulfill certain service requirements, the globe or bulb being practically exhausted of air.

It contains a small quantity of liquid mercury and is filled with mercury vapour. The color of the light is of a strong greenish hue, and generally considered to be objectionable for domestic illuminating purposes. The actinic powers are high and the lamp is very efficient, as the percentage of electrical energy transformed into light is relatively high and its voltage regulation is excellent. Most lamps are constructed to run at a pressure of 115 volts.

The accompanying illustration shows the simple outlines of a Cooper-Hewitt mercurial lamp utilized as a three-phase and single-phase converter for the purpose of converting polyphase and single-phase alternating currents into a direct current, which is used for charging storage batteries. This is an every day application to practical service requirements very much utilized, especially for charging electric vehicle storage batteries. For such work the efficiency of the complete apparatus is about 80 per cent., when the pressure is about 115 volts.



COOPER-HEWITT LAMP AS A CONVERTER.

The anode and cathode terminals afford means whereby the electrical energy is received and delivered to and from the lamp or converter. A platinum wire is sealed in the glass at each terminal, and at the positive terminals or anode the wire connects either with a small globule of liquid mercury, depending upon the position or location of the positive pole or anode or a piece of iron according to the type of electrode used. At the negative pole the wire always connects with a small globule or volume of liquid mercury, forming the negative electrode or cathode. As shown, there are as many positive electrodes as there are positive supply lines or wires, and sometimes an additional positive electrode for starting the arc. There is a neutral wire connecting one pole of the battery to the common or neutral junction of the supply circuit.

When once the apparatus as described above is started, it will automatically operate continuously, for the reason that at no instant can there fail to be an emf and current in the right direction upon at least one of the positive electrodes. The active circuit is from the cathode (negative pole) continuously to one or another of the other electrodes according to which is at each instant of positive potential toward the negative pole. The conducting path automatically interchanges from one of the anodes to another in combination with the cathode, with the cyclic variation to the emf due to the phase difference of the power supply circuit.

The object of tilting the lamp, previous to starting, is to induce a low resistance or good conducting path or circuit in the lamp. The electrical resistance of the mercury vapor lamp is very high when not in action and will not start even if there was an emf of many hundreds of volts. In tilting, the act causes a thin stream or thread of liquid mercury to make contact between the anode (positive pole) and cathode (negative pole), thus providing a conducting path of low resistance. Upon tilting back an arc is started which overcomes the otherwise high resistance of the cathode, and when once in action continues to operate until the current is turned off. The current will flow in one continuous direction from the converter lamp as described, and when so used, performs the double duty of giving off light and converting alternating into direct current.

Starting Induction Motors, Ans. Ques. No. 226.

There are two types of induction motor, viz. the short circuited squirrel cage type of rotor, and the coil wound rotor type. The starting arrangements and apparatus differ for each type. If a motor has to start under heavy load, the coil wound rotor type is much preferable to the squirrel cage type, for it does not take such a large starting current from the supply line. For starting under very light load conditions, the squirrel cage rotor is applicable, it having the advantage of not requiring slip rings and brushes or any starting device in the rotor circuit.

In the starting of a squirrel cage type of induction motor, the starting current has to be cut down and this is done by varying the impressed voltage across the motor terminals. This reduction in voltage is attained by utilizing an auto-transformer with compensator windings from which voltage taps are taken at sectional windings of the compensator. The compensator is inserted between the polyphase supply lines and the stator terminals of the motor. From 5 to 15 horsepower the compensators would be provided with taps for starting the motor at either 50, 65, or 80 per cent of the line voltage, with respective line currents equal to 25, 42 and 65 per cent of the current that would be taken by the motor if no compensator were used. From 25 to 50 horsepower, the conpensator would be provided with voltage taps giving potentials equal to 40, 58, 70 and 85 per cent of the line voltage and respective currents equal to 16, 34, 50 and 72 per cent of the current that would be necessary if the motor were directly connected to the line. The necessity of reducing the starting current is in practice realized, when it is considered that a squirrel cage rotor starting under load with no such starting device, demands an abnormal and disturbing line current, several times the magnitude of its normal current.

Two methods of starting a three-phase induction motor of the squirrel cage type of rotor is shown in Figs. 1 and 2 in which Fig. 1 method would be practical for the 5—15 H. P. motors and Fig. 2 method for the 25—50 horsepower

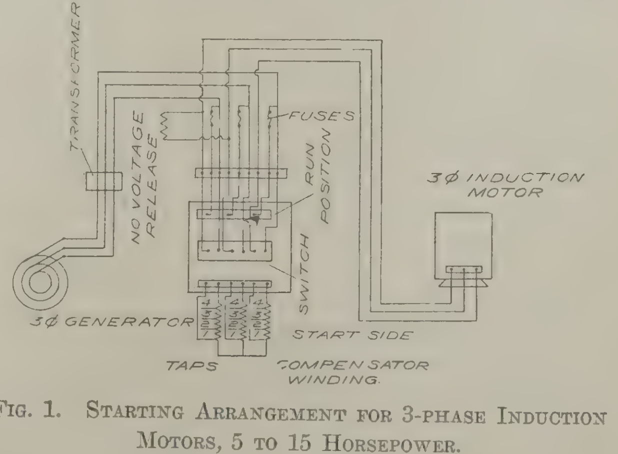


FIG. 1. STARTING ARRANGEMENT FOR 3-PHASE INDUCTION MOTORS, 5 TO 15 HORSEPOWER.

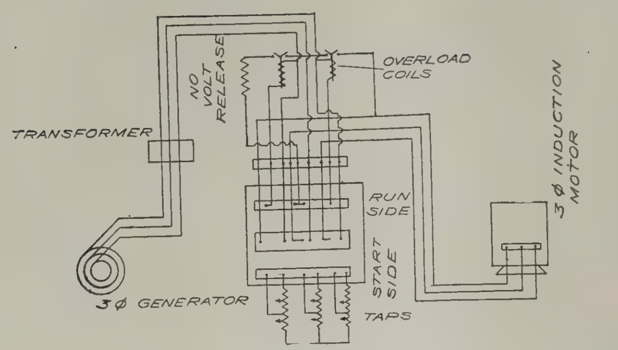


FIG. 2. STARTING ARRANGEMENT FOR 3-PHASE INDUCTION MOTORS, 25-50 HORSEPOWER.

motors. In Fig. 1 the circuits are protected by fuses and a no voltage release and in Fig. 2 by trip coils and no voltage release. The no voltage release allows the starting lever to automatically return to its off position, when the circuit is broken. The series trip coil relay in Fig. 2, can be so adjusted for current capacity, that it will protect the motor from running single phase. The increased load caused by the motor running single phase is sufficient to automatically trip or break the circuit. This automatic action is an advantage over fuses, one only of which may blow out and still the motor run as a single-phase with possible damage. To start the motor the switch lever is pushed over to the

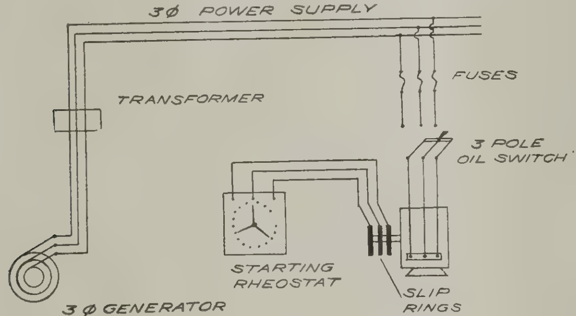


FIG. 3. STARTING ARRANGEMENT FOR A 3-PHASE COIL WOUND ROTOR INDUCTION MOTOR.

starting side and after the motor has attained full speed it is very quickly thrown over to the running contact side.

In the starting of a coil wound rotor, a variable starting rheostat is inserted in the rotor circuit, Fig. 3, through the intermediary of slip rings and brushes. The stator circuit being directly connected to the 3 phase supply by means of a triple pole oil break switch and fuses.

To start the motor, close the main triple pole switch in the stator circuit, then slowly move the handle of the starting rheostat from contact to contact, allowing time enough on each contact for the motor to attain its maximum speed. The interval however, should not be longer than about 30 seconds since overheating of the resistance coils is liable to ensue with possible burn out and damage. The subject of induction motors will be thoroughly considered in the writer's article on alternating current engineering appearing in another section of this publication each issue.

WM. R. BOWKER.

Starting Induction Motors, Ans. Ques. No. 226

Editor Southern Electrician:

Induction motors are of two general types, the rotating secondary or squirrel cage type, and the rotating primary or slip ring type. Small motors up to 5 horsepower of either kind are usually thrown directly on the line. The object of a starting device may be two-fold, first to secure speed control and second, to prevent too great a rush of primary current on starting. The squirrel cage type is made up to 200 horsepower, while the slip ring type is made in the larger sizes principally, small ones being made for certain classes of service requiring variable speed.

The squirrel cage motor as its name indicates has a simple short circuited secondary consisting of two end rings and connecting bars. Its starting torque is low and unless prevented will draw an excessive starting current. The usual way of starting these is by means of an auto-starter which lowers the line voltage. Fig. 1 shows the connections. When the switch is thrown to the right the full line voltage is impressed upon the motor, when to the

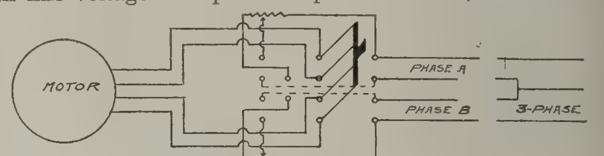


FIG. 1. SQUIRREL CAGE TYPE OF MOTOR WITH AUTO-STARTER.

left, it will be seen from the diagram that there are two auto-transformers in circuit and only a part of the line voltage is used. When the motor has attained its speed the switch is thrown to the right. This scheme of connections is used for constant speed work such as factories and machine shops.

In the slip ring motor the primary revolves while the secondary is stationary, the current being brought to the primary through collector rings, hence the name. Of course the secondary can be short circuited and the motor started by means of an auto starter, just the same as with the squirrel cage type and this is sometimes done. One great advantage of the stationary secondary is that resistance can be inserted for starting work or speed control, greatly increasing the starting torque and adapting the motor for all kinds of variable speed work such as cranes

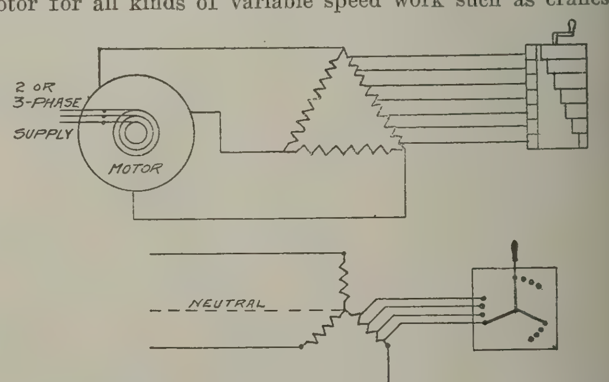


FIG. 2. SLIP RING MOTOR WITH DELTA CONNECTED SECONDARY AND DRUM TYPE CONTROLLER, ONE PHASE SHOWN. FIG. 3. SAME AS FIG. 2, WITH STAR WOUND SECONDARY AND FACE PLATE TYPE CONTROLLER.

and hoists, winches, dredges, etc. The primary is two or three-phase to suit the supply, but the secondary is always wound three-phase; it may be either delta or star connected. In either case resistance is placed in each leg of the circuit and cut out notch by notch, exactly as would be done in starting up a motor by means of a starting box. For small motors a face plate type of controller, as shown in Fig. 2, is generally used, while for large motors a drum controller is employed. This controller, besides cutting in and out the secondary resistance is often also arranged to open, close and reverse the primary circuit, so as to give the operator complete control of the motor with a single handle.

Service Transformer, Ans. Ques. No. 229.

In regard to the service transformer provided with arrangements for different voltages as mentioned in question 229 of the July issue, Fig. 4 gives connections for such a transformer with two primary and two secondary coils.

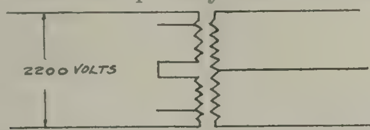


FIG. 4. SERVICE TRANSFORMER DIAGRAM.

This transformer can be connected for 1,100 or 2,200 volts primary and 110-220 volts secondary, and has taps at 10 per cent. of the winding so as to increase the secondary voltage by that amount if desired.

A. G. RAKESTRAW.

Delta vs. Y Connections, Answer Question No. 236

Editor Southern Electrician:

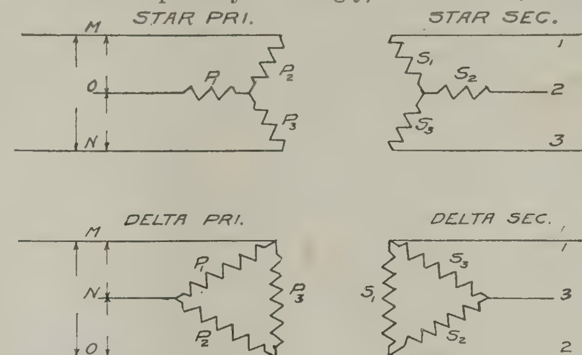
In answering question No. 236 appearing in the August issue of your valued Journal, I believe it would be of greater interest to A. H. J. if he had requested a review of the theory of the star and delta methods of connecting transformers to the line rather than advice on the selection of any particular system. I would suggest therefore, that A. H. J. read the explanation and study the relative advantages of both connections adopting the one best suited to the prevailing conditions.

In as few words as possible, I shall endeavor to explain the theory, and at the same time submit a diagram illustrating the proper methods of connecting the transformers under discussion to the line in Star, Delta, and a combination of both, which may be of interest to others of your readers. It has been customary in the past, until the recent introduction of three-phase transformers, to use three single phase transformers to convert from one pressure to another on three phase circuits. I may add here, that using single phase transformers gives greater flexibility of operation, although the use of three phase transformers, renders a very material saving in iron.

When three transformers are used in a three wire three phase system, the primary coils of the transformers may be connected in the following two ways, namely-Delta connected or Star connected to the supply mains, and in either case the secondary coils may be Delta connected or Star connected to the supply mains, so that four arrangements are possible; the Delta-Delta connection the Delta-Star connection, the Star-Delta connection, and the Star-Star connection. The Delta-Delta connection is however the method most generally used, for reasons explained later in this article.

I shall now take up the manner of calculating the voltages in each of the above connections. Figure I illustrates the three primary and secondary coils of the transformers connected in Star. Figure 2, represents the coils both primary and secondary connected in Delta, and Figure 3 illustrates the methods of connecting the transformers to the three-phase transmission line. Referring to Figure 1, P_1 P_2 and P_3 represent the primary coils of each transformer, while S_1 S_2 and S_3 the secondary windings. M, N and O and 1 2 3 denote the primary and secondary line wires. For the sake of illustration, let us assume the voltage in the primary line wires to be 2200 and the ratio of transformation 20 to 1, all losses being neglected.

The problem then resolves itself into computing the voltage in the various coils and secondary line wires. From the connections shown in figure 1, we note that between any two primary line wires we have two primary coils in series, thus; between M and N we have the coils $P_2 + P_3$ and between N and O, $P_1 + P_3$, between M and O, $P_1 + P_2$ therefore, we see that the line voltage of 2200 is not impressed on one primary coil singly, but on two in series.



FIGS. 1 AND 2. DIAGRAMS FOR STAR AND DELTA CONNECTIONS.

This of course reduces the voltage each coil receives, and is of advantage when very high primary emfs are employed, second, it reduces the number of turns necessary in the primary windings of the transformers.

The emf impressed on each primary coil is equal to $2200/\sqrt{3} = 1270$ volts or a little over one half the primary voltage. The emf received by the corresponding secondary coil, would be in the ratio of primary to secondary turns, and would depend on the ratio of transformation. In our problem we have assumed this ratio to be 20 to 1, therefore the actual voltage neglecting losses of transformation, would be 1270/20 or 63.5 volts. On the other hand the voltage impressed on the secondary feeders would not be the same as in the secondary windings as we would be led to suppose, but will be $\sqrt{3}$ times the voltage in that coil, or 1.732 x 63.5 = 110 volts. The current that the primary winding receives is the same as that of the line, but the current induced in the secondary is greater than that in the primary and in the same ratio that the secondary emf is

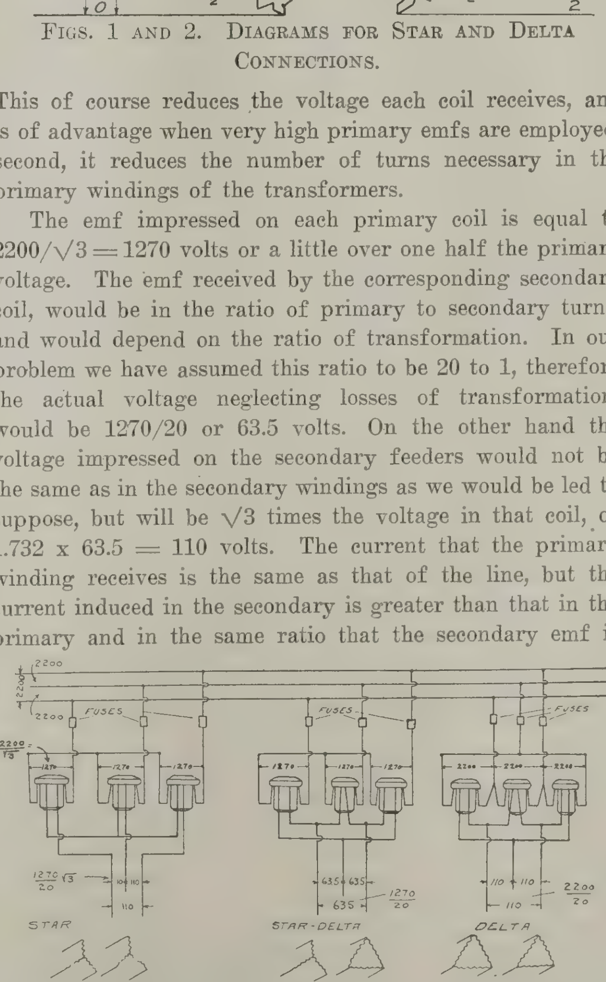


FIG. 3. CIRCUITS FOR THREE-PHASE TRANSMISSION, 2,200 PRIMARY VOLTS, 60 CYCLES, USING SINGLE-PHASE TRANSFORMERS.

less than the primary emf. The current in each pair of the secondary is the same as in the corresponding coil to which it is connected.

DELTA CONNECTIONS.

In this method, which is illustrated in Figure 2, the primary coils of each transformer is connected singly between two of the three primary line wires, and differs from the Star connection in that each winding receives the full line emf while the voltage induced in each of the secondary coils is determined by the ratio of transformation, which in this case is 2200/20 or 110 volts. Not considering losses, the voltage in the secondary lines will be the same as in the secondary coils to which they are connected. The current in the secondary feeders will be $\sqrt{3}$ times the current in the corresponding coils.

The delta method of connection is the one most generally employed, as it has the great advantage, that if one transformer is damaged, it will not cripple the power supply since the others will carry the load. Another advantage is that transformers wound for standard line voltages can be used.

E. J. Mora,
Of Hackett & Mora, Engineers.

Door Bell Wiring, Answer Question No. 230

Editor Southern Electrician:

In the opinion of the writer the most economical method of door and call bell wiring for a residence as mentioned in question 230 of the July issue is shown in the sketch herewith. Low voltage transformers are now on the market for 110 and 6 volts at a cost of about $3.50. These instruments are guaranteed to stand a dead short circuit for hours without burning out should anything go wrong with the system. If the house is not wired for electricity, dry batteries can be used, two or three of the dry cell type being sufficient for the system indicated.

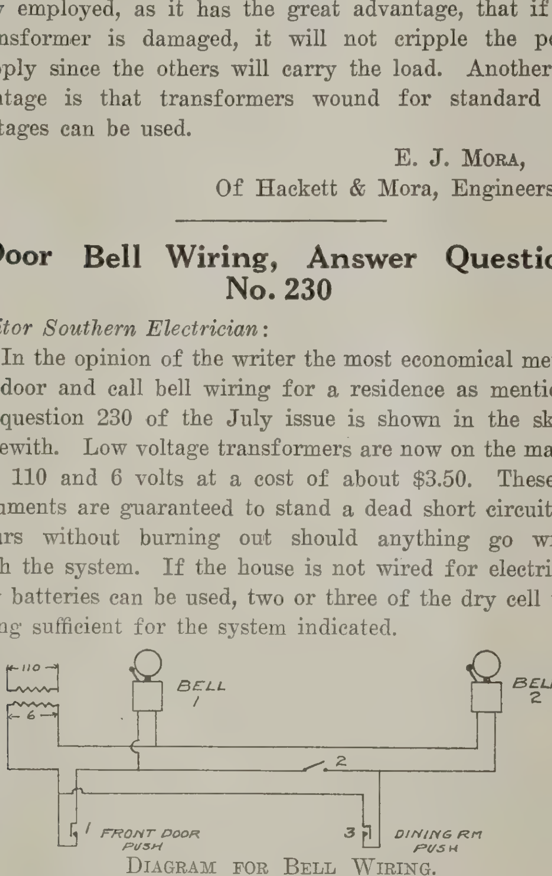


Diagram for Bell Wiring.

For both bells working at once from the front door switch No. 1 is to be used. When it is desired to ring the kitchen bell and from the dining room, switch No. 3 should be used. In order that the kitchen bell may not be operated from the front door when the dining room switch is being operated, separating switch No. 2 is placed in circuit. This switch No. 2 should be open when No. 3 is operated, thus allowing the front bell to be operated separately and the kitchen bell separately. When leaving the dining room switch 2 should be closed. E. D. Dumas.

Call Bell Wiring, Answers Question No. 230

Editor Southern Electrician:

In reply to question 230 in the July issue, I submit a diagram for a door bell and call bell wiring in which the kitchen bell and the bell at the front door are wired in series and connected in series with a battery and front door push button. By an examination of the diagram, it will be seen that bells A and B ring together, when push button D is pressed. The bell B is the master bell. By

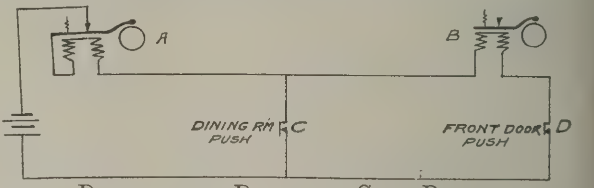


Diagram for Door and Call Bells.

master bell is meant the elimination of the make and break device using only the electro-magnet controlled from some other device, in this case bell A. The strokes of bell A when push button D is operated, control the stroke of bell B, due to the fact that it allows currents to pass into the make and break device of bell A then to bell B, bell B acting in synchronism as it were with bell A. Bell A can also be operated by the push button C in the dining room. Bell B at the front door will not operate when bell A is operated by the push button C, so that both are distinct in operation. The batteries may be located in the basement under the kitchen and may consist of two good dry cells connected in series, when the bells used are ordinary small single stroke ones. Should a larger bell be desired, the battery must be increased to furnish the power.

Arthur L. Gear.

Control of Residence Lamps, Answers Question No. 239

Editor Southern Electrician:

In reply to question 239 by H. B., I submit the following diagram. By inspection of the sketch it will be observed that the hall light A is controlled by 3-way switches at (1) and (2). A lower light B is likewise controlled by 3-way switches (3) and (4). The 4-way switch (6) may be added if desired. The remaining rooms may be wired as the light C, controlled by a 3-way switch (5). These lights must of course be connected to the feeders x, y, z.

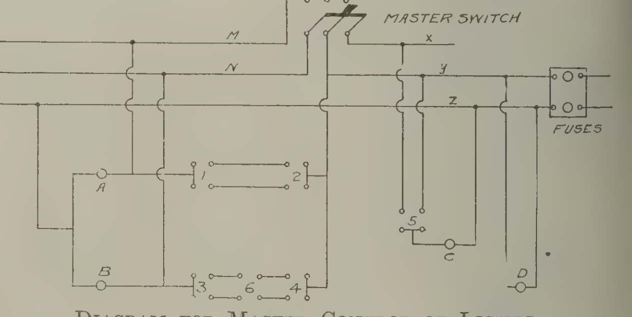


Diagram for Master Control of Lights.

The light at D is connected to wires y and z and is not controlled by the master switch. The wire z feeds all lights, the wire y feeds all switches including master switch. The 3-way lights in halls at A and B operate as usual and both may be out or on or one on and one out. By closing master switch current is transmitted from y through master switch to wires M and N, thus lighting the lamps. The light at C controlled by a 3-way switch is also controlled by master switch. If this arrangement does not fit H. B.'s conditions I shall be glad to furnish other diagrams. C. C. McCauley.

New Apparatus and Appliances.

The Reaction Brush Holder

The Reaction Brush Holder shown in the illustration resented herewith is manufactured by the Baylis Company, of Bloomfield, N. J. The construction is shown in he illustration. A brush beveled at each end rests on an nclined contact plate kept always in positive contact therewith by the combined action of the pressure arm at one end and the action of the commutator at the other. The brush s maintained in close contact with the body of the holder, at in such a way as to leave the brush entirely free for a novement towards and away from the commutator. The ressure arm performs the double function of constantly ressing the brush along the smooth contact plate against he commutator and in conjunction with the commutator re-

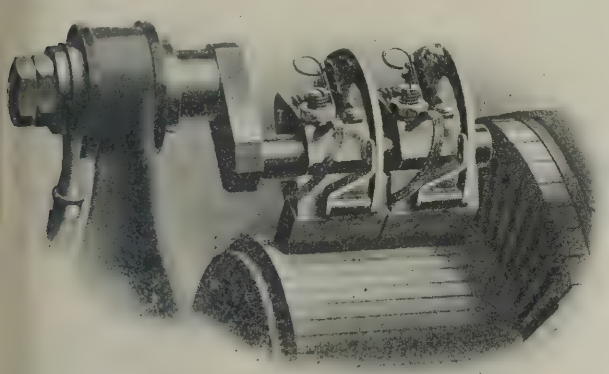


Fig. 1. The Reaction Brush Holder in Position.

ction keeps it always in contact with the body of the older. In designing this brush holder the following features were carefully observed. Efficient contact between rush and holder; freedom of the brush to follow all ordiary irregularities in surface of commutator; the necessity f the brush to move in a straight line, always remaining arallel to a given plane; small inertia of the moving part; w resistance path for the current between commutator and older; facility of handling the holder and removing brush or inspection, dressing or cleaning; simplicity of the holder s a mechanical device.

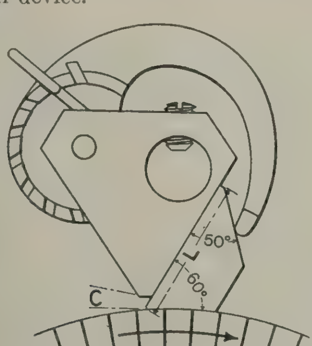


Fig. 2. Showing the Adjustment of the Reaction Brush Holder.

The brush holder is designed so that a number of brushes n be used side by side and there be no space between them. This utilizes the fullest extent of the length of the commutator surface. These brush holders are particularly adapted to special conditions, such as reversing elevator motors, driving machine tools, and electric vehicle motors. In the case of the later the conditions of operation are exceedingly severe, owing to the jar and vibration and lack of proper attention. The brush holders, however, have proved successful in this service.

A New Line of Sockets

The Adams-Bagnall Electric Company, of Cleveland, Ohio, has secured from Mr. W. C. Hine of that city an exclusive license to manufacture and sell a patented line of Universal Holder Sockets. This type of socket is a simple unit taking the place of sockets and shade holder, and at the same time performing the function of a fixture for single unit illumination. The principal of this fixture has been applied to commercial and industrial lighting units and it is being manufactured and placed upon the market by the Adams-Bagnall Company under the trade name of "ABolites."

Fig. 1. Cross Section of Pendant ABolite Showing Positioning Device Thrown Downward. Also Type of Ceiling and Pendant ABolite.

The primary construction characteristic of the ABolite is the provision of a metal support for a reflector to replace variable holders. To this is applied the principal of a patented positioning device attached to a suitable porcelain receptacle. When the positioning yoke is thrown downward, the lamp and reflector are in one position, when thrown upward it is in another position. The accompanying illustration shows the design.

A complete industrial ABolite is made up of two parts, the universal holder socket and the scientifically designed steel reflector. The illustrations given herewith show the various types. The Adams-Bagnall Company has recently

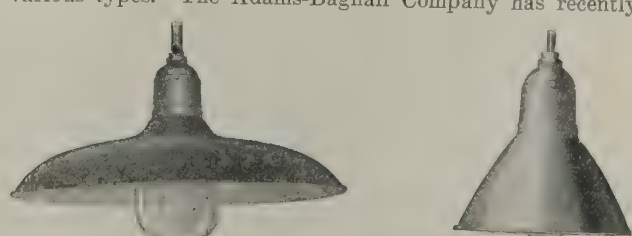
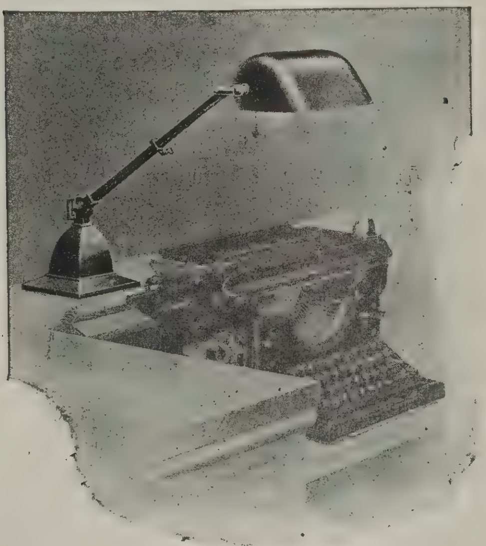


Fig. 2. The Bowl ABolite for 60 and 250-Watt Lamps.

established a department of efficiency engineering for the purpose of studying industrial conditions and co-operate with industrial managers in bringing illumination to a plane where labor efficiency and factory output will be greatly increased. The work of this department is part of the general efficiency movement just launched and it is thought that its establishment will do much toward improving general industrial lighting conditions.

A New Desk Lamp

The accompanying illustration shows an attractive desk lamp marketed by H. G. McFaddin and Co., 38 Warren St., N. Y. The lamp is adopted for office use especially in connection with desks. The lamp is provided with a rich green glass shade having a pure white opal glass reflecting



THE EMERALITE SHADE.

surface inside. Through the use of the shade a subdued and restful light is obtained above it and a bright light focuses on the work. The lamps are marketed under the trade name of "Emeralite" and are adapted for use with any standard 16 or 32 candle power carbon bulb or with Tungsten and Tantalum, 25 or 40 watt sizes.

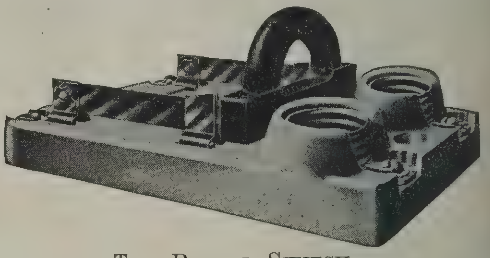
Power Plant Engineering

As typical of good engineering and effective construction of a gas and electric plant, the following information is given on the recent reconstruction of the North Adams gas light company's plant which controls both the gas and electric output of North Adams. The electric department of the company serves North Adams, Adams, Williamstown, Cheshire and Stamford, comprising a population of over 42,000. Its plant has been practically rebuilt by the Light, Heat and Power Corporation, of Boston, Mass., and it is today said to be one of the best equipped in the country. The turbine room contains four horizontal turbines with a normal capacity of station of 4,000 K.W. and a peak capacity of 6,000 K.W.

The above type of plant represents the class of work done by the Light, Heat and Power Corporation, which is equipped to carry out any proposition it undertakes. It commands a large force of experienced engineers, competent to cope with any phase of the gas or electric situation. The officers of the Corporation are Arthur E. Childs, president; Alfred Clarke, vice-president, and Addis M. Whitney, treasurer. J. H. Waterman is the engineer and general superintendent.

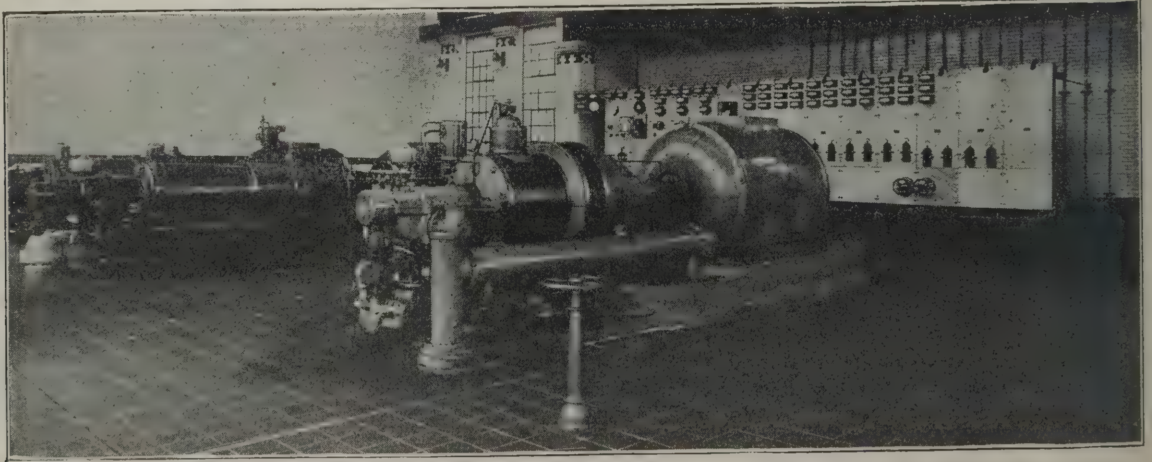
Permel Products

The Permel Manufacturing Company, of Warren, Ohio, was organized in February of this year to take over the business of the Specialty Mfg. Co., the Diamond Electric Company and the Denison Mfg. Co. It will be remembered that the Specialty Mfg. Co., of Warren, were form-



THE PERMEL SWITCH.

erly manufacturers of the Permel Products. It is the purpose of the present company to eventually develop an entire electric line, placing on the market products having a distinction as to construction and appearance. The Permel switches were designed by a practical man and are strong and substantial, enabling an attractive job to be made when they are used. The trade name "Permel" is ingeniously made up and signifies PER-fection, M-echanical, EL-ectrical.



POWER PLANT OF NORTH ADAMS GAS LIGHT 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.

ANDERSON. The American Matt & Twine Company has decided on an extension to its plant, which will amount to $150,000.

ANNISTON. It is understood that arrangements are being made to light the town of Blue Mountain City by electricity.

BESSEMER. The Jefferson Fertilizer Company it is understood will begin construction on the addition to its present factory in the near future.

BIRMINGHAM. It is understoood that the Birmingham Water Light & Power Company is preparing plans for the development of a water power on the Warrior River. According to present arrangements six turbine driven generators will be installed and the plant used to generate electrical energy for the towns of Birmingham, Bessemer, Ensley and other cities in that district.

DOTHAM. The city council has been partitioned by Charles Henderson, of Troy, for permission to furnish lights to Dotham. The plant to furnish the electrical energy is planned for Elba.

HEADSLAND. A contract for the improvement to the municipal electric light and water works system has been awarded to J. B. McCrary Company, Empire Bldg, Atlanta, Ga.

MOBILE. The Mobile Westshore Traction Company has been incorporated with a capital of $10,000. It is the purpose of the company to build an electric railroad from Mobile to Alabama Fort. The incorporators are H. Austell, president; E. E. Posey, Secretary.

MOBILE. The water department of the city is planning a considerable enlargement of pumping facilities. New machinery will be required.

MONTGOMERY. The city commissioners and representatives of the Montgomery Light & Water Company, the Montgomery Traction Co., the Citizens Light, Heat & Power Co., and Western Union and Postal Telegraph Companies are considering the placing of all overhead wires in conduit.

MONTGOMERY. A contract for the erection of the Pythian Temple has been awarded. The cost is approximately $57,000. The Dixie Electric Company has received contracts for electric wiring including fixtures.

REFORM. The installation of an electric light plant is being considered by the Reform Ice & Light Company. J. Newell is manager.

FLORIDA.

JACKSONVILLE. A vote will be taken September 5th on a bond issue for building and extending the electric light system. Bids will also be received for building electric power stations near Taleyrand and the removal of the machinery from the old electric plant to the new power house. The mayor can give other information.

LAKE CITY. It is understood that plans are being considered by M. M. Jackson, owner of the White Springs resort to install electric light plant to supply electricity for the Spring House and for lighting the town.

MIAMI. It is understood that the Miami Electric Company is installing new apparatus in the power house sufficient to double the capacity of the plant. It is also understood that the company will extend its service into Cocoanut Grove, a distance of six miles, and later probably run transmission lines to the Little River.

PABLO BEACH. An electric light plant for Pablo Beach is under consideration, and if the franchise is granted by the council, the work on the plant will begin at once. According to reports a compressed air machine will be used to generate the electrical energy.

PALATKA. A franchise has been granted to T. S. Hammett to operate an electric light plant in Palatka. The franchise calls for the installation of a plant of 225 K. W. with an agreement that the company shall supply electricity for commercial lighting at 12 cents per K. W. hour, with a discount of 10 per cent. for prompt payment. A minimum charge of $1.50 per month is also made. The rate for water service is 4, 5 and 7 cents per K. W. hour, according to the quantity consumed. The ordinance also provides that the company shall pay the city, beginning February 15th, 1923, 1 per cent. of its receipts until the expiration of the franchise or until the city takes over the plant by purchase.

SOUTH JACKSONVILLE. Bids are now open for the construction of an electric light plant and water works for Jacksonville. The consulting engineer is W. W. Lyon, of 305 Duval Bldg., Jacksonville, Fla.

ST. AUGUSTINE. The St. Johns Light & Power Company has been placed in the hands of a receiver, Mr. Bedyson, of St. Augustine. It is understood that the reason assigned for the default of interest on bonds is the fact that the company's surplus earnings have been utilized for extensions and improvements. Neither the electric light or trolley service will suffer under the present arrangements.

GEORGIA.

ALBANY. Bids will be received until September 5th by the Albany Hotel Company for the erection of a fire proof reinforced concrete building to be used as a hotel. Separate bids are asked for heating, plumbing and electrical work.

ALBANY. The Albany Transit Company has been incorporated to build an electric railway in the city and suburban districts of Albany. The capital is $75,000 and the incorporators are C. W. Rawson, S. C. Brown, F. S. Putney and others.

AUSTELL. The establishment of a municipal electric light system in Austell will be voted upon by the people. Election is to be called in the early future.

AUGUSTA. Work on the construction of the dam of the Twin City Power Company, on the Savannah River about 12 miles from Augusta will begin in the early future. The proposed plant will cost one million dollars and supply electric energy to North Georgia and South Carolina. It is understood that lines will also lead into Savannah. Thomas O'Connor, of New York, is interested in the project.

COLUMBUS. It is understood that the Georgia Power Company has applied to the city council for a franchise to construct and operate an electric power plant in Columbus

COLQUITT. A contract for improvements on the municipal electric light and water works system has been given to J. B. McCrary Company, of Atlanta, Ga., to cost approximately $15,000.

DARIEN. A franchise has been granted by the city council for the installation of an electric light plant.

EAST POINT. The Virginia Bridge & Iron Works, with general offices at Roanoke, Va., are planning to expend $50,000 on new buildings, including a machine shop and power house at East Point.

GAINESVILLE. A franchise has been given by the city council to the Gainesville Railway & Power Company allowing the use of streets and alleys for the erection of transmission lines to distribute electrical energy from its plant located on the Chestatee River.

HAZLEHURST. An additional bond issue to the amount of $5,000 has been voted for the installation of an electric light system. The city recently voted an issue of $30,000 in bonds for a municipal electric light plant.

JACKSON. For the purpose of voting on the issue of $11,000 in bonds, the city council have decided to call an election. It is understood that the proceeds are to be used for improvement of the electric light system and water works. The city will enter into contracts with the Central Georgia Power Company for 600 H. P.

MILLEN. The Millen and Newington Railway Company has applied for a charter to build an electric railroad from Millen to some point on the Brinson Railroad in Screven County. The company is capitalized at $75,000 and the incorporators are E. S. Kane, H. S. McCall, W. H. Marsh, W. M. Parker, A. S. Anderson.

WASHINGTON. At a recent election the city voted to issue bonds to the extent of $30,000 for the purpose of constructing an electric light plant and installing a filter plant. The engineers in connection with the work are Westinghouse, Church, Kerr & Co., 10 Church St., New York City.

MOULTRIE. The Moultrie Oil & Fertilizer Company are to erect a plant consisting of cotton oil mill, cotton gin and guano factory. The company has recently been incorporated with a capital stock of $75,000.

KENTUCKY.

ASHLAND. The city is contemplating the issue of bonds for the purpose of building a pumping station.

COVINGTON. A petition has been entered by the Covington Industrial Club asking that the board of aldermen install an ornamental street lighting system on Madison Ave and Pike St.

DANVILLE. Plans for the development of a water power on the Dix River at Kennedy's Mill are prepared by a syndicate of Boston capitalists. It is estimated that the development will be approximately 6,000 H. P., and plans call for a concrete dam 110 feet in height about one mile above the mill. The electrical energy generated at this plant will be transmitted to Richmond, Harroesburg, Stanford, Lancaster, Danville and Nicholasville. It is understood that the proposed plant will cost approximately $1,250,000.

LOUISVILLE. The Crystal Laundry Co is about to spend $25,000 in making improvements to their plant, including new boilers and engines.

LOUISVILLE. The Kentucky Electric Company has made arrangements whereby the contract for lighting the Galt House will be made. It will be remembered that the Galt House propose to install an isolated plant.

LOUISVILLE. The board of pubic works have granted permission to erect boulevard lamps on Jefferson Street between 2nd and 3d Streets and between 3d and 4th Streets. The energy will be supplied by the Kentucky Electric Company for one part and the Louisville Lighting Company for the other part. Arrangements of lamps will be five lamps to the standard, erected without expense to the city and removed should the installation be passed upon unfavorably by the board.

LOUISVILLE. The Electric Vehicle Company has recently completed its plants and is now manufacturing electric commercial trucks.

NEWPORT. The city council has asked for bids for lighting the streets of the city at the rate of $55 each per year for arc lamps and $24 each for incandescents. The Union Light, Heat & Power Company has offered to furnish the service at $65 and $27 each, per year, respectively. It is understood that the council is considering the abolishment of a minimum charge of 85 cents per month to private customers.

OWENSBORO. It is understood that the New Blue Grass Canning Co. is to purchase electrical equipment for their canning factory.

THALMAN. A local company has been formed for the purpose of installing an electric light plant. J. W. Throckmorbon is interested and can give other information.

LOUISIANA.

ALGIERS. The city council has called upon the Algiers Railway, Light & Power Company to extend the street railway system to McLeansville and the Mississippi River, in accordance with the franchise.

BOICE. It is understood that the city has awarded a contract for the construction of an electric light plant.

SHREVEPORT. The city is to vote on a bond issue for the purpose of erecting a municipal light plant to cost about $300,000. The engineer is Anderson Offutt, of New Orleans, La.

VIVIAN. The Vivian Ice, Light & Water Company have been incorporated with a capital stock of $50,000. The incorporators are O. C. Jenks, president andJ. D. Wilkins, secretary.

NORTH CAROLINA.

CHARLOTTE. According to reports the Erwin Cotton Co. is planning to equip the Pearl Cotton Mills and Mill No. 1 with electrical equipment.

HUNTERSVILLE. It is reported that an electric light plant with an output of approximately 35 K. W. driven either by gas or steam power is under consideration by the Bank of Huntersville.

ROCKINGHAM. The Rockingham Machine Company has been incorporated by W. M. Everett, M. L. Hinson and T. C. Leak, Jr. The capital is $15,000 and the company has purchased the Rockingham Foundry & Machine Company's plant and will make additions and improvements to it.

OKLAHOMA.

MULDROW. The city is contemplating an election to vote on an issue of bonds for the installation of electric light and water works system.

MUSKOGEE. The city will receive bids until August 29th for furnishing and erecting pumping machinery. Bids will be received for direct connecting with electric motors and with steam turbines. Specifications can be obtained from the city engineer or at the office of Alexander Porter, 114 Liberty St., New York City. Bids should be addressed to E. H. Flemming, City Clerk.

SOUTH CAROLINA.

CAMDEN. The Camden Water & Light Company has been incorporated. H. G. Garrison is interested.

CHARLESTON. The Charleston Consolidated Railway & Light Company is reported to be considering the installation of three 1,000 K. W. turbo-generators in its new power house at Charleston.

CHARLESTON. Lamar Lindon, of New York City, has been engaged as consulting engineer to make investigations and submit a report on the advisability and cost to the city of installing a municipal electric light plant.

ENOREE. The Enoree Mfg. Co., of Enoree, S. C., has awarded a contract to the Erwin Electric Company, of Spartanburg, S. C., for the installation of 100 K. W. electric plant. The plant will furnish energy to operate the ginnery and for lighting street, stores and residences of the village.

EDGEFIELD. Bids will be received about October 1st for equipment for electric light plant. This equipment consists of a 100 K. W. generator, direct connected to four valve engines, 125 H. P. high pressure boiler and pole lines for a street lighting equipment. The bond issue will be approximately $15,000.

GREER. The Greer Mfg. Co. will erect an addition to its plant costing approximately $250,000.

HONEA PATH. Plans are being considered for the installation of a municipal electric light plant to cost approximately $37,000. The bids for the construction of the plant will be called September 1st. Thos. W. Cochran, of Greenwood, S. C., is engineer in charge.

LAKE CITY. The Farmers Union Ginning & Mfg. Co. is contemplating the installation of an electric light plant.

ORANGEBURG. The commissioners of public works are making additions to the water and electric light plant.

ROCKHILL. An improved system of lighting in the business district of Rockhill is planned, extending from the post office to Railway Ave on Main Street. Ornamental cast iron posts on each side of the street spaced 75 feet bearing a cluster of five lamps will be installed.

TENNESSEE.

CHATTANOOGA. The Georgia Power Co., of Tenn., a branch of the Georgia Power Company, of Atlanta, now developing a large plant at Tallullah, Ga., is constructing transmission lines to Rome, Ga., and proposes to extend them to Chattanooga.

ETAWAH. Plans are under way for the construction of a concrete dam and power house for the Etawah Water & Light Co. The capacity of the power house will be 300 K. W. and the dam will be 300 feet wide by 25 feet high. W. H. Price is general manager and can give other information.

GALLATIN. The Gallatin Laundry Company which has been incorporated with a capital stock of $5,000 will purchase power equipment for their laundry. D. G. Canfield is interested.

JONESBORO. The City is to vote on a bond issue of $25,000 some time during September, the proceeds to be used for the construction of an interurban traction line connecting Jonesboro and Johnson City, Tenn.

KNOXVILLE. It is understood that the Georgia Power Company is making surveys for a transmission line from the power plant at Tallullah Falls, Ga., to Knoxville, Tenn. Work has begun on the line between Tallullah Falls and Franklin, N. C.

NASHVILLE. It is understood that the Nashville Armature Works is adding considerable machinery to its plant. A 25 H. P. 110 volt, D. C. motor and a 10 H. P. three-phase, 220 volt A. C. motor is desired for the new arrangement.

PETERSBURG. The Petersburg Electric Light & Power Company has been granted a charter. This company is capitalized at $2,100 and the incorporators are H. B. Davis, Geo. Mc-
SOUTHERN CONSTRUCTION NEWS.
Adams, J. A. Montgomery and J. C. McRady and O. F. Gill.

PULASKI. Authority has been received from the State Legislature to issue $20,000 in bonds, the proceeds to be used for the construction of a municipal electric light plant. The Plans are prepared by C. L. Wheeler, the electrical superintendent.

ROCKWOOD. The owners of the Rockwood Mills are considering the enlargement of their plant and the installation of a new power plant. If the plan is carried out the mill will be equipped with electrical operation and the company will generate its own energy.

TEXAS.

AUSTIN. The city will hold a special election on August 30th to vote on a proposition presented by W. D. Johnson, of Hartford, Conn., head of the Hydraulic Properties Company of New York. The proposition is for the construction of a dam across the Colorado River at Austin and the installation of a hydro-electric plant. Twenty-five thousand dollars has been deposited by Mr. Johnson to the credit of the city as a guarantee that the plant will be constructed in accordance with the contract and specifications agreed upon. It is understood that the city council has already accepted the proposition made by Mr. Johnson and that the proposed cost is $1,600,000.

FOWLERTON. The Fowler Bros. Land Company, of San Antonio, Tex., will construct an electric light plant.

FORT WORTH. The Fort Worth Southern Traction Company has been incorporated with a capital stock of $1,500,000. The purpose of the company is to construct and operate interurban lines.

WILLS POINT. It is understood that the electric light plant recently burned will be rebuilt by a company composed of J. H. Human, J. E. Owens and E. A. Russell.

TYLER. Contract has been awarded the Tyler Electric Light Co. for a large number of additional street lamps.

KINGMAN, ARIZONA. The annual meeting of the stockholders and directors of the Desert Power & Water Company was held at the office of the corporation at Kingman on July 8th. The following offfcers were elected for the ensueing term: F. A. Wilde, president; James H. Davidson, vice-president; F. A. Wilde, Jr., treasurer and general manager; W. A. Richardson, treasurer. The officers, together, with Mr. W. L. Peters, of Riverside, California, constitute the new board of directors.

Contracts will at once be let for the enlargement of the present engine and boiler rooms and the installing of an additional 1250 K. V. A. direct connected generator and two 1000 horse power boilers, with auxiliary apparatus. This will be the third addition to the plant within two years. This company supplies power to the largest mines in the district, as well as light and power to the city of Kingman, and it is its policy to insure its patrons absolutely dependable and continuous service by having in reserve an ample electrical and mechanical equipment immediately available should any cause necessitate its use. With the improvements now under way it will have the largest and best equipped central service station in Arizona. Transmission line extensions are also being considered.

BOOK REVIEW.

PRACTICAL APPLIED ELECTRICITY. By David Penn Moreton, Associate Professor of Electrical Engineering at the Armour Institute of Technology. Published by Reilly & Britton Company, Chicago, Ill. Price, $2.00.

This work is intended primarily for practical electrical men who desire a working knowledge of electricity and a reliable reference text. The work is based on a series of lectures given to the evening classes of electrical engineering at the Armour Institute, and the compilation is one which covers the entire field of electrical work. While the work is practical a considerable amount of theory is presented in every case. The theory is, however, treated in such a way as to make it entirely plain to the average worker with electrical apparatus. The book is bound in black flexible leather with round corners, is 4½ by 7 inches, and contains 450 pages.

PERSONALS.

JOHN J. DECK has been elected vice-president of Dossert & Co., of New York, to fill the vacancy caused by the resignation of Mr. Charles A. Flynn. Mr. D. J. Fitch has been elected secretary and treasurer of the same company.

EDWIN M. HERR, was elected president of the Westinghouse Electric & Manufacturing Co. at a meeting of the Board of Directors held in New York August 1st. He has been the first vice-president of this company, and in charge of operation of same at East Pittsburg since June 1, 1905. Mr. Herr was born in Lancaster, Pa., May 3, 1860. Upon completion of a common school course, he was given the position of telegraph operator on the Kansas, Pacific Railroad, with which company he remained for two years. He was promoted from the construction train service to the position of Station Agent. In 1881 he entered the Sheffield Scientific School of Yale, graduating in the class of 1884, and worked as an apprentice in the shops of the Pennsylvania Railroad Co. at Altoona, Pa., during the two summer vacations. From 1884 to 1885 he was an apprentice at the West Milwaukee shops of the Chicago, Milwaukee & St. Paul Railroad. He then went to the Chicago, Burlington & Quincy Railroad Co. as a draughtsman in the mechanical engineer's office, and afterwards became assistant engineer of tests, and was promoted from this position to engineer of tests on this road at Aurora, Ill. From 1887 to 1889 he was superintendent of telegraphy, and from 1889 to 1890 was division superintendent of this road. From 1890 to 1892 he was division master mechanic of the Chicago, Milwaukee & St. Paul Railroad at West Milwaukee. From 1892 to 1894 he was superintendent of the Grant Locomotive Works at Chicago. From 1895 to 1897 he was superintendent of motive power and machinery of the Chicago & Northwestern Railroad. From June 1, 1897, to September 10, 1898, he held the same position with the Northern Pacific Railroad. On September 10, 1898, he became assistant general manager of the Westinghouse Air Brake Co. at Wilmerding, Pa. He was promoted to the position of general manager on November 1, 1899, which position he held until June 1, 1905, when he was elected first vice-president of the Westinghouse Electric & Manufacturing Co.

MR. D. S. POLEINER, Southern representative of the Hoskins Glass Company, of Wheeling, West Virginia, is now making a trip throughout the southeast calling upon the gas and electric trade. It is the purpose of this trip to become acquainted with the general requirements for illuminating glassware, to facilitate the company's general sales campaign to begin in September. Anyone interested in glassware can secure considerable information from catalogue No. 16, which takes up a complete line, including the Hoskins Lucida and Lenticular reflectors.

OBITUARY.

J. LEA WATSON. We regret the conditions which make it our duty to announce the accidental death of J. Lea Watson, manager of the Southeastern headquarters in Atlanta for the Allis-Chambers Company. Mr. Watson's death was caused by the explosion of an automatic pistol while unpacking his suitcase in his Atlanta apartments, after a business trip.

Mr. Watson had been a resident of Atlanta for some six years, as manager of the Southern Division of the Allis-Chambers Company. The deceased had been prominent in society in the Georgia city since his arrival, and was a member of several of the more select and exclusive Atlanta clubs, among which were the Capital City Club, and the Piedmont Driving Club. He was also a member of the chamber of commerce, as well as numerous other civic organizations. Mr. Watson was a former resident of Raleigh, leaving to accept the position which he held at the time of his death. During his residence in Atlanta, he made many warm friends who were greatly shocked to hear of his untimely end. The funeral was held at the residence of Mr. Watson's parents. He was unmarried.

INDUSTRIAL ITEMS.

THE MORRIS IRON COMPANY, of 98 West St., New York City, report a large increase in business over the same period of last year. During the past two weeks they have received orders as follows: Battle Creek, Mich., 50 five-light standards; Richmond, Va., 35 five-light standards; Canajoharie, N. Y., 10 five-light standards. As an indication of the type in greatest demand it may be noted that all of these poles are high grade with five lights, four globes being pendant and one upright. The designs selected are fully illustrated in publication number 20, which is now ready for distribution and will be sent to anyone interested upon request to the company.

THE DELTA-STAR ELECTRIC COMPANY, Chicago, Ill., manufacturers of high tension specialties, have removed to 617-631 W. Jackson Boulevard, where increased manufacturing and office facilities have been secured. In addition to high tension devices a complete line of high efficiency Mazda lighting units have been developed and placed on the market July first.

H. M. BYLLESBY & COMPANY confirms the report of purchase of the Pueblo & Suburban Traction & Lighting Company and allied interests in Colorado, the property being taken over June 14, 1911. The Pueblo & Suburban Traction & Lighting Company operates the street railway system of Pueblo and supplies electricity to Pueblo and the Cripple Creek, gold mining district, including the cities of Cripple Rockyford are served with electricity by subsidiary corporations.

THE SMYSER-ROYER CO., of York, Pa., announce that due to the growth of their business, it has become imperative to secure a larger building for the drafting, modeling and office forces. Since April 18, the company has been located in new and more commodious quarters at Northeast corner of 18th and Gilbert Sts., Philadelphia, Pa. This company manufacture architectural and ornamental metal work, cast iron, wrought iron, bronze lamp posts and brackets. B. F. Royer is president; Wm. A. Myers, vice-president and general manager; Wm. H. Myers, secretary and treasurer.

THE CHICAGO FUSE MANUFACTURING COMPANY is introducing several new types of conduit boxes and circulating literature in connection with their design and construction. A small booklet entitled "Union Conduit Boxes and Covers" takes up some of the features. The company is also circulating a pamphlet entitled "Enclosed Fuses and Blocks for 250 and 600 volts.

THE HASKINS GLASS COMPANY, of Wheeling West, Va., is exploiting a new illuminating glassware known as the "Haskins-Lucida." This glassware is claimed to be as pure as Alabaster, free from all defects and prepared in such a manner that all the salts, specks and spots are eliminated.

THE CUTLER-HAMMER MFG. CO., announces that on account of increasing business in the Northwest, Otis & Squires, the Pacific Coast Agents have established a branch office in Portland, Oregon. This office which is in charge of Mr.G. L. Priest, is located at No. 229 Sherlock Building.

THE WESTERN ELECTRIC COMPANY recently sold to the United States Government a complete central battery exchange equipment to be installed at West Point, New York. This equipment consists of a multiple switchboard with a capacity of 3,000 common battery lines, together with frames, racks, a complete power plant an d25,000 feet of paper insulated, lead covered underground cable. In addition to this, the contract calls for all the necessary telephone sets, protectors, outside distributing wire and the installing and connection of the underground cable.

THE STEEL CITY ELECTRIC CO., announces the appointment of Aylsworth Agencies Co., 143 Second St., San Francisco, Cal., as Pacific Coast sales representatives. The Aylsworth Agencies Co. will carry a complete stock of the various materials manufactured for the convenience of the trade including "Star" Bushings, "Steel City" Drawn Steel Outlet Boxes, "Fullman" Adjustable and Non-Adjustable Floor Outlets, Universal Insulator Supports, "Star" Fixture Stems, "Superior" Fish Wire, etc., etc., enabling them to make prompt deliveries on all orders received.

THE FLOUR CITY ORNAMENTAL IRON WORKS has recently completed a large installation of ornamental street lighting at the city of Peoria, Ill. The standard used is known as the "Corinthian" and has been adopted as the standard design.

H. M. BYLLESBY & COMPANY, engineers and managers of public utilities, through their principal office at Chicago, confirm the reported purchase of the Sioux Falls Light & Power Co., of Sioux Falls, South Dakota. This company owns and operates a water power generating plant on the Big Sioux River, reinforced by a modern steam auxiliary station, and serves the greater part of Sioux Falls with current for lighting, transportation and power. Formal possession will be taken in a few days with N. C. Draper, formerly of Zanesville, Ohio, as manager. Improvements and extensions will be made to the property.

THE WESTERN ELECTRIC CO. is about to establish a new house at Richmond, Va.

That the officials of the Western Electric Co. are firm believers in the present prosperity and great future of the South is evinced by the opening of this new house. Arrangements have just been completed whereby a complete stock of telephone apparatus and supplies, power apparatus and general electrical supplies will be carried. This will enable the Western Electric Co. to give their customers in this territory the same prompt service which characterizes that given by the other twenty-four houses of the company's distributing organization.

Mr. H. W. Hall, formerly manager of the Denver house, will have charge of the Richmond organization, and with him will be associated specialists on the various lines handled.

THE NATIONAL METAL MOLDING COMPANY, through their Southern office at Atlanta, is distributing a neatly arranged and complete booklet on metal molding, together with price lists. Information in regard to these products can be secured from the Southern manager, Mr. L. S. Montgomery, 320 Fourth National Bank Bldg., Atlanta, Ga.

TRADE LITERATURE.

SINGLE-PHASE INDUCTION MOTORS. The Emerson Electric Company, of St. Louis, Mo., has recently issued bulletins taking up single-phase induction motors of various designs built with full load starting clutch arrangement. The bulletin takes up the characteristics of the motor as well as details of construction and operation.

FLASHERS. The Reynolds Electric Flasher & Mfg. Co., of 617 West Jackson Boulevard, Chicago, has published Bulletin No. 14, taking up suggestions and original ideas for spectacular flashing effects. The bulletin shows numerous designs that have already been installed as well as possible designs and effects which can be produced by the use of flashers in connection with different types of signs.

LAMPS. The H. G. McFaddin & Co., 38 Warren St., New York, has issued a little booklet entitled "The Emeralite Desk & Piano Lamps." These lamps are fitted with a green-plated glass shade, having a pure white opal glass reflecting surface inside. The lamps are mounted on an appropriate stand which can be adjusted to various positions. The designs are varied, many artistic types being shown.

TELEPHONE APPARATUS. The Kellog Switchboard & Supply Company, with general offices and factory at Chicago, has issued and circulated a new catalogue descriptive of the products manufactured by the company. The catalogue contains 68 pages, and the index includes over 200 items. The material contained under these headings is sufficient to determine the nature of construction and operation of any of the apparatus manufactured by the company. By use of the bulletin a knowledge may be obtained of any piece of telephone apparatus which may be used on any system, however great or small.

TRANSFORMERS. The Allis-Chalmers Company, of Milwaukee, Wis., have issued Bulletin 1076, superseding Bulletin 1047, taking up power transformers. The bulletin contains 10 pages, 8x10 size, with numerous illustrations and descriptive data on construction and installation and operation features.

STEAM TURBINES AND GENERATORS. The Allis-Chalmers Company has issued Bulletin 1079, superseding Bulletin 1054, taking up in detail horizontal turbines of the Parsons type. Numerous photographs of installations are given, showing the nature of the work which turbines of this character are performing. Other information is given on construction and operation.

POLE AND LINE HARDWARE. The St. Louis Malleable Casting Company, of St. Louis, Mo., is circulating electrical catalogue No. 300. This catalogue contains 112 pages, descriptive of pole and line hardware and other electrical specialties manufactured by this company.

MAZDA LAMPS. The General Electric Company, of Schenectady, through their main lamps sales office at Harrison, N. J., has issued Bulletin No. 4850, taking up General Electric Edison Mazda Lamps for standard lighting service. The bulletin contains 28 pages, 8x10 size, and presents numerous illustrations of efficient illuminating systems using these lamps, as well as curves and data showing operation and efficiency.

ELECTRIC STOVES AND RANGES. The Hughes Electric Heating Company, of 226 West Superior Street, Chicago, has issued and is now circulating a neatly arranged bulletin taking up in detail electric stoves and electric plates manufactured by the company. Considerable information is given in regard to the construction of these stoves as well as their operation. Numerous letters are published commenting upon the successful operation in different sections of the country.

D. C. & WM. B. JACKSON, of Chicago and Boston, have removed their Chicago offices to the Harris Trust Building, where much larger quarters will be available for conducting their rapidly increasing business as consulting engineers for electric and allied properties.

COOLING TOWERS. Geo. J. Stocker of St. Louis, Mo.,

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CONTENTS.

Better Illumination

There is no more striking development among the applied sciences, either in magnitude or extent, than the movement for better lighting that has manifested itself within the past two years. The progress in industrial, street and residence lighting has not been marked with any startling departures, nevertheless, much has been accomplished mainly through the more extensive use of incandescent lamps in these fields and through the realization and observation of the fundamental requirements underlying good illumination. Business men have given more attention to better lighting conditions; factory men are realizing more and more the importance of proper illumination in relation to plant out-put, for during the past year a multitude of factories have been equipped with adequate lighting facilities.

Since the advent of the tungsten lamp and other efficient units, scientifically designed reflectors and a sufficient illuminating knowledge to avoid waste, electric lighting has reached its high position through its superiority and economy. There has grown with this development a science known as illuminating engineering and it is now recognized that it requires an experienced electrical engineer to determine the light best adapted for any purpose, considering all conditions, including quantity, quality, distribution, continuity of service, surroundings and costs.

A large variety of light units are now available for this purpose, together with the necessary accessory apparatus. The latest development in the incandescent lamp is the production of ductile tungsten which can be drawn into a fine strong wire, making possible a rugged filament lamp of much higher quality than has ever been obtained before. Drawn tungsten wire as now used in tungsten filament lamps, has a very high initial strength. However, the metal does not retain this initial strength after a few hours' operation, but the fact that the filament can often be bent after burn-out, an impossibility with the filament made by the earlier processes, shows its superiority over the usual pressed filament. The drawn wire filament in tungsten filament lamps is now made in one continuous length, not in several hairpin-like sections as was formerly the case in the old pressed filament tungsten lamp. This has made possible the successful and well-known tantalum method of filament support. The improved method of support as well as the increased strength of the wire, combines to make a lamp far superior to that employing nonductile pressed filaments.

Two new sizes of tungsten filament lamps have been placed on the market and have already received quite an extensive use. These are the 400 and 500-watt sizes. They have in many instances replaced arc lamps owing to the strong illumination they furnish in addition to the many advantages incident to the use of tungsten filament lamps such as conveniences of operation, absence of mechanism liable to get out of order, and steadiness in the illumination. The efficiency of these lamps is quite high (1.13 w. p. c. on high efficiency operation) a fact which makes them successful competitors with nearly all types of arc lamps.

In the industrial lighting field, which is also true of the other lighting fields, aggressive campaigns have been and are being made for the improvement of lighting. The large units, such as 400 and 500 watt tungsten filament lamps, have been used to a great extent with success, carbon filament lamps for drop lights being replaced by these and other metal filament lamps. The tungsten or so-called Mazda cluster, comprising a group of tungsten filament lamps beneath one large metal reflector, has received very favorable recognition in industrial lighting. It occupies a somewhat similar position in this service as the various arc lamps, but in almost every case is superior to the latter. The drawn wire lamp has been found especially adapted to factory lighting, where there is generally a large amount of vibration. In many factories, single units have been used, resulting in a more uniform illumination than when the larger units with a wider spacing have been employed.

In the street lighting field, so many new installations of ornamental street lighting systems have been made during the past two years that this method of lighting business streets has come to stay. During this period probably one third of the cities of the country, of a population greater than 50,000, have installed or have decided to install systems of ornamental street lighting which will not only add to the beauty of the city, but will supply a sufficient quantity of light to be really useful in enabling one to see his way about and in promoting an increased after dark use of the streets. It is difficult to estimate the value of good street illumination yet it is positive. Very little need be said to convince the average citizen of the positive value of well lighted streets. In a great many cases, merchants realizing the advantages to be derived from such systems of street illumination, have banded together and borne the expense, both of installation and operation. In other cases, however, similiar lighting projects have been undertaken by the municipal authorities.

Incandescent street lighting has largely taken the place of lighting by other illuminants and is rapidly 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. Here again, the drawn wire lamp is superior to the old pressed filament type and the multiple lamp can be used as well as the series street lamp, which on account of its heavier filament, was more rugged than the old pressed filament tungsten filament lamp. The series tungsten filament lamp has been found very suitable for replacing gas and gasoline lamps in parks. For sign lighting the low voltage tungsten filament lamps have been substituted for the old carbon lamps, giving a greater brilliancy with a smaller operating cost. The low voltage tungsten filament lamp has also been much used in outline and display lighting. On steam railroads low voltage tungsten filament lamps are being adopted in place of gas or other lighting and are also finding an extensive use in the lighting of automobiles.

In the field of residence lighting the territory electrically lighted is becoming larger every year. The central stations now realize that it is profitable to supply current to a large number of small consumers, if these are located close to each other, and special campaigns have greatly assisted in extending the electric lighting field in residential districts. Much has been done by manufacturers of reflectors in designing new types of residence reflectors which combine with efficiency the desirable artistic features.

This movement generally toward better illumination deserves encouragement from all who have been or may be effected by it. The central station and the manufacturers of illuminants are co-operating in regard to the education of the public to such a point that the glare of a single unit shall not be used as the measure of illumination, it is therefore hoped that with the public support of this effort, the standard for both interiors and exteriors will be established and the effective results considered at the same time as the immediate cost.

The Census on Electrical Manufacturing

A preliminary report has recently been made public by the Bureau of the Census treating the manufacture of electrical apparatus and giving the results of the thirteenth census. The report appears elsewhere in this issue and will be found to consist of comparative statistics and inferences drawn from the data presented by the census of 1899, 1904 and the last one or that of 1909. Neglecting the apologies for the incompletness and a few sweeping generalities, the reports is a masterly attempt to show up the remarkable development during the past decade.

One feature to be regretted is that the five year periods selected for the report above mentioned do not coincide with those for the electrical industries consuming the apparatus, such figures being those for 1907 and the next similar, those for 1912. Since the production and consumption of the products mentioned are so widely separated as to time and since there is in all probability serious effects present due to industrial or financial conditions, any general statements which are the logical conclusions drawn from the actual figures are very deceptive and decidedly puzzling. It is natural to suppose that these census figures are presented in such manner as to enable those interested to obtain something of an idea of the general conditions prevailing during a certain period, taking the electrical industries as a whole. It is to be regretted, however, that the report will not be of much assistance in this regard unless tempered and regulated by a thorough knowledge of conditions during 1904-05, and the results of the panic of 1907.

It has been the general opinion that all branches of electrical industries, including the manufacture of electrical apparatus and machinery, have in the past half decade made marked advancement. This is borne out by the general totals showing number of establishments increasing from 912 to 1255 and an increase of 53 percent. in value of machinery and apparatus manufactured for use in the generation and utilization of electricity during 1904-09. In considering the individual items, care must be exercised in interpreting the data presented. The value of one important class of apparatus is shown less in 1909 than in 1904. It is a difficult matter to attempt an explanation of this decrease when faced by the reports of the companies showing decided increases during the period.

When the complete report is issued, it is hoped that these questionable matters may be cleared up as there will be data more in detail on which to substantiate or destroy the theories now held. All in all the report generally indicates the latent possibilities in the electrical industries and points to the next report as one on which any speculation is beyond comprehension.

Decorative Street Lighting as a Business Investment.

(*Contributed Exclusively to* Southern Electrician.)
BY A. M. KLINGMAN.*

THE subject of ornamental street lighting is undoubtedly at the present time of more general interest to the public than almost any other branch of lighting. This is due to the fact that unconsciously they review the benefits and possibilities to their community in a system of this kind, and feeling a personal interest in its welfare turn their thoughts toward its investigation. In introducing this subject, it must be remembered that feature lighting, display lighting and the like, must be eliminated from our discussion, as such systems are totally different from the subject at hand, and consequently require an entirely different treatment. There is a certain esthetic and a certain scientific side of decorative lighting which although separated in their nature must harmonize to create the desired effect. When an installation is such as to present these features satisfactorily it is at once a success. The vital question, however, in a decorative system of street lighting, is its value as a business investment and as the prime mover in the creation of new business.

DECORATIVE LIGHTING FROM STANDPOINTS OF MERCHANT AND CITY.

Decorative street lighting, as the name implies, should be a pleasing and artistic ornament by day as well as an efficient and artistic means of illumination of the streets by night. With these thoughts in mind, the arguments of adequate street illumination for both the merchant and the community when mentioned, will readily be appreciated.

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Fig. 1. Promenade Lighting, Boston, Mass.

From the merchants' standpoint, streets having an attractive appearance resulting from proper illumination can mean only more business. The human instinct follows somewhat that of the bug in that it seeks the light, consequently, well-illuminated streets are chosen as promenades. By this means, then, an advertisement is made possible of greater value than can be obtained through the press or by canvass. Further, attractive streets and well-lighted streets invite the better class of people, and consequently the better class of trade. Protection is also afforded to the business houses from the attacks of thieves and highwaymen. Thousands of dollars are expended annually in publications by the merchants of a given community without the same percentage of added business which would result from decorative street lighting. This has been proven, but exact statistics are not open for publication.

Fig. 2. Three-Light Decorative System, Warren, Ohio.

From the standpoint of the municipality, the benefits of well-lighted streets are through the protection afforded. The statement is well made, with all due credit to our patrol forces, that every light affords the protection of a patrolman. It is also undoubtedly true that adequately illuminated streets produce better sanitary conditions from the very fact that any uncleanliness is perceptible by good night illumination. Further, the creation of civic pride is a factor that affects the community as a whole. The fact that good lighting can be distinguished from poor lighting, a feature which appeals to everyone of a given community, promotes a personal interest from taxpayers in the welfare and advancement of their sections. As a result better municipal government is secured, the proportion of the criminally inclined becomes less and the spirit of loyalty is aroused when there is a feeling of companionship on a common basis.

The advantages to the merchant and municipality combined through well-lighted streets manifest to the outside world a wide-awake, progressive community and apparent prosperity. If to appear prosperous is to be prosperous, then the creation of new business must follow, and a consequent progress and growth the direct result.

HARMONY, ART AND ENGINEERING IN DECORATIVE LIGHTING.

The harmonious application of an ornamental installation is gratifying indeed. It, like all other good things, can be overdone, however, and defeat the object in view. If an installation is too intensely bright, by contrast the show windows appear poorly lighted, and the whole thing detracts rather than aids the business evolution. On the contrary, however, an installation which is restricted from incorrect design, insufficient appropriation, etc., looks equally bad, as its attractiveness is lost to a great degree and the success of the enterprise somewhat stunted.

FIG. 3. FIVE-LIGHT DECORATIVE SYSTEM, HAMILTON, ONTARIO, CANADA.

The artistic viewpoint is one which very often misleads a community into sacrificing results for art. The writer desires particularly to call attention to the use of upright globes in connection with ornamental street lighting. Granting that personal preference may in cases deem the upright globes more artistic, it must also be borne in mind that the maximum candle power distribution from all efficient types of glassware used for street lighting is toward the direction in which the tip of the lamp points and consequently if installed upright would illuminate the buildings (vertical plane) while the street illumination would be sacrificed.

FIG. 4. DECORATIVE LIGHTING UNDER BALCONIES, MOBILE, ALA.

Placing lamps pendant with an upright lamp as a top light on the standard produces sufficient illumination on the buildings and at the same time produces a better and more uniform illumination on the street. It has been found from tests that a 30 per cent higher illumination may be obtained from such pendant arrangement than from upright globes. There is more or less argument as to whether or not the vertical or horizontal plane in street illumination should be considered. In the writer's estimation it is not a case of which should be considered but which should receive the greater attention. Without question the horizontal or street surface should receive preference, as one of the primary functions of the system has been performed in so doing.

APPROPRIATION METHODS FOR INSTALLATION AND MAINTENANCE.

The first consideration which generally arises when the subject of an ornamental lighting system arises is how the appropriation for installation and maintenance is going to be obtained. Who will be the responsible parties and the best manner in which appropriations or assessments can be handled? This is naturally the first step to be

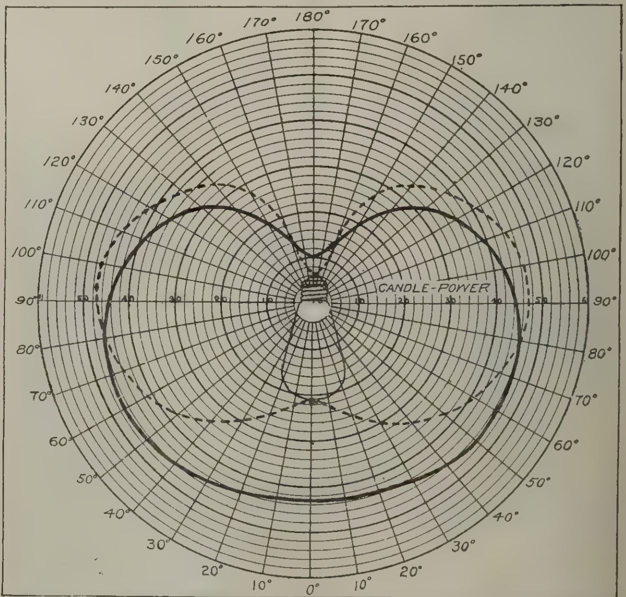


FIG. 5. DISTRIBUTION CURVE FROM GLASSWARE USED FOR ORNAMENTAL STREET LIGHTING.

settled as ultimately it means the success or failure of an ornamental system. It is well therefore to select carefully the basis of the enterprise lest the best returns be lost. There are many ways in which this has been handled, all of which have been more or less successful for a given community. A somewhat brief outline of these will follow, as a suggestion may be given thereby to a community endeavoring to secure the best method of distributing the charges incurred by a proposed installation.

In many instances the installation is put in by the lighting company, the cost being included in the maintenance cost either on a basis of the installation being the property of the lighting company or the property of an organized body paying the maintenance. The maintenance of a decorative system of this kind is borne in many ways. By the merchants of the business district; by the property owners; or by a combination of the two. Another method is for the city to assume a certain share of the maintenance, a very common portion being one-eighth, while the property owners or property owners and tenants jointly, pay the remaining seven-eighths. In some instances the abutting property owners pay for the installation in front of their own property, while the city pays for all street and alley intersections.

The property owners in the other cases install the lighting system, placing upon the tenants the obligation of the maintenance cost. The city and the merchants in some of the towns having come to the writer's notice have paid for the installation while the city pays the maintenance or pays the lamp and globe renewals, leaving the merchant to pay the current cost. In some cases the city and county combined have made an installation and maintain it jointly. The installation and maintenance are in some instances proportioned by the city and the property owners, the city paying 25 per cent while the property owners pay 75 per cent. A few installations only have been made by the lighting company and maintenance given free to the city. A meter has also been used as a basis for ornamental lighting, the rate including installation and operating costs.

It is impossible to say which of the above systems is the better, as local conditions determine this largely. The primary object in view should be to insure payment of the assessment for the floating tenants of the business district. A system which places this responsibility on the parties contracting for the installation, and will absolutely be a safeguard for payment, is the system to be chosen. It has been found that it is preferable to deal with the city or business organization rather than with individual merchants, as it eliminates a great deal of trouble arising from delinquents who do not pay their proportionate share. This finally results in dissatisfaction among the subscribers and produces a condition which is not easily handled by the central station, and is not conducive to the best results.

Fig. 6. Decorative System at Atlanta, Ga.

THE TECHNICAL SIDE OF DECORATIVE LIGHTING.

The technical side of ornamental street lighting is governed largely by the appropriation set aside for this work. Standards, however, should be spaced a distance apart between four and six times the mounting height to obtain the

Fig. 7. Great White Way at Montgomery, Ala.

Fig. 8. Decorative System, Savannah, Ga.

best results. Mounting height is to be understood as the height of the pendant lamps above the street surface. On rather wide streets a very pleasing and symmetrical layout is obtained by spacing the units as nearly as possible a distance apart corresponding to the width of the street with average mounting height. The mounting height of standards should never be less than 11 feet, and the conditions will rarely be met where the mounting height will exceed 14 feet, about 12 feet being an average value.

Fig. 9. Decorative System with Holophane Glassware, Cincinnati, Ohio.

Facing the really influencing factor of installation cost, it must be admitted that data concerning this in an article of this nature is necessarily general. There are figures representing the installation cost per front foot ranging from something less than 65 cents to over $3.25 per front foot, depending on local conditions, spacing of standards and equipment. In general, for average spacing, considsidered from 60 to 85 feet, with average price of pole and substantial underground construction the prices will vary from $2.00 to $2.50 per front foot of property. Or in a very general way, the price of installation of a pole ready to be lighted is approximately double the cost of post complete with lamps and glassware based on average conditions. This statement is made from studying existing conditions, for where a moderate priced pole is used construction of an analagous grade is employed, and correspondingly for the more expensive standards.

OPERATION AND MAINTENANCE COSTS.

The operation and maintenance costs for ornamental systems vary so widely that it is hard to give even an average figure except by modifying the statement by a limited locality. Very broadly, an average current cost may be given as three cents per kilowatt-hour, to which the items of interest, depreciation, lamp and globe renewals, repairs and labor must be added to obtain the total maintenance cost. All or any of these latter items may differ from one locality to another, but with average conditions on a flat rate charge per five-light standard using four 60-watt and one 100-watt lamp for midnight and all night burning, $60.00 to $75.00 can be stated.

The advances made in the last year in this branch of lighting, combined with the enthusiasm exhibited by prospective communities, intimate that the possibilities of extension in the coming year are almost unlimited. In what has gone before, it has been the writer's idea, in a general way, to indicate the trend a proposed installation should take in order to be of the highest possible benefit to a community and to make suggestions which will help in deciding the best policy to pursue in advancing the question of decorative street lighting. A number of Southern cities have made notable progress in this system of lighting, and it is expected that considerable data will soon be available revealing further information of value in determining the nature of systems suited for the particular localities and furnishing dependable material for cost estimations.

Fig. 10. Regenerative Flame Arc System at Pueblo, Col.

Fig. 11. Decorative System at Peoria, Ill.

Central Station Management, Considering Physical and Commercial Features.

(*Contributed Exclusively to* Southern Electrician.)

BY C. H. BROWARD.

IT is not intended in this article to go into the intricate features of this subject, but rather to outline in a general way some of the methods that enter into the efficient conduct of central stations. All public service corporations are organized and operated for the definite purpose of financial gain, and therefore all elements entering into their administration which contribute toward that end should be carefully fostered. Those which are useless or cause a loss should be discarded. Immediate returns in money do not necessarily indicate that the methods employed are the best in the long run, nor, on the other hand, should all policies be condemned which do not show a direct money value.

Electric service companies, like all industrial organizations, have two important factors to consider, namely, the physical properties, and the personal elements within and without the organization. The measure of financial success attained is proportional to the skill and judgment displayed in their management. It will be seen, therefore, that the general manager determines in a very large measure the success or failure of the company. It is evident that he should be a broad-minded, wide-awake, aggressive business man, capable of seeing to it that the several departments are properly conducted, that the attitude of the company toward the public is maintained on a high plane of fair dealing, and that the company's interests do not suffer on account of neglect or discourtesy on the part of any employee. The company, through its officers, should take a definite interest in all questions pertaining to the city's welfare, for as the community prospers, so will the service of the company.

The general manager should, however, be very careful lest his motives be misunderstood and much harm result, for it is evident that while opportunities for much good are present, possibilities for harm are correspondingly large, and even the good intentions of the company can be exploited in such a way as to make them look bad. If the company's activities are too conspicuous, especially in matters affecting legislation, much unfavorable comment may ensue and tend to mold a public sentiment adverse to its interests. No company can afford to be indifferent to what its patrons and the general public think of it.

Questions and discussions of public policy are all important and should receive careful and thoughtful consideration from every manager. He should associate himself and company with the best of the societies whose object is the promotion of the art, take an active interest in their proceedings, and keep informed as to the methods employed by other companies in the treatment of their problems, which are naturally along the same lines as his own. Commercially, the manager should be well informed, capable of conducting financial negotiations, and in every respect keep the company's reputation above reproach. Executive ability of the highest type must necessarily be a part of his qualifications. Not only must he be able to keep the several department heads loyal and alert, but should endeavor to imbue them with progressive ideas and encourage them to greater efforts. With this end in view regular meetings of the department chiefs and general manager, for the purpose of discussing the company's affairs in all their different phases, will do much good.

In order to get a true perspective of the company's interests and be ready for any demand upon him which promises well for the company, the general manager should not be handicapped with an endless routine of details that could be attended to by the department heads. Yet it is essential that he should at all times know just what is going on and have his fingers on the pulse, so to speak, that he may be able to detect any irregularity in good time.

RELATION BETWEEN GENERAL MANAGER AND DEPARTMENT HEADS.

Every employee more or less unconsciously adopts the spirit and ideas of his department chief, and through him those of the general manager. It is thus important that each department chief be watchful of his conduct, allowing nothing to occur that will lessen the respect of the men for him and his methods. Regular meetings between the department heads and their men will do much to promote not only a spirit of friendliness, but a loyalty that will count for a great deal in better, more efficient and more enthusiastic work.

The department heads and the manager should study the problem of handling men to the best advantage, and should in particular study the men whom they employ. Their manners, temperaments and capabilities vary widely under different conditions, and it is often found that an employee who is totally unfit for the position he holds will make a valuable man in some other department. It should therefore be the object of the department chiefs to so dispose both men and materials so that their possibilities will be realized to the best advantage. To do this, an adequate system of records and reports should be kept, showing what the several departments are doing, promptness and completeness in this regard should be insisted upon.

A record of the men in each department costs very little to keep, and if properly maintained can be made valuable. Equipment records, results of tests and inspections, and all data relating to the operation of the system should be kept by the engineering department. Accidents, both to employees, the public, or the apparatus should be investigated as soon as possible, while the details are fresh in minds of the witnesses, and every effort made to determine the cause of the mishap. Steps should then be taken to prevent any other accident from the same cause.

In the offices, promptness, courtesy, and efficiency should be the keynote of the organization, and these qualifications cannot be better encouraged than by strict observance of them by the heads of the departments. It sometimes happens that the office, the engineering, mechanical, and soliciting forces work at cross-purposes, each blaming the other for some oversight that reacted upon another department, such as the sending and receiving of reports, orders, requisitions or some other information. From the very nature of the business, the several departments are linked together in many ways, and it should be seen to that they work harmoniously. The problems of electric service companies are highly complex, and every detail deserves careful consideration. It seems almost impossible to build up an organization that is not either lacking in the number and quality of men, or, on the other hand, has too many men. Both of these methods are wrong, and are gradually giving way under the application of the doctrine of efficiency, to methods that eliminate the useless men and stimulate the others to greater efforts.

WAGES, ADVANCEMENT AND TRAINING OF EMPLOYEES.

The writer believes that a scale of wages should not be so rigidly fixed as to compel capable and ambitious men to go elsewhere to sell their services if it is at all possible to retain them. They will have become accustomed to the company's methods and policies and will be more loyal to a company that voluntarily recognizes their merit than one that does not. If one employee applies himself harder than another and really becomes more valuable, his interest and merit should be recognized, even to the point of advancing him over a less capable man. It is a mistake to promote the men altogether on the basis of length of service. This discourages the best men in the organization, and will cause the company to lose their services, for they can't afford to wait for promotions that are necessarily so slow in coming. Then, too, it is good policy, for it stimulates all of the men to greater endeavor, the benefits of which the company gets. It is further due the men that the company reciprocate in the matter of loyalty and promote its own men whenever possible rather than go outside for men to fill vacancies. This policy will promote a better feeling between the men and the company, which will be mutually beneficial.

It is also an excellent idea to provide some means for the men to obtain specific information on any subject in their departments, and any facilities provided for this purpose will amply repay the company because of the increased interest of the men and the consequent betterment of the service. The men should be encouraged to avail themselves of these privileges and to ask questions on any subject. The question of better industrial education is receiving a great deal of consideration at present in the various engineering societies, which realize that anything that contributes to the betterment of the individual gives to the employer the result of his increased knowledge and ability. It is therefore to the direct advantage of the company to encourage its men to study, and in some instances to provide means toward that end.

The character and ability of the men in the entire organization is then largely determined by the salaries paid, as the men are naturally more interested in their income than they are in the number of hours on duty, how hard the work, or anything else. Then, too, it is almost proverbial that cheap men are more costly than high-priced ones. Since the latter are necessarily of larger calibre, will do more and better work, and because of more satisfactory remuneration will be more apt to stay. Just as the best equipment is the most economical in service, so it pays to have the highest standard among the men.

HOURS OF DUTY AND SATISFACTORY SHIFTS.

In line with the movement to encourage better industrial education and training comes the question of how long it is best to work the men. Local conditions, of course, determine in a large measure routine of operation and number of hours on duty, but of late there has been a tendency among the men to ask for shorter hours and the writer has known some operators in power houses to decline a position that required them to be on duty twelve hours. Ordinarily, ten hours is long enough for a man to be on duty. Some companies have eight-hour shifts and find it very satisfactory as a means of having alert, wide-awake operators on duty all the time. This system affords the men time to study and familiarize themselves with features about the plant that they don't come in contact with while on duty. One large company in the South has adopted a plan that appears to be a step in advance in this respect regarding its power house staff. They are required to be on regular duty for eight hours and when relieved are assigned to some piece of repair work, alteration, extension or anything else that needs to be done. A great part of the time there is no extra work for them to do, and then they have the extra time off. In cases of emergency then, the management has a claim upon them for overtime without extra pay. Another advantage, and perhaps the greatest, is the increased usefulness of the men who gradually learn all ins and outs of the plant, and in cases of emergency are better prepared to act quickly and intelligently. In the power houses and sub-stations the operators will work better if the shifts are occasionally changed so that the night men get some experience during the day run, which is somewhat different in the character of the load. This familiarizes each man with the entire run of the station for twenty-four hours. At the changing of shifts, the outgoing and incoming crews should be required to make one round together to see that everything is in satisfactory shape, and the incoming crew should also look over the station log-book mentioned above and note everything recorded since last on duty. If anything unusual is found, the chief operators, both incoming and outgoing, should be notified so that the responsibility can be definitely determined at once.

It sometimes happens that an otherwise good operator does not work well with a certain chief operator, but would make a good man on another shift. Instead of letting one of them go, it is better to try them on separate shifts, for a new man would simply be an experiment after all. "Knocking," so called, is a mighty disagreeable thing to have in any organization, and if it exists, as soon as it is discovered, the guilty man should be removed if he cannot otherwise be cured.

From the general manager down to the sub-foremen, the right kind of a boss will know all that he needs to know about his immediate department without being told, and will not listen to idle stories derogatory to any of his men or show partiality, as this will very soon produce discord. The next section of this article will take up the management of central station physical properties.

The number 10 Brown & Sharp (B. & S.) gauge wire has an area of approximately 10,000 circular mils, and from this base the other sizes can be figured, if a table should not be at hand.

Central Station Distribution Systems for Lighting and Power.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN)
BY A. G. RAKESTRAW.

THE object of this article is to briefly consider some of the problems which arise in connection with central station distribution and to describe systems which are in common use. Some of these are quite simple, while others are elaborate, but in every case the result sought is the same, namely, to distribute electrical energy with the smallest possible loss, or to put it more accurately, to reduce the sum of the line losses and the investment charges to a minimum and at the same time furnish satisfactory service to the customers. If current could be transmitted without loss, or if some conductor were discovered which offered no resistance to the current, the simplest kind of distribution system would be sufficient. However, under actual operating conditions, we find that these losses become of such magnitude, especially in large installations, that considerable expense is justifiable to effect a reduction.

Before taking up the various systems, let us consider some of the principles involved. Fig. 1 shows a simple line carrying a load of 20 incandescent lamps taking 10 amperes at 110 volts. If this line is of No. 10 wire, and

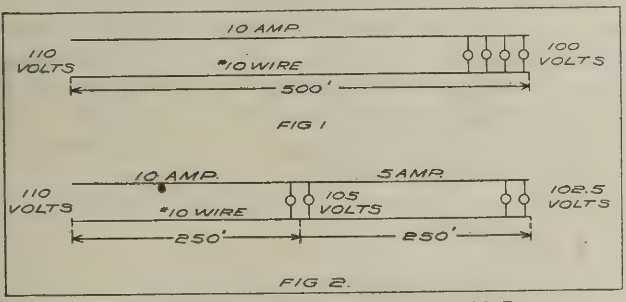


FIG. 1. SIMPLE SYSTEM WITH LOAD OF 20 LAMPS.

FIG. 2. SIMPLE SYSTEM WITH DIVIDED LOAD.

500 feet long, we will have a resistance of one ohm and therefore a drop of 10 volts or nine per cent., which would give 100 volts at the lamps. The input would be 1,100 watts, the power lost on the line 100 watts and the power utilized 1,000 watts, or a loss of nine per cent. In Fig. 2, the load is divided, part being at the end and part at the middle of the line. In this case, the voltage at the middle group is 105 volts, and at the end 102.5 volts. In general the problems of distribution are: First, to provide wire of sufficient size to carry the current without overheating; second, to reduce the voltage drop and the consequent resistance loss; third, to secure uniformity of voltage over the system; and fourth, to provide the machinery, accessories, insulation, etc., necessary to carry out the foregoing requirements.

The carrying capacity need not usually be considered except in quite short runs, such as interior wiring in buildings. For instance, in Fig. 1, No. 14 B. and S. wire would have been sufficient to carry the current without overheating, but the drop would have been excessive. If, however, the line had been but 20 feet long instead of 500, we could have used No. 16 wire with 1.6 volts drop, but it would not have been of sufficient capacity. Therefore we see that the size of wire is sometimes determined by the capacity and sometimes permissible drop.

THE VOLTAGE DROP.

As far as the voltage drop is concerned, the question becomes one of spending money in copper to save loss of energy. The larger the wire, the less the drop, and therefore the less will be the loss, and vice versa. The most economical size of wire, subject to certain commercial limitations, may be determined by a rule known as "Kelvin law," in honor of Lord Kelvin. This law may be stated thus: "The size of wire for the most economical operation is such that the interest on the copper cost and the other accessories which vary with the size of the line, shall be equal to the annual money value of the lost power." Let us take an example of this, assuming the following data: voltage, 500; load 10 horsepower, or approximately 20 amperes; line 500 feet long. Assume also the price of copper at 20 cents per pound, interest at 5 per cent. and power at 1 cent per Kwhr. Consider also that this power is used 10 hours per day or about 300 hours per year.

The relations of the variables involved as given above are shown in Table 1. Fig. 3 expresses the results in the form of curves. It is found that where curves A and B cross, that curve C indicating the total loss, is a minimum bearing out Kelvins law. It appears, therefore, that No. 2 B. and S. is the most economical size of wire to use in this case. The drop is 3.12 volts or a little over one-half per cent. The same load at 220 volts would require 42 amperes. Making a similar calculation which we express by curves B and D, we get No. 00 as the best size of wire, with a loss of 3.27 volts or about one and one-half per

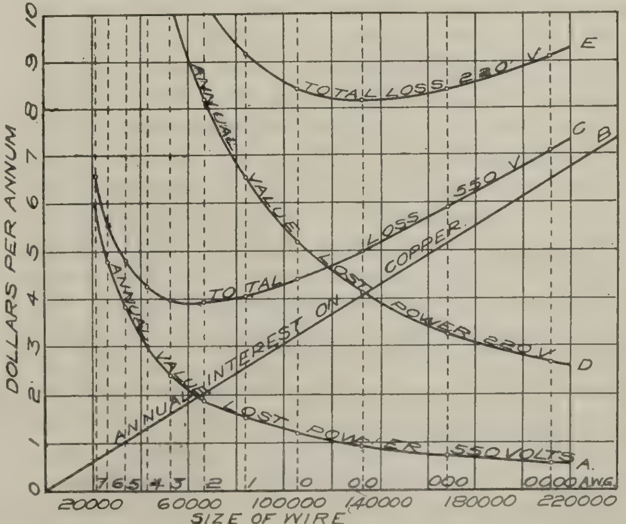


FIG. 3. CURVES SHOWING RELATION OF VARIABLES IN A DISTRIBUTION SYSTEM.

cent. In making these calculations we have considered the cost of the wire as proportional to its weight. This is only approximately true, especially in the smaller sizes, and therefore reference must be made to commercial prices. Note also that these curves are plotted in circular mills. The same results could have been obtained by plotting in wire gauges, but in the case of a problem involving sizes of wire larger than No. 0000, the curve would change direction abruptly at that point. These examples are sufficient to indicate the method of determining the size of wire when the other conditions have been decided upon. This rule is general.

TABLE I. DATA SHOWING VARIABLES INVOLVED IN A DISTRIBUTION SYSTEM OF 550 VOLTS.

Size Wire.	C. M	Ohms.	Drop.	Loss Watts.	K. W. H. Per Yr.	Value of Lost Power.	Weight of Copper.	Cost of Copper.	Annual Interest.	Total Loss.
6	26250	.395	7.90	158	4.74	$4.74	79.5	$15.90	$ .79	$5.53
5	33102	.313	6.26	125.2	376	3.76	100	20.00	1.00	4.76
4	41742	.249	4.98	99.6	299	2.99	127	25.40	1.27	4.26
3	52633	.197	3.94	78.8	236	2.36	160	32.00	1.60	3.96
2	66373	.156	3.12	62.4	187	1.87	203	40.60	2.03	3.90
1	83694	.124	2.48	49.6	148.8	1.49	255	51.00	2.55	4.04
0	105534	.0981	1.96	39.2	117.6	1.18	322	64.40	3.22	4.40
00	133079	.0778	1.556	31.1	93.3	.93	406	81.20	4.06	4.99
000	167805	.0617	1.234	24.7	74.1	.74	513	102.60	5.13	5.87

The higher the voltage, the less loss and less percentage drop. This is in general true, since the higher the voltage the smaller will be the current required to transmit a given amount of power, and therefore the smaller will be the line loss and the investment in copper. However, the increasing voltage while it permits the use of a smaller wire also calls for an increased investment in insulation, protective devices, transformers, etc., so that it is necessary to take the cost of all these into account in figuring the economy. For the present, considering direct current circuits of 110, 220, and 500 volts and having given the amount of load and length of line we may easily determine the copper losses for each voltage. For instance the losses plus the copper investment for a 10 horsepower motor load over a 500 foot line might be $4.00 for 550 volts, $8.00 for 220 volts and $16.00 for 110 volts. Now if the interest on the increased cost of motor and insulation did not equal the increased loss, it is plain that it is more economical to use the higher voltage. While in theory Kelvin's law holds good for a change in voltage as well as for sizes of wire, yet it is not practicable to plot curves showing this relation due to commercial limitations as to standard voltages.

VOLTAGE UNIFORMITY AND REGULATION.

Besides line loss, we must consider voltage uniformity over the system and the regulation or the steadiness of voltage. In the examples just taken, the size of wire which is most economical to use figures out with quite a low drop. This, however, is not always the case. If, for instance, we consider a lighting load of 20 amperes at 220 volts, with a line 1,000 feet long and assume that this load is used 1,000 hours per year, or about three hours per day, by applying Kelvins rule, we obtain No. 5 B. and S. wire as the best size. However, the drop would be 12.52 volts or nearly 6 per cent., which is too much for satisfactory lighting service and on this account a larger wire would likely be necessary.

It would not make much difference if the current was generated at 220 volts and if there were a drop of 20 volts between the powerhouse and the customer, as long as this 200 volts was kept uniform and steady over the system. If one set of customers received 200 volts, and another group 210, and still another 218, however, it would be difficult to be sure that lamps furnished would give satisfactory life and candle power, and if the consumer purchased any lamps for himself, he would have great trouble in getting the selection which he needed. Furthermore, since the drop increases with the current, the voltage at the outlying points would vary greatly with the time of day, being perhaps 200 volts at periods of heavy load and might rise to 215 or 218 volts during times of light load. Under these circumstances it would be impossible to furnish lamps which would give good service. Moreover, if there should happen to be a large motor on the lighting circuit and if the same should be started and stopped frequently as in elevator operation, the lights would flicker more or less violently with a decidedly annoying effect. These are problems that every central station has to meet, and in many cases they are serious, in others they have become critical. To obviate therefore these causes of dissatisfaction, and to aid in reducing the line loss, demands the use of various devices, accessories, and calls for the expenditure of large sums of money in high tension apparatus, sub-stations, transmission lines, etc.

THE SYSTEMS IN USE.

There are practically two standard systems of distribution used today in this country. One is the direct current Edison three-wire system, using 110-220 volt circuits for light and 220 volts for power. The other is the 2,200 volt, single, two or three-phase A. C. with step-down transformers, supplying 110 volt or 110-220 volt single-phase lighting service and small single-phase motors, and also two or three-phase transformers supplying 220 or 440 volt polyphase motors. Occasionally we will find 2,200 volt induction motors connected directly to the line.

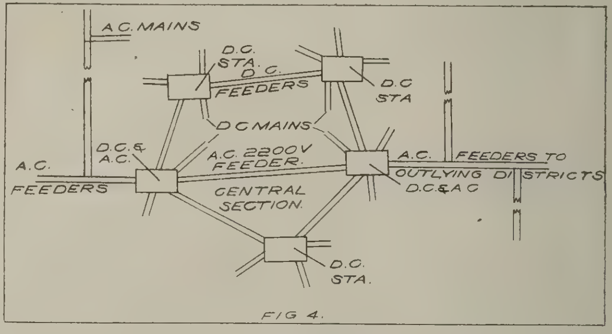


Fig. 4. Several D. C. Stations Connected Through Low Tension Feeders.

These systems are of course subject to many modifications. We find many modern stations generating entirely alternating current and stepping up to 6,600, 10,000 or 20,000 volts, three-phase, which supplies a number of sub-stations each with transformers and rotary converters. These sub-stations supply adjacent territory with 2,200 volts A. C. or 110-220 volts D. C. or both, as the needs may require. Fig. 4 shows a number of direct current generating stations in the central part of a city, all tied together through their low tension feeders, from which are taken the direct current mains. Two of these stations also contain alternating current generators from which 2,200 volt lines traverse the outlying districts. These may or may not be tied together by a 2,200 volt line as shown. This is a very common arrangement. Fig. 5 shows a layout of a large central station in which purposely a large number of combinations are given, both alternating and direct current. This is typical of a large number of central stations in successful operation. The booster set near the end of the direct current lighting circuit, and the accumulator on the railway circuit, will be considered later.

The simplest system which can be imagined would be a two-wire direct current, but it is seldom used, for the reason that with standard incandescent lamps the voltage would be practically limited to 110 volts, and the copper investment would be excessive. The two-wire service is used, however, for power purposes, and on lighting for short runs, and we will describe some of the ways in which this service may be distributed. Many of the remarks will be applicable to three-wire circuits and to alternating current as well as direct current. Fig. 6 represents the "tree" system, which is open to objection in that the voltage varies too much from point to point. It is true, that knowing the loads at points A, B, C, etc., we can compute the drop to X, Y, Z, etc., and by a careful selection of the size of wire in the branches we can get a close agreement between the terminal voltage, but this is hardly a satisfactory arrangement. The "loop" system is shown in Fig. 7. As will be seen each lamp is the same distance (electrically) from the point of supply. Fig 8 shows the "feeder and main" system. In this diagram A, B, C are the feeders from which taps are taken. At 1, 2 and 3, are short cross-feeders from which the mains are taken. Knowing the approximate load and the distance of these distribution points from the power house, the feeders, A, B, and C, can be calculated so as to give about the same voltage at each point, independent of distance. The "ring system" of feeders is laid out on a plan similar to that shown in Fig. 4.

To raise the voltage on the far end of a direct current line, a booster set is sometimes used. This arrangement is shown in Fig. 5, and is a combination of a direct current motor with a low tension compound wound generator, in series with one side of the line. For instance, if the voltage at point B has fallen to 210 volts, the shunt field of the booster is adjusted to give 10 volts, thus raising the voltage to 220. The field is compound wound because at heavy loads there is greater voltage drop and therefore more boosting voltage required. An accumulator or storage battery is often used in this connection, especially in railway work. One application is shown in Fig. 5 where it is placed at the extreme end of the line. Suppose that at this point the voltage varies from 550 volts under light load to perhaps as low as 450 volts during periods of heavy traffic. This would be very objectionable, because the speed of all the cars would be proportionately reduced and much time lost when it could be least spared. If a battery of 500 volts normal were placed here, it would be charging during light loads, that is through the night, and would furnish power to the line whenever the voltage dropped below that of the battery.

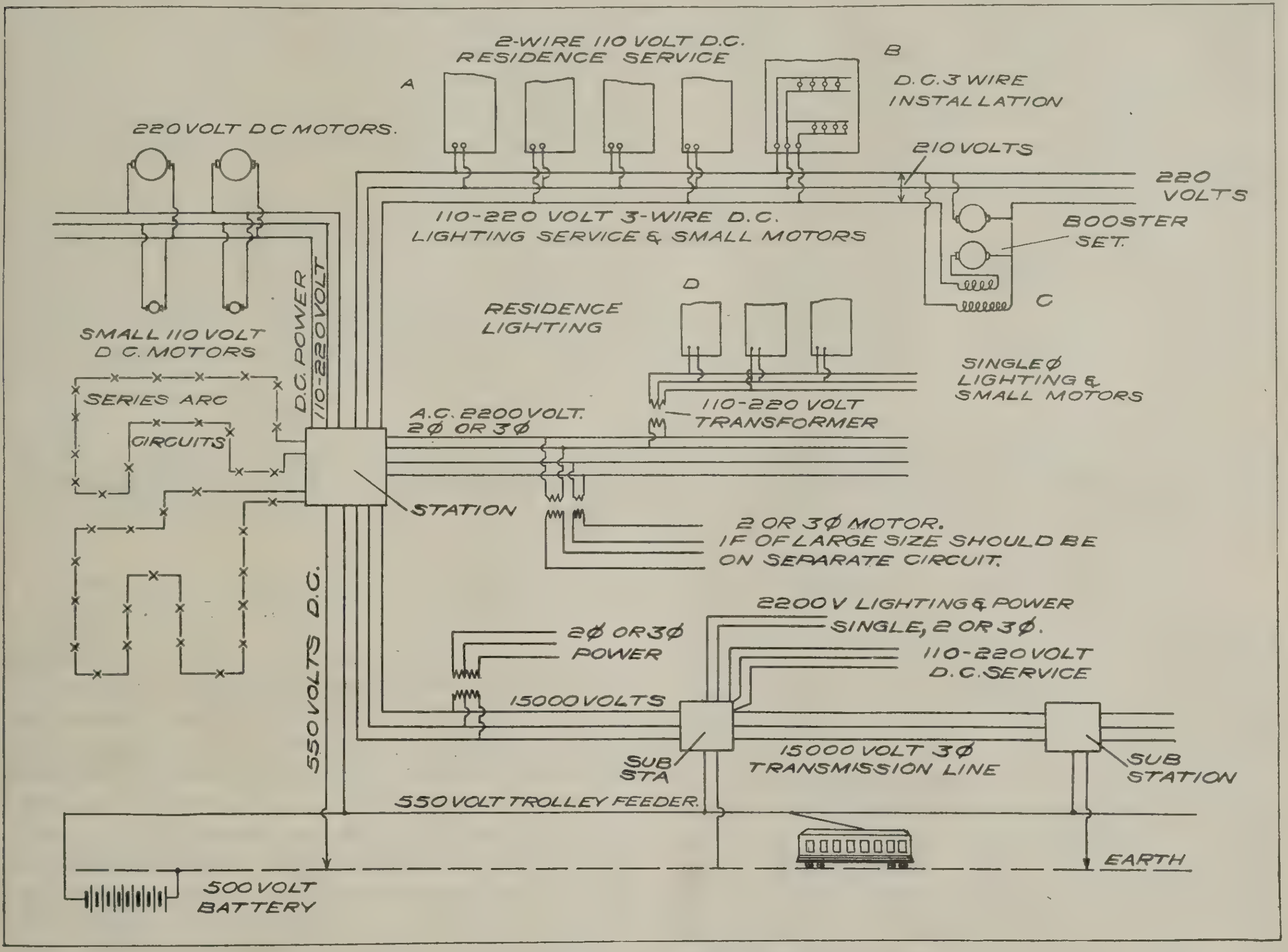
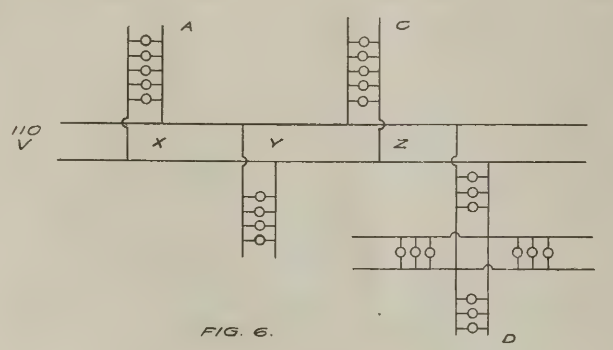


Fig. 5. Layout for a Large Central Station.

DIRECT CURRENT DISTRIBUTION VOLTAGES.

For direct current power we find that 220 volts appears to be the most used, small motors at 110 volts running often from the lighting mains. A separate circuit should be used, however, for motor service wherever possible to avoid the flickering of lights. A voltage of 500 has been used to some extent for power, but the added difficulty in keeping 500 volt motors from flashing and "bucking" and the liability of receiving shocks when working around them together with the fact that separate circuits are required in every case for power and light, has to some extent discouraged their use.



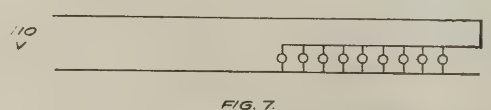


Fig. 6. Tree System of Distribution.
Fig. 7. Loop System of Distribution.

The two-wire direct current system is modified for lighting circuits by the raising of the voltage to 220 volts, and the running of a "neutral wire." This is simply a multiple series arrangement, with a third wire to take care of any unbalanced load. The connections are shown in Fig. 9. If there are just the same number of lamps on one side as the other, there will be no current flowing in the neutral wire, but if there are a few more on one side than the other, there will be a small unbalanced load. Care should be taken, therefore, to have the load as evenly divided as possible so as not to overload the neutral wire. It was formerly considered good practice to have each customer connected up to the three wires as shown at B in Fig. 5, so as to increase the closeness of balancing and also that in case one side of the line were put out of service it would only affect one half of his lights. With more reliable service, this has not seemed necessary, and houses are now usually wired for two-wire circuits, with adjacent houses connected to alternate sides of the line as shown at A and D in Fig. 5. This applies as well to three-wire alternating current connections.

The 110-220 volt current may be generated in different ways. Fig. 9 shows the usual way of using two independent generators. The same result may be secured by a three-wire generator with two independent armature windings, or by a 220 volt generator with collector rings and a balancing coil. This is the "Scott" system and is shown in Fig. 10. A generator with a third brush may be used where the unbalancing is very slight, since if any considerable amount of current is drawn from the third brush, it will produce heavy sparking at the commutator due to the field distortion. If the unbalancing is negligible it is indeed possible to run with a disconnected neutral, as shown in Fig. 11, but in this case the effect of unbalanced load will be to increase the voltage on one side of the circuit and decrease it on the other, which unless very small, will cause trouble.

Another way of producing a 110-220 volt current is to generate at 220 volts and use a balancing set, as shown in Fig. 12. This set is usually located at the power house, but may be connected anywhere along the line. Another way is to have a small 110 volt generator across one side of the line, belted up with the main generator, as shown in Fig. 13. When the negative side of the line has the most load, this machine runs as a generator and supplies the needed current, but when the positive side has the most load, it runs as a motor and furnishes mechanical power to the main generator.

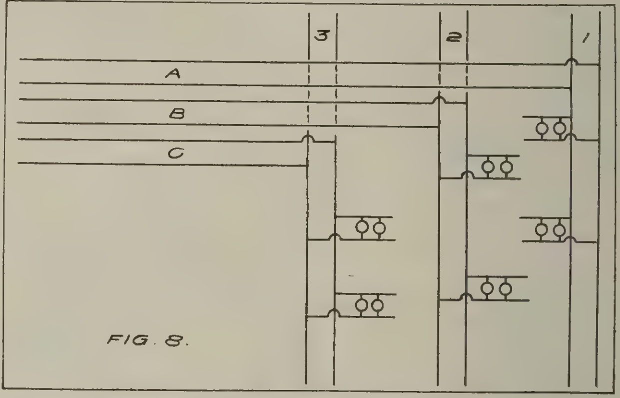


Fig. 8. Feeder and Main System of Distribution.

With direct current there is a limit to the economical voltage, and in going above this point it is necessary to use alternating current. Alternating current possesses the advantage of capability of transformation from one voltage to another, so that it can be economically transmitted long distances at high voltage and reduced to a value convenient for use. Fig. 5 shows the usual plan for alternating current distribution. There is much discussion as to the relative merits of alternating current and direct current for the thickly settled parts of cities, however the alternating current is the only suitable medium for suburban districts. Of course in figuring the relative economy, we must take into account the cost of transformers, and transformer losses, etc., to balance against the great saving in copper.

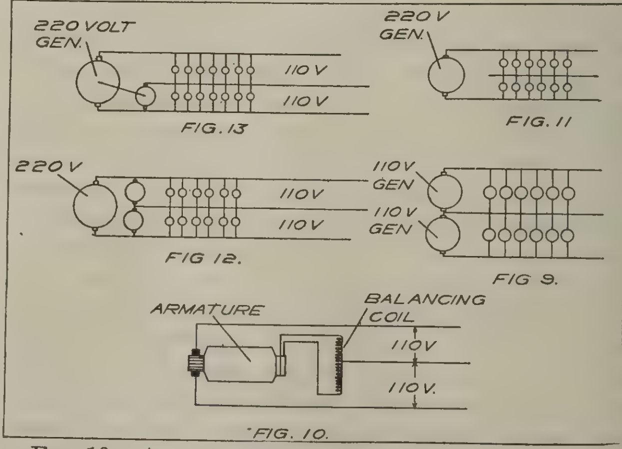


Fig. 10. Arrangements of Generating Systems.

ALTERNATING CURRENT DISTRIBUTION VOLTAGES.

The usual alternating current distribution voltage is 2,200 volts, with 110-220 volt secondaries for light, and 220, 440 or 550 for power. The 440 and 550 volt alternating current motors are reliable in action and do not require the large wire necessary for 220 volt direct current motors of the same size. The original plan of distributing the low tension alternating current was to put a transformer on each house, but most companies are now using larger transformers on a 110-220 volt low tension bank, and supplying a number of customers from one transformer as shown.

With the increase in the size of the territory served, a point will be reached where the service cannot be economically handled from one point. Naturally with 220 volt direct current this point is soon reached, and the usual procedure was to build another station and connect it with the first. This practice soon resulted in a string of interconnected stations, as in Fig. 4, forming a very reliable system, but requiring a large investment in copper and machinery and valuable land in the central sections of the city. With alternating current of course, one station can serve a much larger territory, and the generators can be located at fewer points. With further increase in territory and the combinations which have been effected between operating companies, one large station now usually supplies, through its system of high tension transmission lines and sub-stations, immense territories covering hundreds of square miles.

UNDERGROUND DISTRIBUTION.

There is one feature of the situation as regards distribution in business districts which now has to be taken into account, namely the demand for underground service. A voltage of 2,200 alternating current is easily handled on pole lines and does not have to be shut off for the purpose of making connections. When the service is underground and connections have to be made in manholes, the connections cannot be made when the cables are alive, and there is sure to be some inconvenience attending the turning off of the current, if even for a short time. With the 220 volt direct current this is not necessary and therefore the direct current is preferred by many for down town distribution.

There are a number of other important phases of this question, especially as regards reliability and synchronizing, for a fuller discription of which I would refer the reader to an article by Dr. C. P. Steinmetz in the proceedings of the A. I. E. E. for 1911.

Design of Industrial Lighting Systems.

(*Contributed Exclusively to* Southern Electrician)

BY LLOYD GARRISON, ILLUMINATING ENGINEER.

IN DESIGNING any lighting installation there are certain principles which must be borne in mind. The relative importance of these varies with the class of service but no installation will be satisfactory or will it fulfill its function, that is, highest efficiency of operation compatible with proper protection of the eyesight, unless all are considered. These principles may be stated briefly as follows: (1) An excessive light flux entering the eye fatigues that organ; (2) insufficient light causes eye-strain; (3) sharp cross-lights or contrasts irritate the eye; (4) no contrast whatever is productive of eye-strain; (5) moving shadows are particularly irritating to the eye.

In view of these facts, it is the purpose of this article to show the application of these principles to the lighting of industrial plants.

In most industrial plants the attention of the workman is confined closely to some particular point or operation; therefore the interest of one designing a lighting system for such a plant must be centered upon the points or operations engaging the chief attention of the workman. Other considerations become subsidiary to this, but in proportion as the work of the average workman varies from the particular to the general, the other conditions approach predominance.

As a concrete example of the principles named, the case of a man turning out work on a lathe will be considered. In such a connection the matter of insufficient light needs little consideration, for a workman will invariably secure a larger lamp in some manner. The problem of excessive light, however, is very important and must receive careful attention. There are two phases of this which must be considered, namely, light entering the eye direct from the source and light reflected from other objects. Considering the first phase, the fact at once appears, with which everyone is familiar, that a light placed nearly between the eye and the work is of such intensity as to make the work appear dim. In other words the eye is blinded, which is the common way of stating that in adjusting itself to the strong light from the source, it renders itself more or less insensible to relatively weak light reflected from the object illuminated. Obviously the light source must be removed from the position indicated, and to avoid affecting the eye as a cross-light, must be so placed that no direct light will enter the eye. Such a result could be obtained by placing the light above or at the side of the head, but this arrangement introduces another objection because of the fact that the sensitiveness of the eye is determined, not by the light reflected from the work alone but quite as much by that coming from the walls and neighboring objects. Therefore to get the greatest efficiency the strongest light must be concentrated upon the object to be observed by means of some reflector, which prevents all direct rays from reaching the eye. An illustration of this principle may be found in the ordinary stand lamp which darkens the walls of a room and enables the eye to read without irritation by the use of much less light flux than is necessary when a lamp using a translucent reflector is hung in the middle of the room.

Having arranged a satisfactory reflector, it becomes necessary to study the light reflected from the work. Immediately the character and color of the work assumes considerable importance. The eye naturally judges by contrasts. If a very efficient diffusing reflector is used for a background and a very poor reflector is contrasted against this, as for instance print on paper, relatively lower illumination is required than when the contrast is less marked. Beyond a certain point, however, it is not advisable to increase the reflected light flux owing to decrease in the sensitiveness and therefore in the efficiency of the eye. With a proper amount of illumination provided, the most important element of reflected light to be considered is glare. This without any doubt is one of the

Fig. 1. Good Illustration of General Illumination.

most fruitful sources of eye trouble caused by light. If the light is reflected from a rough surface such as is left by the first cuts of a lathe, no trouble will be experienced. As the cuts become finer and the surface of the work becomes more smooth, the reflection becomes more regular, with the result that light of considerable intensity is reflected from the work in close proximity to the cutting tool. The resulting effect is the same as when the source of light itself is placed directly in the line of vision, and if the eye strain produced is allowed to continue day after day, permanent injury will likely result. The elimination of this evil in the case assumed, is rather difficult, but the best results can be obtained by the use of a movable light source, which will enable the workman to so adjust the reflection that it will be removed as far as possible from the cutting tool or eliminated entirely.

The subject of cross-lights has been considered with reference to local lighting, but in the case of general lighting care must be exercised in so arranging that no sharp cross-lights will affect the eyes of the workman. At the same time, sufficient illumination must be provided on all surfaces which the eye must observe closely to prevent too sharp contrast and consequent eye strain. As a general rule the latter point can be cared for by local lighting and only enough uniform general lighting need be provided to permit movement about the room. Too great general illumination has a tendency to reduce the relative amount of light reflected from the work, requiring the closest observation and therefore to reduce the efficiency of the eye. Also there is a greater tendency for the workman's attention to wander.

Another fruitful source of eye trouble is found in a multiplicity of shadows, especially when the latter are moving. No better idea of the annoyance caused by such things can be obtained than by an attempt to read when passing under a tree through the foliage of which the sun is shining. The same thing can be noted in a draughting room or when attempting to write at a desk illuminated from several sources. This feature may prove one of considerable importance in industrial lighting when sources are so placed that the shadows of moving parts are cast upon objects receiving the close attention of the eye. Such arrangements should always be avoided.

In the case of industrial work which does not require close attention of the eye, such as the supervision of the work of a machine or a group of machines, the importance of local lighting becomes second to that of general lighting. It is well, of course, to provide local lighting or a movable drop cord equipped with proper reflector wherever such may be needed, but emphasis should be placed upon the general lighting. The relative importance of the various principles is changed considerably in this connection from that in the case of local lighting. The minimum flux is determined only by the amount of light required and is productive of no great eye strain. An excessive amount of light is perhaps more damaging than too little, owing to the tiring of the eye, but this is not so important as when the attention of the eye is concentrated upon some particular work. Neither are sharp contrasts and cross-lights so damaging as when the attention of the eye is confined to one thing, for by its continual roving, the eye rests the various parts of the retina which might otherwise tire if the same image was constantly impressed on the same spot. Care should be taken, however, to provide light sources which are not blinding, as the action of an intensely bright image on the eye is very rapid and destructive. Proper use should be made of frosted or opalescent glass to diffuse the light from sources of high intrinsic brilliancy. Such methods reduce the efficiency of the light source, it is true, but the increase of efficiency in the eye more than offsets any such loss. Contrary to the effect of contrasts, in resting the eye which is moving, lack of contrast does the reverse and for this reason. Unless color arrangements will permit, care should be used in installing any system, such as indirect lighting, which will produce a lack of contrast. Also light sources should be so placed that moving shadows are eliminated as far as

Fig. 2. Factory Where 100-Watt Tungsten Lamps Give a Uniform Illumination.

possible, for any shadow, the motion of which is so rapid that the eye cannot easily keep itself adjusted, will, if continued in motion for a prolonged time, severely tire the eye.

In the foregoing discussion, although a concrete example was chosen, an attempt has been made to enunciate the principles governing correct lighting rather than to give the method of handling any particular case. The application of these principles as regards fixtures, reflectors, etc., will bear discussion. For local lighting where the

FIG. 3. FACTORY WITH LOW CEILING WHERE 60-WATT TUNGSTEN LAMPS HAVE BEEN A SUCCESS.

light source may be considered fixed, such as on a linotype machine, a flexible gooseneck equipped with a parabolic reflector serves the purpose very well, while for work requiring a movable light, such as molding, the same reflector fastened to a wooden handle is serviceable. In the case of general lighting which is supplementary to local lighting, a few large frosted tungstens hung high and equipped with diffusing reflectors will prove ample. This method is preferable to the use of a larger number of small units since the first cost is less and the multiplicity of shadows is reduced. In most installations one-half foot candle on the floor is ample. For interiors where general illumination is the object, installations similar to the foregoing are suitable, but the illumination should not fall below two-foot candles and where the work requires close attention should not fall below seven or eight. Often in the case of large shops having high, dingy walls and ceiling, or where cranes interfere with the hanging of lights, and for yards, flame arcs will be found serviceable. In any case where tungstens are used the lamps and their reflectors should be cleaned periodically as a collection of dust greatly reduces the efficiency.

The following approximate values for use with tungstens and holophane reflectors is given to serve as a guide for laying out general lighting installations. In the case of flame arcs or other illuminants, the individual curves of the lamps must be used. For these the reflection factors are given. The wattage of tungsten or Mazda lamps per square foot of floor space necessary to produce an illumination of one candle foot on the working plane follows: These lamps may be hung seventen feet or less above the working plane.

WATTAGE OF MAZDA LAMPS TO PRODUCE AN ILLUMINATION OF ONE FOOT CANDLE.

	Color of Walls and Ceiling		
	Dark	Medium	Light
Watts per square foot.......	.30	.23	.20

REFLECTION FACTORS FOR USE WITH ILLUMINANTS OTHER THAN TUNGSTENS.

Walls and Ceiling.		
Dark	Medium	Light
1.1 to 1.5	1.5 to 2.0	2.0 to 2.5

In using the latter table, the average value of illumination should be multiplied by the factor and its increase added to the various values obtained from the curves of the lamp, as the increase due to reflection is usually fairly uniform.

Every installation is a study within itself and the scientific handling of the problem is a matter of importance, although manufacturers as a rule do not realize this. The value lies not alone in the saving due to the most efficient use of light but to a greater extent in the increased efficiency of employes. No man working under unfavorable conditions can do his best and if his eyes are constantly laboring under a strain from which they are as constantly trying to get away, his attention cannot fail, even unwittingly, to be distracted from his work. This very fact may easily mean a yearly loss to the manufacturer, greater than the cost of a proper installation, and it is to be hoped that the owners of factories and shops will rapidly come to realize the importance of proper lighting.

Water Power in Austria Hungary

At present there is considerable interest manifested in the further development of water power in Austria-Hungary. In Hungary and Croatia there are two large projects under consideration concerning the final development of water power. One of these projects was outilned by the firm of Albert Buss & Co., of Basel, Switzerland, and is now under consideration by the Hungarian Ministry of Agriculture. According to this project, it is contemplated to utilize the water power of the Danube on the Pressburg-Raab section. The plan comprises the construction of a canal which will equally serve the interests of navigation and irrigation. In the cities of Pressburg, Wieselburg, and Raab are to be biult three reservoir embankments, by which it will be possible to produce an electric energy exceeding 40,000 horsepower, which will be partly used for lighting those cities.

A second project, for the accomplishment of which French capitalists are interested, concerns the final development of the existing water power in the town of Zengg in Croatia. After completing the building of all locks the power obtained will be 60,000 to 80,000 horsepower.

It is further proposed by the management of the Hungarian Government Railways that power be furnished them to obtain electric current for operating the railways from Fiume to Croatia by electricity. The cost of building and completing this plant is estimated at $14,210,000 to $16,-240,000. This project has so far progressed that exhaustive negotiations are already being made with those parties who might likely use electric power.—*Consular Report.*

The Calculation of Illumination and a General Survey of Conditions.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

BY E. J. MORA, CONSULTING ENGINEER.

THE engineer of today, is generally on the lookout for labor and time saving methods. It was with this end in view that the writer has compiled and employed the tables to be described in what follows. Their use will save an illuminating engineer considerable work and time in solving lighting problems. Before explaining these tables, it may be interesting in the way of a review, to take up the fundamental laws and formulae, upon which the science of illuminating engineering is based.

The law for deriving the intensity of illumination is generally expressed as follows: The intensity of illumination produced by a source of light, varies inversely as the square of the distance the point is from that source. The mathematical expression of the above law, when the point is in a plane normal to the ray of light, is as follows:

$$In = C\ P/l^2 \qquad (1)$$

In this equation, In equals the normal illumination; C P equals the candle power of the source; l, equals the distance the point is from the light source in the direction of the beam of light. The above formula does not hold for surfaces not perpendicular to the light ray, but an expression can be obtained from the above and the cosine law, that will give the intensity of illumination on the horizontal plane.

Referring to Fig. 5, the intensity at the point C can be obtained by equation (1), providing the point is considered in a plane normal to the ray A C. Then multiplying this value by the cosine of Θ, where Θ is the angle between the beam of light and the vertical, the equation (I) then takes the following form:

$$Ih = C\ P \times \cos\ \Theta/l^2 \qquad (2)$$

In the above equation (2), Ih equals the horizontal intensity at point C in fort-candles; C P equals the candle power of the source; l, equals distance to C in the direction of the ray of light; and Θ, equals the angle the ray makes with the vertical.

It is evident that the distance AC or l may be troublesome to obtain, therefore by simple trigonometry, equation (2) can be expressed so that it will contain the vertical distance h which is in most cases given or can be easily measured. The formula for horizontal illumination in foot-candles or equation (2) may then be written in the form:

$$Ih = (C\ P \times \cos\ \Theta/l^2) \times (\cos^2\ \Theta/\cos^2\ \Theta)$$
$$= C\ P\ \cos^3\ \Theta\ /\ l^2\ \cos^2\ \Theta \qquad (3)$$

From Figure 5, however, $\cos\ \Theta = h/l$ and $\cos^2\ \Theta = h^2/l^2$. Substituting this value of $\cos^2\ \Theta$ in equation (3) we get the following equation:

$$Ih = C\ P\ \cos^3\ \Theta/h^2 \qquad (4)$$

This equation (4) is the one generally used in solving lighting problems and the values in table 3 are derived from it.

Referring now to the tables as given, table No. 1, gives the various angles made by a ray of light, with a vertical line drawn through the light unit under consideration, and is the ratio of the heights and horizontal distances to the given point. See Figure 4. It is seen from this diagram that $\text{Tan}\ \Theta = BC/AB$, where BC equals the distance from the vertical to the point, while AB is the mounting height of the light unit above the horizontal plane.

Table 2, merely gives the values of the cosine cubed of the angles in table 1. The method of obtaining these, is familiar to all engineers and will not be explained here.

Table 3 or the table of constants, gives the intensity of illumination produced at a given point from a light source of one candle-power when suspended at heights of 4 to 30 feet above the horizontal plane and the point considered at distances of one to 50 feet from the perpendicular through the light source. That is one to 50 feet from a point directly underneath the light source on the horizontal plane. The constant given which has been called K is found by substituting in equation (4), the $\cos^3$ of the given angle and the square of the height h.

Therefore $K = \cos^3\ \Theta\ /\ h^2$ and $I = C\ P \times K \qquad (5)$

The value of $\cos^3\ \Theta$ is found in table 2 for the given height and horizontal distance to the point under consideration.

The following example will assist in illustrating the method of using the tables. Assume a light source with a distribution of candle power similar to that shown in Fig. 6. It is then desired to compute the intensity of illumination produced at the point P, 20 feet from a point under the light unit, the latter suspended 10 feet above the plane as illustrated in Fig. 7. Referring to table 1, with a vertical distance of 10 feet, and a horizontal distance of 20 feet, it is seen that the ray AP forms an angle of 63°-26′ with the vertical AO. Referring to the distribution curve, it is seen that the candle power at the above angle in the direction of P, is about 76, then referring to table 3 the constant K for the given height of 10 feet and horizontal distance of 20 feet, is found to be .00093. Now substituting in equation (5) the result is as follows: $Ih = C\ P \times K$ or $Ih = 76 \times .00093 = .07068$ foot-candles.

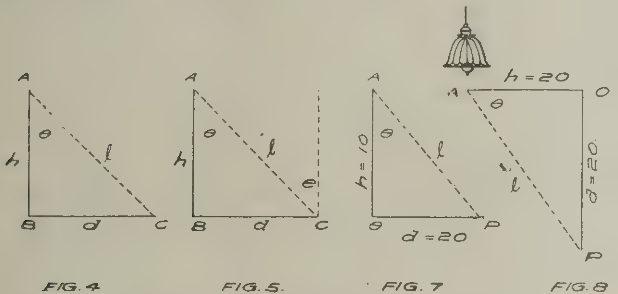
To obtain the illumination on a vertical plane or wall the operation is reversed. Thus the vertical distances become the horizontal distances, and the horizontal distances become the vertical as shown in Fig. 8. The same applies to the distribution curve, this must also be reversed.

SYSTEMS OF ILLUMINATION.

In general, systems of illumination may be classified broadly as direct and indirect. In the former system the greater part of the light flux falls on the working plane as the direct rays of the illuminant, while in the latter, the light units are concealed from view and the illumination is produced by reflected light from the ceiling and the upper part of side walls. In cases of direct illumination there is an indirect component, whose magnitude depends on the light directed to the ceiling and walls and their reflecting power.

INDIRECT ILLUMINATION.

There are two ways in which indirect illumination may be produced, one being by the use of coves, and the other using inverted reflectors, backed by an opaque bowl or basket and suspended from the ceiling, the light flux being directed towards the ceiling, and then reflected to the working plane, the ceiling becoming a secondary light source. In cove lighting the lamps are placed in coves along the ceiling at the sides of the room, or at the center of the room. These lamps are arranged in suitable metal reflectors which in some installations line the interior of the cove, and designed so as to direct as much of the light flux as possible towards the ceiling. A modification of this method has been made in numerous installations within the past few years, especially in large railroad stations; this modification consists in employing individual reflectors, placed in recesses along the side wall and at an angle such that the maximum flux is directed to the ceiling, the ceilings generally being arched in shape.



FIGS. 4, 5, 7 AND 8. DIAGRAM SHOWING HEIGHTS AND HORIZONTAL DISTANCES CALCULATED.

In the inverted reflector system suspended from the ceiling, it is possible to vary the light distribution within a wide range, as in the direct system. For example when it is desired to confine the light flux within a small area of the ceiling, a concentrating reflector is employed, and when a wide distribution is required, a distributing reflector is used. The reflectors used in the inverted system, are of high reflecting power, and are made of a single piece of blown glass, covered on the outside with a coating of pure silver, giving a good reflecting efficiency. In some installations reflectors have been used which are to a certain extent translucent, permitting a small amount of the light to fall on the working plane direct. These reflectors are of artistic shape, and made of special glass; it is a compromise between the direct and indirect.

The height of suspension varies with conditions, but it has been found in practise, that the distance of the light unit from the ceiling, and the distribution of the reflectors can be varied, within wide limits without materially altering the intensity of the illumination on the working plane. This method of indirect lighting appears to give a higher efficiency than by the use of cove lighting, for the reason that in cove lighting as usually employed several years ago, the light flux before reaching the plane of illumination, suffers two reflections, one from the ceiling and one from the walls, whereas from the inverted reflector system the bulk of the light reaches the working plane after one reflection from the ceiling. In connection with this reflection, it has been estimated by various authorities, that the loss of a single reflection from light colored ceiling amounts to about 40 per cent of the light reaching the ceilings. Assuming then that the walls have the same co-efficient of reflection, the light directed to the walls from the ceiling would suffer another 40 per cent. Should the walls be dark in color, this loss may reach as high as 90 per cent, therefore it is at once seen that in order for this method of lighting to be efficient, the ceiling in particular, and walls must be of light color.

It must be remembered however, that cove lighting systems have been greatly improved, and it is possible today, to so design the reflectors in the coves, that a large percentage of the light flux may be directed to the ceiling at such an angle, that the light suffers only one reflection, as mentioned in the fore part of this article. This result is obtained by the use of individual reflectors, located in recesses, many reflectors being used.

DIRECT VS. INDIRECT LIGHTING.

It will be of interest to make a comparison between the direct and indirect systems, and of importance to consider briefly the physiological effect of the lighting. In direct lighting and day-light illumination, the floors receive the maximum flux of light. By a directive side illumination of the walls from the day-light entering the room from the windows, the light throughout is well diffused, this does not mean, however, that there are no shadows, for owing to the direction of the light, the various objects in the room will cast more or less shadows. This shadow is of great importance in distinguishing articles clearly, and giving the proper perspective.

In connection with indirect lighting, where the units are suspended from the ceiling using inverted reflectors, the above conditions are found to be the reverse. The ceiling in this case becomes the brightest portion of the room, and

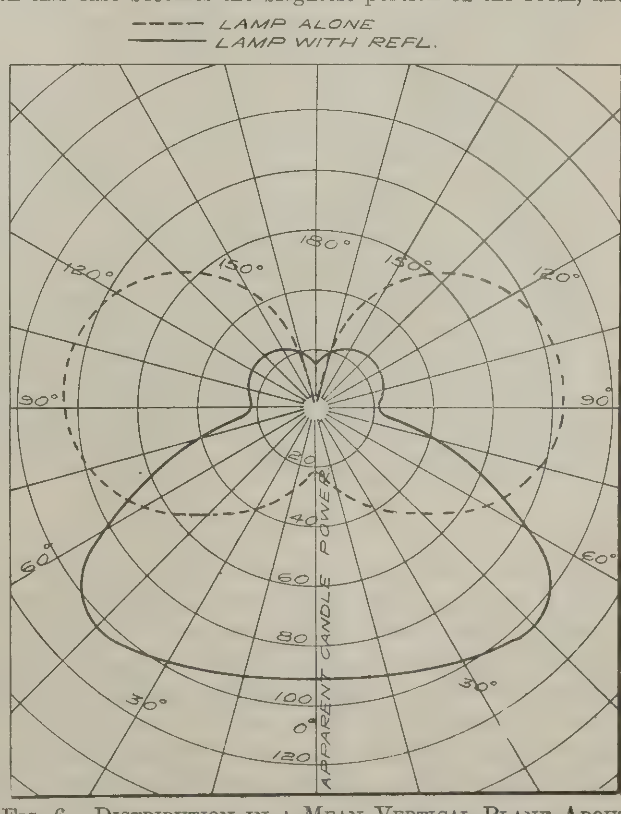


FIG. 6. DISTRIBUTION IN A MEAN VERTICAL PLANE ABOUT 100-WATT FROSTED BOWL TUNGSTEN LAMP WITH 8-INCH REFLECTOR.

TABLE 1. ANGLES MADE BY RAY OF LIGHT WITH VERTICAL THROUGH LIGHT UNIT.

HORIZONTAL DISTANCES = D.

VERTICAL DISTANCES = h.

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
4	0	14°-02'	26°-34'	36°-52'	45°	51°-20'	56°-19'	60°-15'	63°-26'	66°-02'	68°-12'	70°-01'	71°-34'	72°-54'	74°-03'	75°-04'	75°-58'	76°-46'	77°-28'	78°-07'	78°-41'
5	0	11°-19'	21°-48'	30°-58'	38°-40'	45°	50°-12'	54°-28'	58°	60°-57'	63°-26'	65°-33'	67°-23'	68°-58'	70°-21'	71°-34'	72°-39'	73°-37'	74°-29'	75°-15'	75°-58'
6	0	9°-28'	18°-26'	26°-34'	33°-41'	39°-48'	45°	49°-24'	53°-08'	56°-19'	59°-02'	61°-23'	63°-26'	65°-13'	66°-48'	68°-12'	69°-27'	70°-34'	71°-34'	72°-28'	73°-18'
7	0	8°-08'	15°-57'	23°-12'	29°-45'	35°-32'	40°-36'	45°	48°-49'	52°-07'	55°	57°-32'	59°-45'	61°-42'	63°-26'	64°-59'	66°-22'	67°-37'	68°-35'	69°-46'	70°-42'
8	0	7°-08'	14°-02'	20°-33'	26°-34'	32°	36°-52'	41°-11'	45°	48°-22'	51°-20'	53°-58'	56°-19'	58°-24'	60°-15'	61°-56'	63°-26'	64°-48'	66°-02'	67°-10'	68°-12'
9	0	6°-20'	12°-32'	18°-26'	23°-58'	29°-03'	33°-41'	37°-52'	41°-38'	45°	48°-01'	50°-43'	53°-08'	55°-18	57°-15'	59°-02'	60°-38'	62°-06'	63°-26'	64°-39'	65°-46'
10	0	5°-43'	11°-19'	16°-42'	21°-48'	26°-34'	30°-58'	35°-	38°-40'	41°-59'	45°	47°-44'	50°-12'	52°-26'	54°-28'	56°-19'	58°- x	59°-32'	60°-57'	62°-14'	63°-26'
11	0	5°-12'	10°-18'	15°-15'	19°-59'	24°-27'	28°-27'	32°-28'	36°-02'	39°-17'	42°-16'	45°	47°-29'	49°-46'	51°-50'	53°-45'	55°-29'	57°-06'	58°-34'	59°-56'	61°-11'
12	0	4°-46'	9°-28'	14°-02'	18°-26'	22°-37'	26°-34'	30°-15'	33°-41'	36°-52'	39°-48'	42°-31'	45°	47°-17'	49°-24'	51°-20'	53°-08'	54°-47'	56°-19'	57°-43'	59°-02'
13	0	4°-24'	8°-45'	13°	17°-06'	21°-02'	24°-46'	28°-18'	31°-36'	34°-42'	37°-34'	40°-14'	42°-43'	45°	47°-07'	49°-5'	50°-54'	52°-36'	54°-10'	55°-37'	56°-59'
14	0	4°-05'	8°-08'	12°-06'	15°-57'	19°-39'	23°-12'	26°-34'	29°-45'	32°-44'	35°-32'	38°-09'	40°-36'	42°-53'	45°	46°-58'	48°-49'	50°-32'	52°-07'	53°-37'	55°
15	0	3°-49'	7°-36'	11°-19'	14°-56'	18°-26'	21°-48'	25°-01'	28°-04'	30°-58'	33°-41'	36°-15'	38°-40'	40°-55'	43°-01'	45°-	46°-51'	48°-35'	50°-12'	51°-43'	53°-08'
16	0	3°-35'	7°-08'	10°-37'	14°-02'	17°-21'	20°-33'	23°-38'	26°-34'	29°-21'	32°	34°-31'	36°-52'	39°-06'	41°-11'	43°-09'	45°	46°-44'	48°-22'	49°-54'	51°-20'
17	0	3°-22'	6°-43'	10°	13°-14'	16°-23'	19°-26'	22°-23'	25°-12'	27°-54'	30°-28'	32°-54'	35°-13'	37°-24'	39°-28'	41°-25'	43°-16'	45°	46°-38'	48°-11'	49°-38'
18	0	3°-11'	6°-20'	9°-28'	12°-32'	15°-31'	18°-26'	21°-15'	23°-58'	26°-34'	29°-03'	31°-26'	33°-41'	35°-50'	37°-52'	39°-48'	41°-38'	43°-22'	45°	46°-33'	48°-01'
19	0	3°-01'	6°-01'	8°-58'	11°-53'	14°-45'	17°-31'	20°-13'	22°-50'	25°-21'	27°-45'	30°-04'	32°-17'	34°32'-	36°-23'	38°-17'	40°-06'	41°-49'	43°-27'	45°	46°-28'
20	0	2°-52'	5°-43'	8°-32'	11°-19'	14°-02'	16°-42'	19°-17'	21°-48'	24°-14'	26°-34'	28°-49'	30°-58'	33°-01'	35°	36°-52'	38°-40'	40°-22'	41°-59'	43°-32'	45°
21	0	2°-44'	5°-26'	8°-08'	10°-47'	13°-23'	15°-57'	18°-26'	20°-51'	23°-12'	25°-28'	27°-39'	29°-45'	31°-46'	33°-41'	35°-32'	37°-18'	38°-59'	40°-36'	42°-08'	43°-36'
22	0	2°-36'	5°-12'	7°-46'	10°-18'	12°-48'	15°-15'	17°-39'	19°-59'	22°-15'	24°-27'	26°-34'	28°-37'	30°-35'	32°-28'	34°-17'	36°-02'	37°-42'	39°-17'	40°-49'	42°-16'
23	0	2°-29'	4°-58'	7°-26'	9°-52'	12°-16'	14°-37'	16°-56'	19°-11'	21°-22'	23°-30'	25°-34'	27°-33'	29°-29'	31°-20'	33°-07'	34°-49'	36°-28'	38°-03'	39°-34'	41°-'01
24	0	2°-23'	4°-46'	7°-08'	9°-28'	11°-46'	14°-02'	16°-16'	18°-26'	20°-33'	22°-37'	24°-37'	26°-34'	28°-27'	30°-15'	32°	33°-41'	35°-19'	36°-52'	38°-22'	39°-48'
25	0	2°-17'	4°-34'	6°-51'	9°-05'	11°-19'	13°-30'	15°-39'	17°-45'	19°-48'	21°-48'	23°-45'	25°-38'	27°-28'	29°-15'	30°-58'	32°-37'	34°-13'	35°-45'	37°-14'	38°-40'
26	0	2°-12'	4°-24'	6°-35'	8°-45'	10°-53'	13°	15°-04'	17°-06'	19°-06'	19°-02'	22°-56'	24°-46'	26°-34'	28°-18'	29°-59'	31°-36'	33°-11'	34°-42'	36°-09'	37°-34'
27	0	2°-07'	4°-14'	6°-20'	8°-26'	10°-29'	12°-32'	14°-32'	16°-30'	18°-26'	20'-19'	22°-10'	23°-58'	25°-43'	27°-34'	29°-3'	30°-39'	32°-12'	33°-41'	35°-8'1	36°-32'
28	0	2°-03'	4°-05'	6°-07'	8°-08'	10°-07'	12°-06'	14°-02'	15°-57'	17°-49'	19°-39'	21°-27'	23°-12'	24°-54'	26°-34'	28°-11'	29°-45'	31°-16'	32°-44'	34°-10'	35°-32'
29	0	1°-58'	3°-57'	5°-54'	7-°51'	9°-47'	11°-41'	13°-34'	15°-25'	17°-14'	19°-02'	20°-46'	22°-29'	24°-09'	25°-46'	27°-21'	28°-53'	30°-23'	31°-50'	33°-14'	34°-36'
30	0	1°-55'	3°-49'	5°-43'	7°-36'	9°-28'	11°-19'	13°-08'	14°-56'	16°-42'	18°-26'	20°-08'	21°-48'	23°-26'	25°-01'	26°-34'	28°-04'	29°-32'	30°-58'	32°-21'	33°-41'

	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
4	79°-13'	79°-42'	80°-08'	80°-32'	80°-55'	81°-15'	81°-34'	81°-52'	82°-09'	82°-24'	82°-39'	82°-52'	83°-05'	83°-17'	83°-29'	83°-40'	83°-50'	83°-59'	84°-09'	84°-18'
5	76°-36'	77°-12'	77°-44'	78°-14'	78°-41'	79°-07'	79°-31'	79°-53'	80°-13'	80°-32'	80°-50'	81°-07'	81°-23'	81°-38'	81°-52'	82°-06'	82°-18'	82°-30'	82°-42'	82°-52'
6	74°-03'	74°-45'	75°-23'	75°-58'	76°-30'	77°	77°-28'	77°-54'	78°-19'	78°-41'	79°-03'	79°-23'	79°-42'	79°-59'	80°-16'	80°-32'	80°-47'	81°-02'	81°-15'	81°-28'
7	71°-34'	72°-21'	73°-04'	73°-44'	74°-21'	74°-56'	75°-28'	75°-58'	76°-26'	76°-52'	77°-16'	77°-40'	78°-01'	78°-22'	78°-41'	79°	79°-17'	79°-04'	79°-49'	80°-04'
8	69°-09'	70°-01'	70°-49'	71°-34'	72°-15'	72°-54'	73°-30'	74°-03'	74°-35'	75°-04'	75°-32'	75°-58'	76°-22'	76°-46'	77°-07'	77°-28'	77°-48'	78°-07'	78°-24'	78°-41'
9	66°-48'	67°-45'	68°-38'	69°-27'	70°-12'	70°-54'	71°-34'	72°-11'	72°-46'	73°-18'	73°-49'	74°-17'	74°-45'	75°-10'	75°-35'	75°-58'	76°-20'	76°-41'	77°	77°-19'
10	64°-32'	65°-33'	66°-30'	67°-23'	68°-12'	68°-58'	69°-41'	70°-21'	70°-58'	71°-34'	72°-07'	72°-39'	73°-08'	73°-37'	74°-03'	74°-29'	74°-53'	75°-15'	75°-37'	75°-58'
11	62°-21'	63°-26'	64°-26'	65°-23'	66°-15'	67°-04'	67°-50'	68°-33'	69°-14'	69°-52'	70°-28'	71'°02'	71°-34'	72°-04'	72°-33'	73°	73°-27'	73°-51'	74°-15'	74°-37'
12	60°-15'	61°-23'	62°-27'	63°-26'	64°-22'	65°-13'	66°-02'	66°-48'	67°-31'	68°-12'	68°-50'	69°-27'	70°-01'	70°-34'	71°-05'	71°-34'	72°-02'	72°-28'	72°-54'	73°-18'
13	58°-14'	59°-25'	60°-31'	61°-33'	62°-32'	63°-26'	64°-17'	65°-06'	65°-51'	66°-34'	67°-15'	67°-53'	68°-30'	69°-04'	69°-37'	70°-09'	70°-38'	71°-07'	71°-34'	72°
14	56°-19'	57°-32'	58°-40'	59°-45'	60°-45'	61°-42'	62°-36'	62°-26'	64'-14'	64°-59'	65°-42'	66°-22'	67°-01'	67°-37'	68°-12'	68°-45'	69°-16'	69°-46'	70°-15'	70°-42'
15	54°-28'	55°-43'	56°-53'	58°	59°-02'	60°-01'	60°-57'	61°-49'	62°-39'	63°-26'	64°-11'	64°-53'	65°-33'	66°-12'	66°-48'	67°-23'	67°-56'	68°-28'	68°-58'	69°-27'
16	52°-42'	53°-58'	55°-11'	56°-19'	57°-23'	58°-24'	59°-21'	60°-15'	61°-07'	61°-56'	62°-42'	63°-26'	64°-08'	64°-48'	65°-26'	66°-02'	66°-37'	67°-10'	67°-42'	68°-12'
17	51°	52°-18'	53°-32'	54°-41'	55°-47'	56°-49'	57°-48'	58°-44'	59°-37'	60°-28'	61°-16'	62°-01'	62°-45'	63°-26'	64°-06'	64°-43'	65°-19'	65°-54'	66°-27'	66°-58'
18	49°-24'	50°-43'	51°-57'	53°-08'	54°-15'	55°-18'	56°-19'	57°-15'	58°-10'	59°-02'	59°-51'	60°-38'	61°-23'	62°-06'	62°-47'	63°-26'	64°-03'	64°-39'	65°-13'	65°-46'
19	47°-52'	49°-11'	50°-26'	51°-38'	52°-46'	53°-50'	54°-52'	55°-50'	56°-46'	57°-39'	58°-30'	59°-18'	60°-04'	60°-48'	61°-30'	62°-11'	62°-49'	63°-26'	64°-20'	64°-36'
20	46°-24'	47°-44'	48°-59'	50°-12'	51°-20'	52°-26'	53°-28'	54°-28'	55°-24'	56°-19'	57°-10'	58°-	58°-47'	59°-32'	60°-15'	60°-57'	61°-36'	62°-14'	62°-51'	63°-26'
21	45°	46°-20'	47°-36'	48°-49'	49°-58'	51°-04'	52°-07'	53°-08'	54°-05'	55°	55°-53'	56°-43'	57°-32'	58°-18'	59°-02'	59°-45'	60°-25'	61°-04'	61°-42'	62°-18'
22	43°-40'	45°	46°-16'	47°-29'	48°-39'	49°-46'	50°-49'	51°-50'	52°-42'	53°-45'	54°-38'	55°-29'	56°-19'	57°-06'	57°-51'	58°-34'	59°-16'	59°-56'	60°-34'	61°-11'
23	42°-24'	43°-44'	45°	46°-13'	47°-23'	48°-30'	49°-34'	50°-36'	51°-35'	52°-31'	53°-26'	54°-18'	55°-07'	55°-55'	56°-41'	57°-25'	58°-08'	58°-49'	59°-28'	60°-06'
24	41°-11'	42°-31'	43°-47'	45°	46°-10'	47°-17'	48°-22'	49°-24'	50°-23'	51°-20'	52°-15'	53°-08'	53°-58'	54°-47'	55°-34'	56°-19'	57°-02'	57°-43'	58°-24'	59°-02'
25	40°-02'	41°-21'	42°-37'	43°-50'	45°	46°-07'	47°-12'	48°-14'	49°-14'	50°-12'	51°-07'	52°	52°-51'	53°-40'	54°-28'	55°-13'	55°-57'	56°-40'	57°-20'	58°
26	38°-56'	40°-14'	41°-30'	42°-43'	43°-53'	45°	46°-05'	47°-07'	48°-07'	49°-05'	50°-01'	50°-54'	51°-46'	52°-36'	53°-24'	54°-10'	54°-54'	55°-37'	56°19'-	56°-59'
27	37°-52'	39°-10'	40°-26'	41°-38'	42°-48'	43°-55'	45°	46°-03'	47°-03'	48°-01'	48°-57'	49°-51'	50°-43'	51°-33'	52°-21'	53°-08'	53°-53'	54°-36'	55°-18'	55°-59'
28	36°-52'	38°-09'	39°-24'	40°-36'	41°-46'	42°-53'	43°-57'	45°	46°	46°-58'	47°-55'	48°-49'	49°-41'	50°-32'	51°-20'	52°-07'	52°-53'	53°-37'	54°-19'	55°
29	35°-55'	37°-11'	38°-25'	39°-37'	40°-46'	41°-53'	42°-57'	44°	45°	45°-58'	46°-54'	47°-49'	48°-41'	49°-32'	50°-21'	51°-09'	51°-55'	52°-39'	53°-22'	54°-03'
30	35°	36°-15'	37°-29'	38°-40'	39°-48'	40°-55'	41°-59'	43°-01'	44°-02'	45°	45°-56'	46°-51'	47°-44'	48°-35'	49°-24'	50°-12'	50°-58'	51°-43'	52°-26'	53°-08'

	41	42	43	44	45	46	47	48	49	50
4	84°-26'	84°-34'	84°-41'	84°-48'	84°-55'	85°-02'	85°-08'	85°-14'	85°-20'	85°-26'
5	83°-03'	83°-13'	83°-22'	83°-31'	83°-40'	83°-48'	83°-56'	84°-03'	84°-10'	84°-18'
6	81°-40'	81°-52'	82°-03'	82°-14'	82°-24'	82°-34'	82°-43'	82°-52'	83°-01'	83°-09'
7	80°-19'	80°-32'	80°-45'	80°-58'	81°-09'	81°-21'	81°-32'	81°-42'	81°-52'	82°-02'
8	78°-58'	79°-13'	79°-28'	79°-42'	79°-55'	80°-08'	80°-20'	80°-32'	80°-44'	80°-55'
9	77°-37'	77°-54'	78°-11'	78°-26'	78°-41'	78°-56'	79°-10'	79°-23'	79°-36'	79°-48'
10	76°-18'	76°-36'	76°-54'	77°-12'	77°-28'	77°-44'	77°-59'	78°-14'	78°-28'	78°-41'
11	74°-59'	75°-19'	75°-39'	75°-58'	76°-16'	76°-33'	76°-50'	77°-06'	77°-21'	77°-36'
12	73°-41'	74°-03'	74°-24'	74°-45'	75°-04'	75°-23'	75°-41'	75°-58'	76°-14'	76°-30'
13	72°-24'	72°-48'	73°-11'	73°-32'	73°-53'	74°-13'	74°-32'	74-°51'	75°-08'	75°-26'
14	71°-09'	71°-34'	71°-58'	72°-21'	72°-43'	73°-04'	73°-25'	73°-44'	74°-03'	74°-21'
15	69°-54'	70°-21'	70°-46'	71°-10'	71°-34'	71°-56'	72°-18'	72°-39'	72°-59'	73°-18'
16	68°-41'	69°-09'	69°-36'	70°-01'	70°-26'	70°-49'	71°-12'	71°-34'	71°-55'	72°-15'
17	67°-29'	67°-58'	68°-26'	68°-52'	69°-18'	69°-43'	70°-07'	70°-30'	70°-52'	71°-13'
18	66°-18'	66°-48'	67°-17'	67°-45'	68°-12'	68°-38'	69°-03'	69°-27'	69°-50'	70°-12'
19	65°-08'	65°-40'	66°-10'	66°-39'	67°-7''	67°-33'	67°-99'	68°-24'	68°-48'	69°-12'
20	64°	64°-23'	65°-03'	65°-33'	66°-02'	66°-30'	66°-57'	67°-23'	67°-48'	68°-12'
21	62°-53'	63°-26'	63°-58'	64°-29'	64°-59'	65°-28'	65°-55'	66°-22'	66°-48'	67°-13'
22	61°-47'	62°-21'	62°-54'	63°-26'	63°-57'	64°-26'	64°-55'	65°-23'	65°-49'	66°-15'
23	60°-42'	61°-18'	61°-51'	62°-24'	62°-56'	63°-26'	63°-55'	64°-24'	64°-51'	65°-18'
24	59°-39'	60°-15'	60°-50'	61°-23'	61°-56'	62°-57'	62°-57'	63°-26'	63°-54'	64°-22'
25	58°-38'	59°-14'	59°-50'	60°-24'	60°-57'	61°-13'	61°-59'	62°-29'	62°-58'	63°-26'
26	57°-37'	58°-14'	58°-50'	59°-25'	59°-59'	60°-31'	61°-33'	61°-33'	62°-03'	62°-32'
27	56°-38'	57°-15'	57°-52'	58°-28'	59°-02'	59°-35'	60°-07'	60°-38'	61°-09'	61°-38'
28	55°-40'	56°-19'	56°-56'	57°-32'	58°-07'	58°-40'	59°-13'	59°-45'	60°-15'	60°-45'
29	54°-44'	55°-34'	56°	56°-37'	57°-12'	57°-46'	58°-19'	58°-52'	59°-23'	59°-53'
30	53°-48'	54°-28'	55°-06'	55°-43'	56°-19'	56°-53'	57°-27'	58°	58°-31'	59°-02'

TAN Θ = D/h.

is the secondary light source from which the illumination of the room is obtained. The result of this diffused illumination, is the absence of side shadows, being opposite to the results produced by ordinary day-light, besides the room seems to have an unnatural appearance. In considering the physiological effect of indirect lighting, the proportions of the room and use of same, should be taken into consideration. For example in a room of great ceiling height, where the ceiling is not in the field of view, a relatively high brightness of the ceiling is not objectionable, while, on the other hand in a room with a low ceiling which is constantly in the field of vision, this brightness of ceiling would be objectionable and to a certain extent impair the ability to see clearly.

The visibility of objects depends on several factors, one of the most important of which is to have a greater intensity of illumination on the object viewed than on the surrounding walls and ceiling. Therefore the high intensity of illumination produced on the ceiling, and walls by the indirect method decreases the visual sensibility; especially is this true, when these surfaces are in the field of view. The result is that the eye is unable to see distinctly objects placed on the working plane.

One chief objection charged against the indirect system is, the absence of shadows, or the unnatural position and faintness of same. In large rooms illuminated by the indirect method, the downward light is very noticeable and it is sometimes difficult to distinguish the features of a person at a distance when standing under this light, for the reason that the strong downward light coming from the ceiling as it does with this method, produces shadows on the face of the person in such a manner as to make the face look unnatural.

The illumination produced by the indirect system, is nearly uniform and as this is only required in a few cases, it can be termed an objection, for the reason that variations in the intensity of illumination in different parts of the room is desirable as being, restful to the eye. For ex-

TABLE 2. VALUES OF COSINE CUBES FOR ANGLES IN TABLE 1.

HORIZONTAL DISTANCES = D.

VERTICAL DISTANCES = h.

h	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
4	1.0	.9131	.7155	.5120	.3535	.2438	.1705	.1221	.0894	.0670	.0512	.0399	.0316	.0254	.0207	.0171	.0142	.0120	.0102	.0087	.0075	.0065	.0057	.0050	.0044	.0039
5	1.0	.9428	.8005	.6305	.4760	.3535	.2623	.1963	.1489	.1145	.0894	.0709	.0569	.0462	.0380	.0316	.0265	.0224	.0191	.0165	.0142	.0124	.0109	.0096	.0085	.0075
6	1.0	.9597	.8539	.7155	.5762	.4535	.3535	.2756	.2160	.1705	.1362	.1099	.0894	.0737	.0611	.0512	.0433	.0368	.0316	.0273	.0237	.0207	.0182	.0161	.0142	.0127
7	1.0	.9701	.8889	.7765	.6544	.5385	.4377	.3535	.2855	.2315	.1887	.1547	.1279	.1066	.0894	.0756	.0644	.0552	.0476	.0414	.0361	.0316	.0279	.0247	.0220	.0196
8	1.0	.9770	.9131	.8210	.7155	.6099	.5120	.4263	.3535	.2932	.2438	.2036	.1705	.1439	.1221	.1042	.0894	.0772	.0670	.0584	.0512	.0451	.0399	.0355	.0316	.0283
9	1.0	.9818	.9302	.8539	.7630	.6681	.5762	.4920	.4175	.3535	.2993	.2538	.2160	.1845	.1583	.1362	.1179	.1025	.0894	.0795	.0692	.0611	.0543	.0484	.0433	.0389
10	1.0	.9851	.9428	.8788	.8005	.7155	.6305	.5496	.4760	.4107	.3535	.3043	.2623	.2266	.1963	.1705	.1488	.1304	.1145	.1011	.0894	.0795	.0709	.0634	.0569	.0512
11	1.0	.9877	.9524	.8980	.8300	.7544	.6765	.6006	.5288	.4637	.4052	.3535	.3086	.2695	.2360	.2067	.1819	.1603	.1418	.1258	.1120	.0999	.0894	.0804	.0723	.0653
12	1.0	.9897	.9597	.9131	.8539	.7866	.7155	.6446	.5762	.5120	.4535	.4005	.3535	.3122	.2756	.2438	.2160	.1918	.1705	.1524	.1362	.1221	.1098	.0989	.0894	.0810
13	1.0	.9912	.9655	.9250	.8731	.8131	.7487	.6826	.6179	.5557	.4980	.4449	.3966	.3535	.3151	.2810	.2509	.2241	.2006	.1801	.1618	.1459	.1317	.1192	.1081	.0981
14	1.0	.9924	.9701	.9348	.8889	.8353	.7765	.7155	.6544	.5952	.5389	.4863	.4377	.3934	.3535	.3178	.2855	.2568	.2315	.2087	.1887	.1705	.1547	.1406	.1279	.1167
15	1.0	.9934	.9739	.9428	.9021	.8539	.8005	.7441	.6871	.6305	.5762	.5245	.4760	.4315	.3909	.3535	.3199	.2895	.2623	.2378	.2160	.1963	.1787	.1631	.1488	.1362
16	1.0	.9941	.9770	.9495	.9131	.8696	.8210	.7689	.7155	.6622	.6099	.5594	.5120	.4674	.4263	.3883	.3535	.3220	.2932	.2672	.2438	.2225	.2036	.1861	.1705	.1566
17	1.0	.9948	.9796	.9551	.9224	.8831	.8387	.7906	.7408	.6903	.6403	.5919	.5453	.5014	.4601	.4217	.3861	.3535	.3238	.2964	.2717	.2492	.2287	.2100	.1932	.1778
18	1.0	.9954	.9818	.9597	.9302	.8946	.8539	.8096	.7630	.7155	.6681	.6212	.5762	.5329	.4920	.4535	.4175	.3842	.3535	.3253	.2993	.2756	.2538	.2341	.2160	.1994
19	1.0	.9959	.9836	.9638	.9371	.9044	.8672	.8263	.7828	.7380	.6931	.6482	.6042	.5621	.5218	.4837	.4476	.4140	.3826	.3535	.3268	.3019	.2793	.2584	.2391	.2215
20	1.0	.9963	.9851	.9672	.9428	.9131	.8788	.8409	.8005	.7583	.7155	.6726	.6305	.5896	.5496	.5120	.4760	.4423	.4107	.3810	.3535	.3280	.3043	.2827	.2623	.2438
21	1.0	.9966	.9865	.9701	.9479	.9207	.8889	.8539	.8161	.7765	.7359	.6951	.6544	.6146	.5762	.5389	.5034	.4697	.4377	.4078	.3798	.3535	.3292	.3066	.2855	.2661
22	1.0	.9969	.9877	.9727	.9524	.9273	.8980	.8653	.8300	.7929	.7544	.7155	.6765	.6380	.6006	.5641	.5288	.4953	.4637	.4334	.4052	.3785	.3535	.3304	.3086	.2884
23	1.0	.9972	.9888	.9750	.9563	.9331	.9060	.8755	.8425	.8076	.7713	.7341	.6969	.6596	.6232	.5876	.5533	.5201	.4883	.4581	.4295	.4027	.3773	.3535	.3313	.3104
24	1.0	.9974	.9897	.9770	.9597	.9383	.9131	.8847	.8539	.8210	.7866	.7514	.7155	.6797	.6446	.6099	.5762	.5433	.5120	.4820	.4535	.4263	.4005	.3763	.3535	.3322
25	1.0	.9976	.9905	.9787	.9628	.9438	.9194	.8928	.8639	.8329	.8005	.7668	.7328	.6985	.6642	.6305	.5976	.5654	.5345	.5047	.4760	.4489	.4230	.3985	.3754	.3535
26	1.0	.9978	.9912	.9804	.9655	.9470	.9250	.9004	.8731	.8438	.8131	.7811	.7487	.7155	.6826	.6498	.6179	.5862	.5557	.5265	.4980	.4707	.4449	.4201	.3966	.3744
27	1.0	.9979	.9918	.9818	.9679	.9508	.9302	.9071	.8815	.8539	.8247	.7942	.7630	.7313	.6998	.6681	.6367	.6059	.5762	.5470	.5188	.4920	.4661	.4410	.4175	3950
28	1.0	.9981	.9924	.9830	.9701	.9541	.9348	.9131	.8889	.8629	.8353	.8063	.7765	.7463	.7155	.6848	.6544	.6245	.5952	.5664	.5389	.5120	.4863	.4614	.4377	.4149
29	1.0	.9982	.9929	.9842	.9721	.9570	.9391	.9186	.8959	.8713	.8448	.8175	.7889	.7597	.7304	.7007	.6713	.6420	.6132	.5852	.5577	.5312	.5057	.4810	.4571	.4344
30	1.0	.9983	.9934	.9851	.9739	.9597	.9428	.9236	.9021	.8788	.8539	.8277	.8005	.7724	.7441	.7155	.6871	.6586	.6305	.6029	.5762	.5496	.5245	.4997	.4760	.4535

h	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
4	.0035	.0031	.0028	.0025	.0023	.0020	.0019	.0017	.0016	.0014	.0013	.0012	.0011	.0010	.0009	.0009	.0008	.0008	.0007	.0007	.0006	.0006	.0006	.0005	.0005
5	.0067	.0060	.0054	.0049	.0044	.0040	.0037	.0034	.0031	.0028	.0026	.0024	.0022	.0021	.0019	.0018	.0016	.0015	.0014	.0013	.0013	.0012	.0011	.0011	.0009
6	.0114	.0102	.0092	.0083	.0075	.0069	.0063	.0057	.0053	.0048	.0044	.0041	.0038	.0035	.0033	.0030	.0028	.0026	.0025	.0023	.0022	.0020	.0019	.0018	.0017
7	.0176	.0158	.0142	.0129	.0117	.0107	.0097	.0090	.0082	.0075	.0069	.0064	.0059	.0055	.0051	.0048	.0044	.0042	.0039	.0036	.0034	.0032	.0030	.0028	.0027
8	.0254	.0229	.0207	.0188	.0171	.0156	.0142	.0131	.0120	.0111	.0102	.0094	.0087	.0081	.0075	.0070	.0065	.0061	.0057	.0054	.0050	.0047	.0044	0042	.0039
9	.0350	.0316	.0286	.0260	.0237	.0217	.0199	.0182	.0168	.0154	.0142	.0132	.0122	.0114	.0106	.0099	.0092	.0086	.0081	.0075	.0071	.0066	.0063	.0059	.0056
10	.0462	.0419	.0380	.0347	.0316	.0290	.0265	.0244	.0224	.0207	.0191	.0177	.0165	.0153	0142	.0133	.0124	.0116	.0109	.0102	.0096	.0090	.0085	.0080	.0075
11	.0592	.0537	.0489	.0446	.0408	.0374	.0343	.0316	.0292	.0270	.0250	.0231	.0215	.0200	.0187	.0174	.0163	.0152	.0142	.0134	.0126	.0118	.0111	.0105	.0099
12	.0737	.0670	.0611	.0559	.0512	.0471	.0433	.0399	.0368	.0341	.0316	.0294	.0273	.0254	0237	.0222	0207	.0195	.0182	.0171	.0161	.0151	.0142	.0135	.0127
13	.0894	.0817	.0746	.0685	.0629	.0578	.0534	.0492	.0456	.0423	.0392	.0365	.0339	0316	0296	0276	.0259	.0242	.0228	.0214	.0201	.0190	.0179	.0169	.0159
14	.1066	.0975	.0894	.0822	.0756	.0697	.0644	.0595	.0552	.0512	.0476	.0444	.0414	.0386	.0361	.0337	.0316	.0297	.0279	.0262	.0247	.0233	.0220	.0207	.0196
15	.1248	.1145	.1053	.0970	.0894	.0826	.0765	.0709	.0657	.0611	.0569	.0530	.0495	.0462	.0433	.0406	.0380	.0358	.0336	.0316	.0298	.0281	.0265	.0251	.0237
16	.1439	.1325	.1221	.1127	.1042	.0965	.0894	.0830	.0772	.0719	.0670	.0625	.0584	.0546	.0512	.0480	.0451	.0424	.0399	.0376	.0355	.0335	.0316	.0299	.0283
17	.1640	.1513	.1398	.1294	.1198	.1111	.1033	.0960	.0894	.0833	.0779	.0728	.0681	.0638	.0599	.0562	.0528	.0497	.0469	.0442	.0417	.0393	.0372	.0352	.0334
18	.1845	.1705	.1583	.1467	.1362	.1267	.1179	.1099	.1025	.0957	.0894	.0836	.0785	.0737	.0692	.0649	.0611	.0576	.0543	.0512	.0484	.0457	.0433	.0410	.0389
19	.2055	.1906	.1771	.1646	.1532	.1426	.1331	.1242	.1161	.1086	.1016	.0953	.0894	.0839	.0789	.0744	.0700	.0660	.0623	.0588	.0557	.0527	.0499	.0473	.0448
20	.2266	.2110	.1963	.1831	.1705	.1594	.1488	.1392	.1304	.1221	.1145	.1076	.1011	.0950	.0894	.0842	.0795	.0751	.0709	.0670	.0634	.0600	.0569	.0539	.0512
21	.2482	.2315	.2160	.2019	.1887	.1764	.1653	.1547	.1451	.1362	.1279	.1203	.1132	.1066	.1004	.0947	.0894	.0845	.0799	.0756	.0716	.0680	.0644	.0611	.0581
22	.2695	.2522	.2360	.2225	.2067	.1939	.1819	.1705	.1603	.1507	.1418	.1335	.1258	.1187	.1120	.1057	.0999	.0945	.0894	.0847	.0804	.0762	.0723	.0688	.0653
23	.2909	.2728	.2557	.2399	.2253	.2115	.1987	.1871	.1760	.1657	.1562	.1472	.1388	.1311	.1239	.1172	.1107	.1050	.0994	.0942	.0894	.0850	.0807	.0768	.0730
24	.3122	.2932	.2756	.2593	.2438	.2295	.2160	.2036	.1918	.1808	.1705	.1611	.1524	.1439	.1362	.1290	.1221	.1157	.1099	.1042	.0989	.0941	.0894	.0852	.0810
25	.3331	.3137	.2955	.2784	.2623	.2474	.2334	.2202	.2080	.1963	.1857	.1755	.1659	.1572	.1488	.1410	.1339	.1269	.1205	.1145	.1116	.1036	.0986	.0939	.0894
26	.3535	.3337	.3151	.2976	.2810	.2653	.2509	.2370	.2241	.2119	.2006	.1901	.1801	.1705	.1618	.1536	.1459	.1386	.1317	.1252	.1192	.1134	.1081	.1030	.0981
27	.3738	.3535	.3343	.3163	.2993	.2832	.2681	.2538	.2404	.2279	.2160	.2048	.1944	.1845	.1751	.1664	.1583	.1505	.1431	.1362	.1298	.1237	.1179	.1123	.1073
28	.3934	.3732	.3535	.3352	.3179	.3010	.2855	.2708	.2568	.2438	.2315	.2197	.2087	.1985	.1887	.1794	.1705	.1624	.1547	.1474	.1406	.1341	.1279	.1221	.1167
29	4127	.3921	.3722	.3535	.3358	.3190	.3028	.2878	.2734	.2598	.2468	.2347	.2233	.2124	.2023	.1925	.1808	.1749	.1666	.1590	.1517	.1449	.1382	.1321	.1263
30	.4315	.4107	.3909	.3716	.3535	.3364	.3199	.3043	.2895	.2756	.2623	.2498	.2378	.2266	.2160	.2060	.1963	.1873	.1787	.1705	.1631	.1557	.1488	.1424	.1362

$$Ih = (CP/h^2) \cos^3 \Theta.$$

ample, when a person is reading a book on which there is a certain intensity of illumination, the person often finds relief and restfulness in looking towards objects having a lower intensity, in other words the muscles of the iris are relaxed. It is also claimed, that in viewing objects under the indirect lighting, that a higher intensity on the object is required than with the direct system. This is due to the fact as mentioned in another part of this article; that the ceiling and walls are brightly illuminated and exercise a powerful influence on the eyes of an observer.

THE EFFICIENCY OF VARIOUS SYSTEMS.

1. Indirect lighting cove, 20 to 35 per cent.
2. Indirect lighting with suspended units 35 per cent.
3. Direct lighting with lamps placed near ceiling frosted 50 per cent.
4. Direct lighting lamps placed near ceiling and equipped with efficient reflectors 75 per cent.

The above table gives the efficiencies of both the indirect and direct systems, as found by tests made by several authorities. The lower limit of 20 per cent for cove lighting is perhaps for systems where the light flux is subjected to more than one reflection. From the table it is at once seen that the most efficient system is the direct using well designed reflectors, the indirect system coming second place in the list.

A point often lost sight of in connection with the installation of the indirect system employing units suspended from the ceiling, is the effect of dust; since the reflectors are usually pointed upwards, the dust accumulates very quickly on the interior face of the reflector thereby reducing its reflecting power. If not cleaned at frequent intervals, this will reduce the illumination to a very perceptible extent. In cove lighting this trouble due to dust is also encountered, more so perhaps in the open cove system, because generally the coves are placed at a great height from the floor and the frequency of cleaning depends to some extent on the accessibility to the light units.

The initial cost of the inverted reflector system, is also higher than with the direct system. In one type of cove lighting the lamps are usually placed in the coves on from 8 to 18-inch centers, in order to avoid spotted effects. The large number of lamps employed, necessarily means more outlets, more wiring and switches, to control the different sections, thereby increasing the first cost. There is therefore not much to commend this system, as it is costly and inefficient. The initial cost of the inverted reflector system, is also high in comparison with the direct, but it is not due

TABLE 3. CONSTANTS FOR INTENSITY OF ILLUMINATION

HORIZONTAL DISTANCES = D.

VERTICAL DISTANCES = h.

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
4	.06250	.05706	.04471	.03200	.02209	.01523	.01065	.00763	.00558	.00418	.00320	.00249	.00197	.00158	.00129	.00106	.00088	.00075	.00063	.00054
5	.04000	.03771	.03202	.02522	.01904	.01414	.01049	.00785	.00595	.00458	.00357	.00283	.00227	.00185	.00152	.00126	.00106	.00089	.00076	.00066
6	.02778	.02666	.02372	.01988	.01601	.01260	.00982	.00766	.00600	.00474	.00378	.00305	.00248	.00205	.00170	.00142	.00120	.00102	.00088	.00076
7	.02041	.01980	.01814	.01585	.01336	.01099	.00893	.00721	.00583	.00472	.00385	.00316	.00261	.00218	.00182	.00154	.00131	.00113	.00097	.00084
8	.01563	.01527	.01427	.01283	.01118	.00953	.00800	.00666	.00552	.00458	.00381	.00318	.00266	.00225	00191	.00163	.00140	.00121	.00105	.00091
9	.01235	.01212	.01148	.01054	.00942	.00825	.00711	.00607	.00515	.00436	.00370	.00313	.00267	.00228	.00195	.00168	.00146	.00127	.00110	.00098
10	.01000	.00985	.00943	.00879	.00801	.00716	.00631	.00550	.00476	.00411	.00354	.00304	.00262	.00227	.00196	.00171	.00149	.00130	.00115	.00101
11	.00826	.00816	.00787	.00742	.00686	.00623	.00559	.00496	.00437	.00383	.00335	.00292	.00255	.00223	.00195	.00171	.00150	.00132	.00117	.00104
12	.00694	.00687	.00666	.00634	.00593	.00546	.00497	.00448	.00400	.00356	.00315	.00278	.00245	.00217	.00191	.00169	.00150	.00133	.00118	.00106
13	.00592	.00587	.00571	.00547	.00517	.00481	.00443	.00404	.00366	.00329	.00295	.00263	.00235	.00209	.00186	.00166	.00148	.00133	.00119	.00107
14	.00510	.00506	.00495	.00477	.00454	.00426	.00396	.00365	.00334	.00304	.00275	.00248	.00223	.00201	.00180	.00162	.00146	.00131	.00118	.00106
15	.00444	.00442	.00433	.00419	.00401	.00380	.00356	.00331	.00305	.00280	.00256	.00233	.00212	.00192	.00174	.00157	.00142	.00129	.00117	.00106
16	.00391	.00388	.00382	.00371	.00357	.00340	.00321	.00300	.00279	.00259	.00238	.00219	.00200	.00183	.00167	.00152	.00138	.00126	.00115	.00104
17	.00346	.00344	.00339	.00330	.00319	.00306	.00290	.00274	.00256	.00239	.00222	.00205	.00189	.00173	.00159	.00146	.00134	.00122	.00112	.00103
18	.00309	.00307	.00303	.00296	.00287	.00276	.00264	.00250	.00235	.00221	.00206	.00192	.00178	.00164	.00152	.00140	.00129	.00119	.00109	.00100
19	.00277	.00276	.00272	.00267	.00260	.00251	.00240	.00229	.00217	.00204	.00192	.00180	.00167	.00156	.00145	.00134	.00124	.00115	.00106	.00098
20	.00250	.00249	.00246	.00242	.00236	.00228	.00220	.00210	.00200	.00190	.00179	.00168	.00158	.00147	.00137	.00128	.00119	.00111	.00103	.00095
21	.00227	.00226	.00224	.00220	.00215	.00209	.00202	.00194	.00185	.00176	.00167	.00158	.00148	.00139	.00131	.00122	.00114	.00107	.00099	.00092
22	.00207	.00206	.00204	.00201	.00197	.00192	.00186	.00179	.00171	.00164	.00156	.00148	.00140	.00132	.00124	.00117	.00109	.00102	.00095	.00090
23	.00189	.00189	.00187	.00184	.00181	.00176	.00171	.00166	.00159	.00153	.00146	.00139	.00132	.00125	.00118	.00111	.00105	.00098	.00092	.00087
24	.00174	.00173	.00172	.00170	.00167	.00163	.00159	.00154	.00148	.00143	.00137	.00130	.00124	.00118	.00112	.00106	.00100	.00094	.00089	.00084
25	.00160	.00160	.00158	.00157	.00154	.00151	.00147	.00143	.00138	.00133	.00128	.00123	.00117	.00112	.00106	.00101	.00096	.00090	.00086	.00081
26	.00148	.00148	.00147	.00145	.00143	.00140	.00137	.00133	.00129	.00125	.00120	.00116	.00111	.00106	.00101	.00096	.00091	.00087	.00082	.00078
27	.00137	.00137	.00136	.00135	.00133	.00130	.00128	.00124	.00121	.00117	.00113	.00109	.00105	.00100	.00096	.00092	.00087	.00083	.00079	.00075
28	.00128	.00127	.00127	.00125	.00124	.00122	.00119	.00116	.00113	.00110	.00107	.00103	.00099	.00095	.00091	.00087	.00083	.00080	.00076	.00073
29	.00119	.00119	.00118	.00117	.00116	.00114	.00112	.00109	.00107	.00104	.00100	.00097	.00094	.00090	.00087	.00083	.00080	.00076	.00073	.00070
30	.00111	.00111	.00110	.00109	.00108	.00107	.00105	.00103	.00100	.00098	.00095	.00092	.00089	.00086	.00083	.00080	.00076	.00073	.00070	.00067

	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
4	.00046	.00040	.00035	.00031	.00027	.00024	.00021	.00019	.00017	.00016	.00014	.00012	.00011	.00010	.00010	.00009	.00008	.00007	.00007	.00006
5	.00057	.00049	.00043	.00038	.00034	.00030	.00027	.00024	.00021	.00019	.00017	.00016	.00015	.00014	.00012	.00011	.00010	.00010	.00009	.00008
6	.00066	.00058	.00051	.00045	.00039	.00035	.00032	.00028	.00026	.00023	.00021	.00019	.00018	.00016	.00015	.00013	.00012	.00011	.00011	.00010
7	.00074	.00064	.00057	.00050	.00045	.00040	.00036	.00032	.00029	.00026	.00024	.00022	.00020	.00018	.00017	.00015	.00014	.00013	.00012	.00011
8	.00080	.00070	.00062	.00055	.00049	.00044	.00040	.00036	.00032	.00029	.00027	.00024	.00022	.00020	.00019	.00017	.00016	.00015	.00014	.00013
9	.00085	.00075	.00067	.00060	.00053	.00048	.00043	.00039	.00035	.00032	.00029	.00027	.00025	.00022	.00021	.00019	.00018	.00016	.00015	.00014
10	.00089	.00080	.00071	.00063	.00057	.00051	.00046	.00042	.00038	.00035	.00032	.00029	.00027	.00024	.00022	.00021	.00019	.00018	.00017	.00015
11	.00093	.00083	.00074	.00066	.00060	.00054	.00049	.00044	.00040	.00037	.00034	.00031	.00028	.00026	.00024	.00022	.00021	.00019	.00018	.00017
12	.00095	.00085	.00076	.00069	.00062	.00056	.00051	.00047	.00042	.00039	.00036	.00033	.00030	.00028	.00026	.00024	.00022	.00020	.00019	.00018
13	.00096	.00086	.00078	.00071	.00064	.00058	.00053	.00048	.00044	.00041	.00037	.00034	.00032	.00029	.00027	.00025	.00023	.00022	.00020	.00019
14	.00096	.00087	.00079	.00072	.00065	.00060	.00054	.00050	.00046	.00042	.00039	.00036	.00033	.00030	.00028	.00026	.00024	.00023	.00021	.00020
15	.00096	.00087	.00079	.00072	.00066	.00061	.00055	.00051	.00047	.00043	.00040	.00037	.00034	.00032	.00029	.00027	.00025	.00024	.00022	.00021
16	.00095	.00087	.00080	.00073	.00067	.00061	.00056	.00052	.00048	.00044	.00041	.00038	.00035	.00032	.00030	.00028	.00026	.00024	.00023	.00021
17	.00094	.00086	.00079	.00073	.00067	.00062	.00057	.00052	.00048	.00045	.00041	.00038	.00036	.00033	.00031	.00029	.00027	.00025	.00024	.00022
18	.00092	.00085	.00078	.00072	.00067	.00062	.00057	.00053	.00049	.00045	.00042	.00039	.00036	.00034	.00032	.00030	.00028	.00026	.00024	.00023
19	.00091	.00084	.00077	.00072	.00066	.00061	.00057	.00053	.00049	.00046	.00042	.00040	.00037	.00034	.00032	.00030	.00028	.00026	.00025	.00023
20	.00088	.00082	.00077	.00071	.00066	.00061	.00057	.00053	.00049	.00046	.00043	.00040	.00037	.00035	.00033	.00031	.00029	.00027	.00025	.00024
21	.00086	.00080	.00075	.00070	.00065	.00060	.00056	.00052	.00049	.00046	.00043	.00040	.00037	.00035	.00033	.00031	.00029	.00027	.00026	.00024
22	.00084	.00078	.00073	.00068	.00064	.00060	.00056	.00052	.00049	.00046	.00043	.00040	.00038	.00035	.00033	.00031	.00029	.00028	.00026	.00025
23	.00081	.00076	.00071	.00067	.00063	.00059	.00055	.00052	.00048	.00045	.00043	.00040	.00038	.00035	.00033	.00031	.00030	.00028	.00026	.00025
24	.00079	.00074	.00070	.00065	.00061	.00058	.00054	.00051	.00048	.00045	.00042	.00040	.00038	.00035	.00033	.00031	.00030	.00028	.00026	.00025
25	.00076	.00072	.00068	.00064	.00060	.00057	.00053	.00050	.00047	.00045	.00042	.00040	.00037	.00035	.00033	.00031	.00030	.00028	.00027	.00025
26	.00074	.00070	.00066	.00062	.00059	.00055	.00052	.00049	.00047	.00044	.00042	.00039	.00037	.00035	.00033	.00031	.00030	.00028	.00027	.00025
27	.00071	.00067	.00064	.00060	.00057	.00054	.00051	.00048	.00046	.00043	.00041	.00039	.00037	.00035	.00033	.00031	.00030	.00028	.00027	.00025
28	.00069	.00065	.00062	.00059	.00056	.00053	.00050	.00048	.00045	.00043	.00041	.00038	.00036	.00035	.00033	.00031	.00030	.00028	.00027	.00025
29	.00066	.00063	.00060	.00057	.00054	.00052	.00049	.00047	.00044	.00042	.00040	.00038	.00036	.00034	.00033	.00031	.00029	.00028	.00027	.00025
30	.00064	.00061	.00058	.00056	.00053	.00050	.00048	.00046	.00043	.00041	.00039	.00037	.00036	.00034	.00032	.00031	.00029	.00028	.00026	.00025

	40	41	42	43	44	45	46	47	48	49	50
4	.00006	.00006	.00005	.00005	.00004	.00004	.00004	.00004	.00004	.00003	.00003
5	.00008	.00007	.00006	.00006	.00006	.00005	.00005	.00005	.00004	.00004	.00004
6	.00009	.00008	.00008	.00007	.00007	.00006	.00006	.00006	.00005	.00005	.00005
7	.00010	.00010	.00009	.00009	.00008	.00007	.00007	.00007	.00006	.00006	.00006
8	.00012	.00011	.00010	.00010	.00009	.00008	.00008	.00007	.00007	.00007	.00006
9	.00013	.00012	.00011	.00011	.00010	.00009	.00009	.00008	.00008	.00007	.00007
10	.00014	.00013	.00012	.00012	.00011	.00010	.00010	.00009	.00009	.00008	.00008
11	.00015	.00014	.00013	.00013	.00012	.00011	.00010	.00010	.00009	.00009	.00008
12	.00016	.00015	.00014	.00014	.00013	.00012	.00011	.00010	.00010	.00009	.00009
13	.00018	.00016	.00015	.00014	.00013	.00013	.00012	.00011	.00011	.00010	.00009
14	.00018	.00017	.00016	.00015	.00014	.00013	.00013	.00012	.00011	.00011	.00010
15	.00019	.00018	.00017	.00016	.00015	.00014	.00013	.00012	.00012	.00011	.00011
16	.00020	.00019	.00018	.00017	.00016	.00015	.00014	.00013	.00012	.00012	.00011
17	.00021	.00019	.00018	.00017	.00016	.00015	.00014	.00014	.00013	.00012	.00012
18	.00021	.00020	.00019	.00018	.00017	.00016	.00015	.00014	.00013	.00013	.00012
19	.00022	.00021	.00019	.00018	.00017	.00016	.00015	.00015	.00014	.00013	.00012
20	.00022	.00021	.00020	.00019	.00018	.00017	.00016	.00015	.00014	.00013	.00013
21	.00023	.00021	.00020	.00019	.00018	.00017	.00016	.00015	.00015	.00014	.00013
22	.00023	.00022	.00021	.00020	.00018	.00018	.00017	.00016	.00015	.00014	.00013
23	.00023	.00022	.00021	.00020	.00019	.00018	.00017	.00016	.00015	.00015	.00014
24	.00024	.00022	.00021	.00020	.00019	.00018	.00017	.00016	.00016	.00015	.00014
25	.00024	.00023	.00021	.00020	.00019	.00018	.00018	.00017	.00016	.00015	.00014
26	.00024	.00023	.00022	.00021	.00019	.00019	.00018	.00017	.00016	.00015	.00015
27	.00024	.00023	.00022	.00021	.00020	.00019	.00018	.00017	.00016	.00015	.00015
28	.00024	.00023	.00022	.00021	.00020	.00019	.00018	.00017	.00016	.00016	.00015
29	.00024	.00023	.00021	.00021	.00020	.00019	.00018	.00017	.00016	.00016	.00015
30	.00024	.00023	.00022	.00021	.00020	.00019	.00018	.00017	.00017	.00016	.00015

$$Ih = (CP/h^2) \cos^3 \Theta.$$

$$Ih = CP \times K,$$

where $K = \cos^3 \Theta / h^2 =$

Intensity for one candle power.

so much to the wiring, as the cost is made up of reflectors and fixtures.

One of the disadvantages charged against the direct system, is the fact that the light units are more or less exposed to the field of view. This is more noticeable, in a long narrow room, where the units are placed on a low ceiling. For example if a person should stand at the end of a long room and look towards the opposite end, the light units appear to converge with the floor, and seem to be in the direct line of vision. In drafting rooms and offices where the elimination of shadows is desired, indirect light is of great and recognized value, in other cases it may be regarded as a luxury, as it is an inefficient mode of light utilization. Notwithstanding, the disadvantages pointed out above, indirect lighting has been used to a great extent within the past few years, and many notable installations have been made giving apparent satisfaction.

Outlets in private houses should be laid out from the standpoint of their general use, and also of the especial use which will be required of them when occasional entertainments are given. These conditions can never be met by a single high efficiency unit, which is a barbarism in any home. A 40-watt Tungsten filament lamp is the limit of wattage that should be allowed to any one lamp, not outlet, in a private house.

A New Graphical Method for Determining Flux from E. M. F.

(Contributed Exclusively to SOUTHERN ELECTRICIAN)

BY MONTFORD MORRISON.

SINCE the discussion of flux and emf involves the process of differentiation and integration together with mathematical formulation, a simple method eliminating the necessary mathematical theory is desirable. The discussion that follows has this for its object and accomplishes it graphically. Mathematicians, physicists, and more lately chemists, admit the superiority of graphical demonstration over the complicated proofs of formulated mathematics. Not only does applied science call for a demonstration, but in the presentation of the fundamental theory the reader's understanding, which is his conception, depends upon some other action with which he can see relation. In many cases a graph may show the student in a few minutes what might require hours of work with equations. Some of the methods, for instance, of evaluating the co-efficients of a sine series would require much time to thoroughly master all of the theory in its details. A graph reveals immediately the entire method.

The statement is often made that nearly all equations may be differentiated but very few integrated. This, however, refers to the methods of the calculus. Integration is not like differentiation, a direct operation, but consists in recognizing the given expression as the differential of a known function, or in reducing it to a form where such recognition is possible. All functions can be differentiated, but all cannot be integrated; that is, their integrals cannot be expressed in terms of known functions by pure calculus. However, if an equation is given and it is capable of graphic representation, it can be integrated by one of the many mechanical means. Further, if formulation is desired this can be accomplished according to Fourier's Law. Thus, any function whatsoever can be integrated approximately if the several branches of mathematics be employed.

Present day engineering has reduced engineers to practical scientists. The old methods of construction by mere experience have long since been substituted by the most advanced theories of science, though they sometimes are but experiments. This advance calls for simple methods in the use of the theory, and although they may be approximate they will usually suffice for engineering work if they come within one per centum.

A few years ago engineers were contented with comparatively rough estimates, but the tendency of today leans towards accuracy. It is easily remembered that only a few years since, many of the more practical treatises on electricity and magnetism were contented with "equivalent sinusoid approximations" for irregular flux and currents plotted in rectangular co-ordinates and the "equivalent circle approximations" in polar co-ordinates, for their graphic representations and calculations. The thorough engineer of today must treat irregular curves with Fourier's series or really obtain true graphs of the flux or currents and either differentiate or integrate for the unknown functions. While the following method was designed primarily to do this work, it will serve equally as well for mechanical engineers in the calculation of the different moments, curves of stability and inertia, if properly used.

Mathematically speaking, differentiation is the process of finding the differential co-efficient of a given function. The differential co-efficient is then denoted by the symbol dy/dx and is the limit of the fraction $\Delta x/\Delta y$ as Δx and Δy individually approach zero as a limit and the fraction approaches some fixed limit, such as 10, 13, or 5. That is, the differential co-efficient of y with respect to x. Therefore the differential calculus is the science of rates, and its fundamental object is to determine and compare rates of change. Since the most fundamental expression in the science of electricity relates to the rates of change in flux, differential calculus is the base for the calculation of varying current phenomena.

The tangent to a curve at any point has the direction of the curve at that point. Let Φ denote the angle XAP in Fig. 1. Now, as P moves along the curve EPF, Φ varies accordingly and gives the direction of the curve at any point P relative to the X-axis. The tangent of Φ is the slope of the curve at the point of tangency. In the same figure let y equal a function of x, and s denote the length of the path traced by (x, y). Starting at E, suppose (x, y) to move along the curve to P and thence along the tangent PC. Then, when x equals OD, the change of x and that of y will both become uniform with respect to s. Hence PC, PH and HC, will represent ds, dx and dy, respectively, when x equals OD. Hence

$$dx/dy = \tan \Phi \qquad (1)$$

This shows that in order to differentiate a curve graphically, it is only necessary to find the angles that the tangents make with the x-axis and obtain the tangents of these angles.

With the several existing methods of graphical differentiation, too strenuous an attempt has been made to obtain accuracy by using the geometric meaning of dy/dx. Practice has shown it entirely impractical as well as impossible to locate the exact point of tangency by merely drawing a line to coincide with some part of the curve and then attempting to find the point or still worse, selecting a point and trying to read the angle that its tangent makes with some other line. The former method is most difficult to use, when the radius of curvature is long and the latter with radius of curvature short. It is, therefore, desirable to have a method of uniform ease of application and a good average of accuracy, in place of methods of alternating ease and extreme difficulty, striving to obtain theoretical accuracy, but because of the varying difficulty of application, have neither a fair nor uniform accuracy.

In order to explain and apply the following method at the same time, and thereby save the time of the reader, we shall start with an actual flux curve,* Fig. 2, curve *a*, the equation of which is,

$$\Phi = 944 \sin \Theta + 223 \sin 3 (\Theta - 7^\circ 24') + 14 \sin 5 (\Theta - 14^\circ 3') + 3 \sin 7 (\Theta + 19^\circ 40') \quad (i)$$

We shall first compute the ordinates of the differential curve by this graphic method and after differentiating the equation by means of the calculus, compare the results.

Before differentiating the curve, it will be found convenient to fix the horizontal width of the curve to the scale of comparison used, so that the divisions of period M_1, M_2, M_3, will be of some unit value. That means that instead of the period being 2π, it will have in graphic representation n units of length. The use of this will be explained later. The curve is given, either in the form of a table, graph or an equation, in this case the equation of the curve being given. From the equation we may make a table of ordinates convenient for plotting. Thirty ordinates per period will suffice for this illustration with data as follows:

Data for Curve a.

Degrees	Ordinates
52	—3.51
46	— .17
40	+3.06
34	5.50
28	6.89
22	7.38
16	7.42
10	7.26
4	7.21
— 2	7.53
— 8	8.12
—14	8.73
—20	9.03
—26	8.43
—32	6.50

Since 30 ordinates per period are to be used, the graphic length used will be 30 units. Making the centimeter the unit, the horizontal width of the curve for one period will be 3 decimeters and the distances M_1 M_2, M_2 M_3, etc., will be one centimeter. Consider P_1 Q_1 P_2, P_2 Q_2 P_3, etc., as right-angle triangles. If the sides P_1 P_2, P_2 P_3, etc., were straight lines, it is evident that these lines would be parallel to the tangent of some point on the curve between the limits of the straight line. As Δx approaches zero, this unknown point of tangency approaches its confinement to the absolute middle point between the limits of the straight lines P_1 P_2, etc. The radii of curvatures for the various

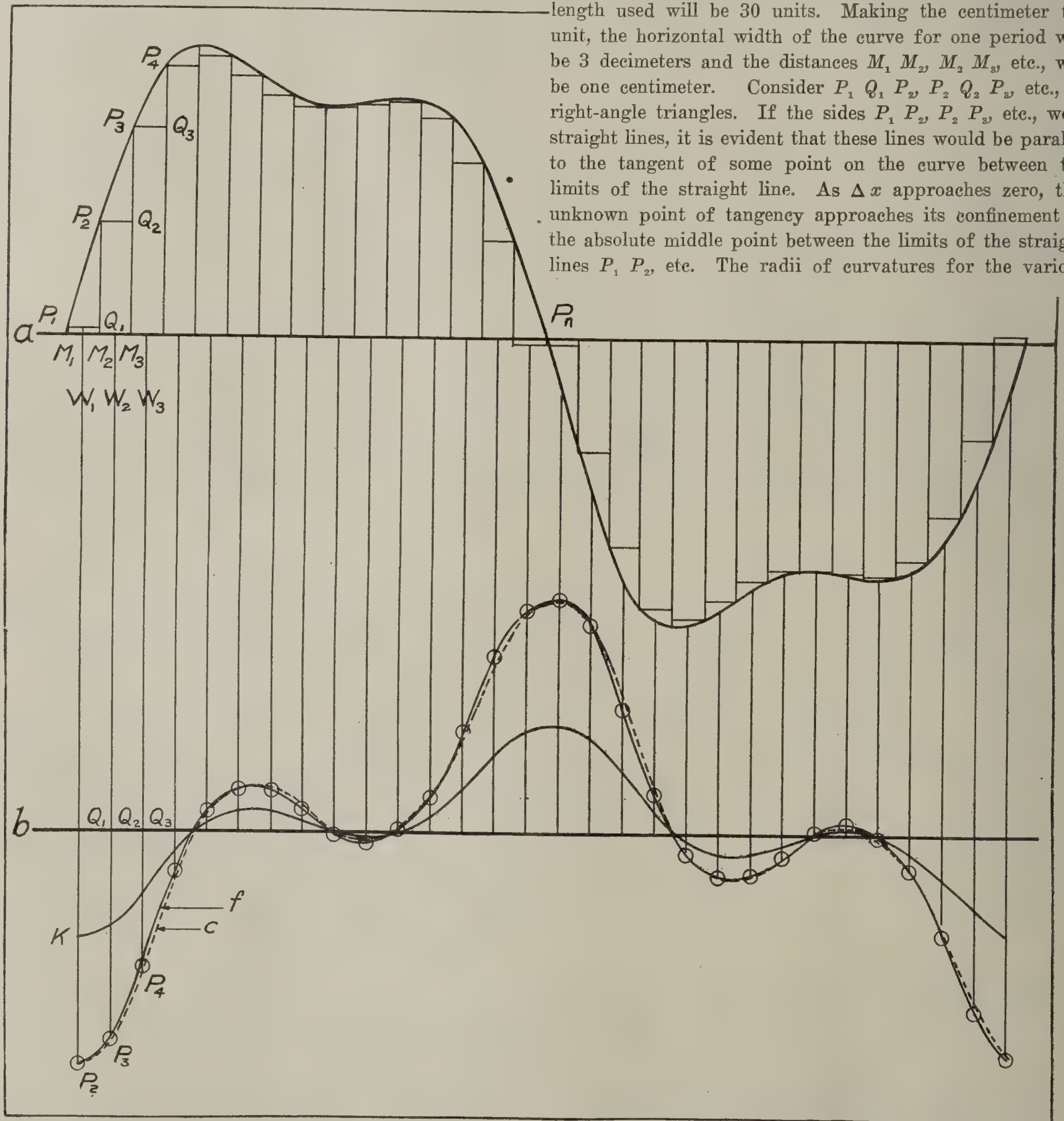


Fig. 2. Diagram Showing Integration of a Flux Curve.

points on the curve will determine the number of ordinates for the period when a constant accuracy is required. By geometry the middle points between P_1 P_2, etc., are the intersections of perpendiculars erected at the middle points of P_1 Q_1, etc. Therefore P_2 Q_1/P_1 Q_1, etc., very closely approximate the differential of the curve for the points W_1 W_2 etc. Since the sides P_1 Q_1, etc., of the triangles are of unity value, the tangents of the angles P_2 P_1 Q_1, etc., may be calculated with greatest ease. The differential of curve a is then with reference to the figure,

$$\frac{dy}{dx}(W_n) = \left[\left(P_{n+1}\,Q_n\right) - \left(Q_n\,M_{n+1}\right)\right] \div P_n\,Q_n. \quad (ii)$$

that is, the rate of change at any ordinate W may be found by substituting the value of the sub-number of that ordinate for n in (ii). Using this formula and calculating the rates of change at W_1, W_2, etc., we obtain the following data:

DATA FOR CURVES b.

ORDINATES BY GRAPHS } X { PROPORTIONALITY FACTOR, 2.18		DEGREES
3.34	7.28	—41
2.99	6.52	—35
1.93	4.22	—29
.60	1.30	—23
— .30	— .65	—17
— .61	—1.33	—11
— .59	—1.29	— 5
— .32	— .70	+ 1
+ .05	+ .11	7
.16	.35	13
— .04	— .09	19
— .49	—1.07	25
—1.39	—3.02	31
+2.44	+5.33	37
3.23	7.04	43

The figures in the first column plotted with respect to the angles in the third column, give the curve K on abscissa b. Now, differentiate curve a,

$$\Phi = 944 \sin \Theta + 223 \sin 3\ (\Theta - 7^\circ\ 24') + 14 \sin 5\ (\Theta - 14^\circ\ 3') + 3 \sin 7\ (\Theta + 19^\circ\ 40')$$

$$d\,\Phi$$

$$d\Phi/dt = - 944 \cos \Theta - 675 \cos 3\ (\Theta - 7^\circ\ 24') - 70 \cos 5\ (\Theta - 14^\circ\ 3') - 21 \cos 7\ (\Theta - 19^\circ\ 40').$$

This curve is plotted with an axis of abscissa b, being the curve c. Take some ordinate, preferably the maximum, of curve c and find the ratio between the ordinates of the curves at that point on the abscissa. This proportionality factor is about 2.18. Now, multiplying the ordinates of curve K by 2.18 and plotting the curve, we have the curve f. The limits of the accuracy desired, may be represented by the radius of a circle, and by the centers of the circles at the limits of the ordinates, the accuracy may be judged. If not sufficiently accurate, a greater number of ordinates must be resorted to, or the ordinates may be shifted along the abscissa, or the horizontal width of the curve may be increased. In practice rarely ever is the flux curve the given function. Almost any instrument that will compute the flux can be made to compute the emf or current by making the emf or the current proportional to the flux. The problem is usually to calculate the flux from the emf. Therefore the problem of most interest is to begin with the emf and go through the reverse operation.

By construction, the ordinates P_2 Q_1, etc., of the curve f of abscissa b are proportional to lines P_2 Q_1, etc., of the curve a, and therefore the integration may be performed this way, making use of the integral symbol as follows:

$$\int \left(M_n + (P_n\,Q_n)/2\right) = P_n\,Q_{n-1} + Q_{n-1}\,P_n, \quad (iii)$$

that is, the integral for any time along the abscissa may be found by reversing the operation of differentiation, and this may be performed graphically by substituting the sub-numbers of the ordinates for n in (iii). It is not believed that any practical help would be derived from plotting this integral curve. The only advantage would be an illustration of the accuracy, and since in this case it would be about the same as obtained in differentiating the original curve, we already have one illustration. After the work of differentiation or integration has been completed, the horizontal width and the maximum ordinate may be changed if desirable.

The area of curve a, as it now stands is, of course,

$$\frac{1}{n}\sum_{n=1}^{n=n}\left(M_1+M_2+M_3+\ldots M_n\right) base\ length \quad (iv)$$

Now, since the distance between the ordinates is unity and their number is n, then n may be substituted for the base length in (iv) and the equation of area then becomes,

$$A = \sum_{n=1}^{n=n} M_1+M_2+M_3+\ldots\ldots M_n \quad (v)$$

and from table of curve a, (v) equal 96.74. The actual area of the curve taken with a planimeter is 96.7 cm. The second decimal place could not be read on the planimeter at hand because only the hundred square centimeter calibration could be used and hence on this curve it was not possible to use but the last three readings, the first being zero.

*From a Bureau of Standards publication.

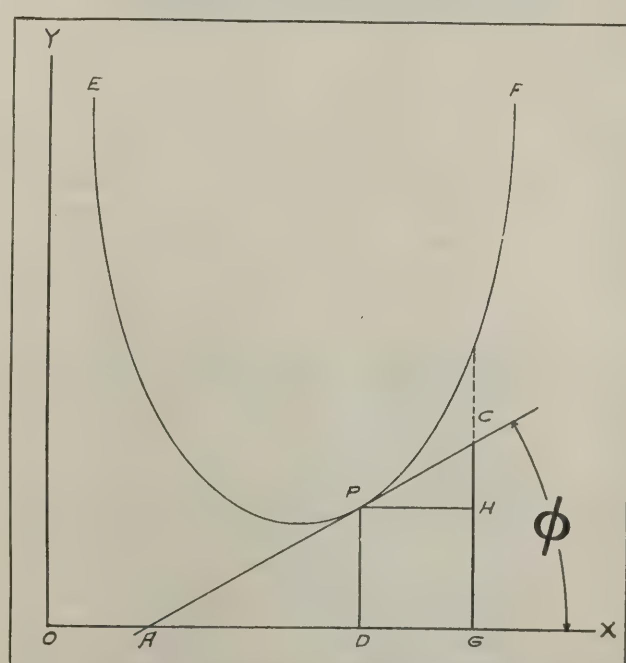


FIG. 1. GEOMETRICAL MEANING OF DY / DX.

The Electrical Great White Way of New York City.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

BY B. M. BLUM.

ONE thing that indicates perhaps more significantly than anything else, the high stage of development which the electric sign has attained and also proves its value as a forceful advertising medium, is the fact that a regular sight-seeing service has recently been established for the purpose of seeing the "Great White Way" at New York City after dusk. The wonderful electrical displays on Broadway have always attracted a great deal of attention both in this country and abroad and New Yorkers have frequently called them their "free show." That a regular auto-bus service should be opened for seeing this show, certainly indicates that there must be something worth while seeing.

To every one who chooses to see the so-called show from the bus and is willing to pay the fare which is one dollar, a program is given called "A Guide to the Great White Way." It contains illustrations and descriptions of all the signs along the route together with considerable interesting data about New York in general. Let us now take the trip mentally and inspect the Great White Way as it is today.

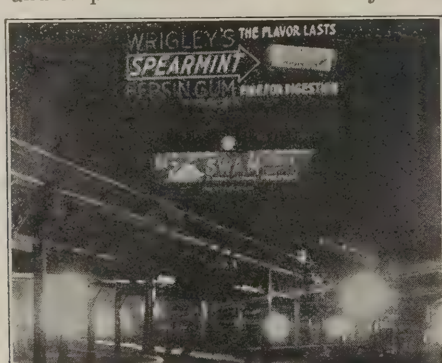


FIG. 1. WRIGLEY'S SPEARMINT SIGN AT 32ND STREET.

Starting from the Bartholdi Hotel at Madison Square, we ride up Broadway as far as 32nd Street. Here the curtain rises and we see, facing Greely Square, the "first act." This is the Spearmint electric sign, as high as a four-story building and over three times as long, the actual dimensions being 48 by 153 feet. The printed guide tells us that the spear in this display is one hundred and one feet long and the package twenty by fifty-two feet. The letters of the word "Wrigley's" are fourteen feet high, those forming "Pepsin Gum" being twelve and a half feet. It is illuminated by 2,950 white, green, and red globes. The sight-seer is given an excellent idea of the immensity of this first display owing to the fact that it is of the "steady" type, that is, it does not flash. The Swan Fountpen advertisement shown underneath this sign is nineteen feet high and ninety-seven feet wide.

As we continue up Broadway past the Herald Building, we are confronted by "Act II" at Broadway and 37th Street, already known to New Yorkers as the Chariot Race. It is 60 feet high and 90 feet long and is probably the most elaborate sign on Broadway. The lower portion of this display is devoted to a portrayal of the chariot race scene from Ben Hur. In the foreground is seen the main chariot drawn by two fiery horses, while at the left, apparently approaching at full gallop, are seen the other contestants. Every possible bit of action is reproduced with wonderful reality from the waving of the horses' maines and the driver's cloak to the clouds of dust thrown up by the horses' hoofs. The roadway shown in this sign is completely studded with bulbs constantly flashing in such manner as to intensify the apparent speed at which the chariots are racing onward. This display contains 20,000 globes and 500,000 feet of wire, over ninety-five miles. It is not taken up with one advertisement but is used to advertise a number of different products by means of three lines of monogram boxes which form the upper part of the structure.

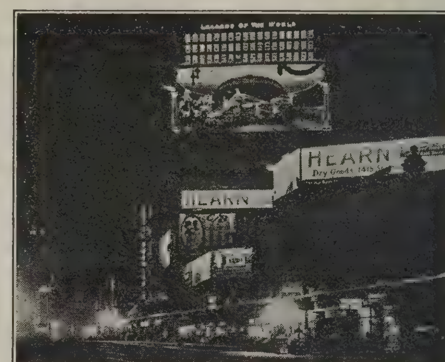


FIG. 2. THE CHARIOT RACE SIGN AT BROADWAY AND 37TH STREET.

Two blocks further up on the route we stop for a moment just outside the Metropolitan Opera House, and looking over our shoulder, we see the Corticelli silk display facing north towards Times Square. This is another interesting sign in front of which crowds are gathered every evening. It shows the Corticelli kitten playing with a spool of red silk. The electrical action consists in the apparent unwinding of the thread from the spool and the continuous motion of the kitten's paws. Lines of globes representing silk begin to appear across the kitten, until it seems to be all tangled up. The picture is then switched off for an instant and the entire effect repeated. The dimensions of

FIG. 3. CORTICELLI SILK SIGN NEAR METROPOLITAN OPERA HOUSE.

this sign are 50 by 46 feet. The kitten is 36 feet wide and 30 feet high, and the spool 15 by 10 feet. This sign contains nearly 2,000 globes.

The next sign to command attention, is the one advertising Heatherbloom petticoats at the corner of Seventh Avenue and Forty-second Street. This display has occupied its position for a number of years and has become a really famous landmark for Broadway's cosmopolitan crowds. At the right hand side of the sign, holding an umbrella, is shown a girl 54 feet tall whose skirt is apparently flapping in the wind. This and the constant rainfall which constitutes the rest of the action in this display, give it perhaps the most realistic effect ever produced in an electric sign. The moving skirt design is certainly suggestive of petticoats. The width of the umbrella is 22 feet and the length of the girl's shoe 6 feet. The number of globes used

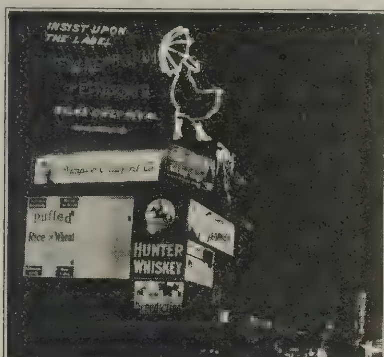


Fig. 4. Heatherbloom Petticoat Sign at Seventh Ave. and 42nd. Street.

is 2,030. The big painted bulletins below this electric sign receive their illumination from brilliant electric reflectors, making this one of the brightest spots on the Great White Way.

Passing the Times Building and Rector's we enter Longacre Square. Here, above the glare of the numberless smaller signs of hotels, theatres and restaurants, there loom up four of the most prominent big electrics, namely, the C/B Corset, Porosknit Underwear, White Rock Water, and Kayser Gloves. The C/B sign, situated on the roof of the Cafe Madrid, is 50 feet high by 50 feet wide. This is a beautiful and artistic display, all the lights of which remain steady with the exception of a few hundred or so which are scattered over all parts of the sign and flash continually, giving the effect of twinkling stars. There are 1,994 lamps in this sign. The Porosknit Underwear sign on the opposite side is the largest in the Square, being 55 feet high by 108 feet long. This is an advertisement appealing primarily to men, and the design, that of two youngsters sparring, is one that no man can overlook. This Porosknit pair amuse thousands by their lively boxing bouts every evening. The total number of globes is 3,430.

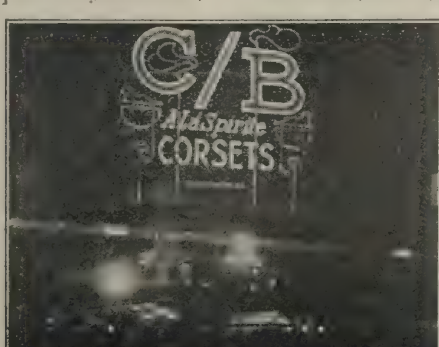


Fig. 5. C/B Corset Sign, Longacre Square.

The White Rock sign, one of the latest additions to the Great White Way, is situated at the apex of Longacre Square, the most dominating advertising location in civilization, and while being impressive as an advertisement, is also unusually artistic, being considered by many to be the most beautiful illuminated advertisement ever seen on Broadway. It is truly an object of beauty and something of utility for the passerby. This sign is an example of the courteous use of outdoor advertising space. The clock bows its courteous greeting to the people and tells them the time of day, and illuminates the dial for their convenience at night. The sign is 62 feet high and 50 feet wide, while the diameter of the clock itself is 20 feet. The minute hand is 9 feet long

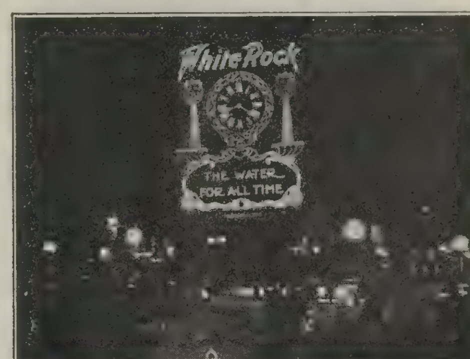


Fig. 7. White Rock Sign, Longacre Square.

and weighs 140 pounds. There are 3725 globes in this display. At the sides are two lions' heads spouting streams of water, which appear to be in continuous motion.

The Kayser Glove sign, another very elaborate display of the changing type, is situated at Broadway and 49th Street, but is visible not only from Longacre Square, but also down Broadway for a distance of one mile. First is shown the woman holding a glove at arm's length and then by a series of rapid flashes she is seen drawing it on her left hand. The accompanying illustration shows the last phase of his sign. This display measures 56 feet at its widest point and contains 1,677 globes.

Our journey is now drawing to an end as there is but one more display to see. It is at Broadway and 54th Street on the roof of an eighteen story building and is itself almost six stories high. This sign advertises Wrigley's Spearmint Gum and is a reminder of the one at 32d Street. It is interesting to note that no matter where one stands between 32nd and 54th streets on Broadway, either one or the other of these two gigantic signs is always in sight. They

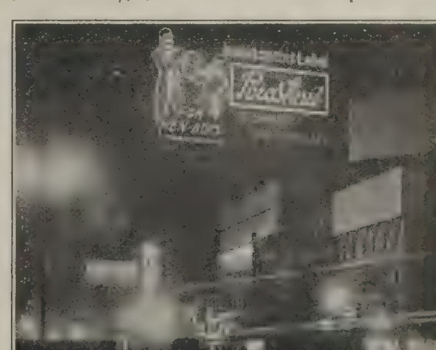


Fig. 6. Porosknit Underwear Sign, Longacre Square.

literally get the crowds "coming and going." The spear is 125 feet long, the height of the words "Wrigley's" and "Spearmint," 21 feet. The total width is 125 feet.

These big displays are almost invariably those of national advertisers, and it is a fact that many concerns who use them charge one quarter of their cost to local advertising and three quarters to national advertising. Such is the nature of the crowds that throng Broadway. According to police records, between two and three hundred thousand people pass every day through the Great White Way, and it is through the great number of transients who form a big percentage of this vast army, that news of these electrical displays finds its way into every nook and corner in the nation. How long it takes for these visiting thousands to duplicate themselves is difficult to calculate, but every day brings new crowds to gaze and marvel at New York's Great White Way.

Fig. 8. Kayser Glove Sign, Longacre Square.

Fig. 9. Wrigley's Spearmint Gum Sign at Broadway and 54th Street.

The effectiveness of electric signs in inscribing an advertising message in terms of such quick and powerful appeal to the eye, that he who runs may read, has been utilized by the national advertisers to such advantage that other classes of advertisers are using them. Notable among this latter class is boards of trades of hustling and growing cities desirous of attracting capital and additional population, and the manufacturer who reminds the passing public of the existance and location of his plant.

Recent Central Station Policies and Developments in England.

(*Contributed Exclusively to* Southern Electrician.)

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

During recent years, despite the great loss of revenue caused by the introduction and general adoption of the metallic filament lamp, the financial position of English central stations has, in the main, steadily improved and, now that the metallic filament crisis is past, a period of unparalleled prosperity is confidently expected. Large supply stations being chiefly confined to large manufacturing towns, find no insuperable difficulty in extending their off-peak load at a rate commensurable with the growth of the evening lighting demand. Indeed, in most cases, a material improvement in the annual load factor of the undertaking is made from year to year.

Among the most interesting developments may be noted the rapid extension of bulk supply of current to large works and outlying communities. On contracts for large quantities of electricity for periods ranging from 3 up to 5, 8 or 10 years, the supply station can afford to quote exceptionally favorable rates and, by this means, numerous large works and small communities have been prevented from installing their own generating equipment. Such central supply is economical to the purchaser and the supply authority attains higher load factor, lower running costs per unit, and greater financial stability by possessing guaranteed loads of such magnitude.

Quite a number of provisional orders taken out by small towns or villages have been lapsed in favor of bulk supply from an adjacent large central station. The wisdom of this policy is usually indubitable though the prospects of small independent generating stations have lately much improved. The Accrington central station supplies the adjacent town of Haslingden with current, cars and men for its tramway system. This arrangement expires in December 1912, after which Haslingden will supply the cars from its own distributing station. Another interesting instance of municipal bulk purchase is to be found in the offer of the East Anglian Ice Co., to supply the Oulton Broad Council with from 10,000 to 30,000 units per annum at 5 cents per B. T. U.; the Council is prepared to spend $12,500 on its feeders and distributing network.

Some 48 English towns now take supply in bulk from neighboring central stations and there is an ever increasing number of cases in which more or less restricted supply is permitted to consumers outside the authorized area of the undertaking concerned. Recent bulk contracts concluded with railways include the agreement of the Aberdeen station to supply the Great Northern Railway of Scotland with current for lighting, heating and power for five years from March, 1911 at 4.25 cents per unit for the first year and 4 cents per unit afterwards, the railway being liable for not less than 135,000, 140,000, 150,000 and 160,000 units in the 1st., 2nd., 3rd., and 4th. and 5th. years respectively. The London and North Western Railway has recently applied to the Acton station for supply to all the stations, sidings, signals and railway premises in the area of the latter. The present gas consumption of the company is about five million cubic feet per annum.

Cases in which individual works have entered into 5 year contracts for the supply of not less than 100,000 and 500,000 kw hours per annum might be indefinitely cited. Thus the Stockton-Tees station has agreed to supply a large works at 1.375 cents per unit for 2 years and then at 1.25 cents per unit for a further 3 years, a minimum annual payment of $2,500, being guaranteed. To secure this load $25,000 capital outlay will be required, of which $18,-500 will be expended in the first year of supply. In Hackney there is a firm which has been consuming 300,000 units per year and which has now entered into a 3 years contract for not less than 500,000 units per year at $10 per kw. maximum demand plus 1 cent per unit, while in other areas the fixed charge falls to $5 per kw. Dartford supplies power consumers taking not less than 150,000 kw. hours per year at 2 cents per unit providing the demand does not exceed 100 kw. from 4 to 6 p. m. in January and December.

Blocks of flats in large cities are largely supplied on the "telephone" system; the "farming out" of current from a central supply board in the buildings has many objections. Though bulk supply possesses obvious advantages in the case of large works and small communities, the perfection of suction gas plant and Diesel oil engines has greatly enhanced the possibility of economical independent generation in such cases. Water power is utilized to no important extent in England. Indeed, in numerous instances, small provincial stations have shown more rapid extension and more profitable operation than for larger concerns. This is often attributable to keen local interest in the scheme, a happy condition seldom attained in large towns. A striking instance of rapid development in a small station is the case of Grassington, where a 20 kw. water turbine was installed in 1909. In the six months preceding March 31st, 1911, the demand on this station rose from 30 per cent. to 85 per cent. of the total plant capacity.

At the present day, there are 38 stations in the United Kingdom having a plant capacity less than 100 kws.; 55 having over 100 kw. but less than 250 kw. generator capacity and, in all, 151 having less than 500 kw. of machinery installed. The total number of central stations is about 420.

RECENT SUPPLY POLICIES AND APPLICATIONS OF ELECTRICAL ENERGY.

Exhaustive treatment cannot be given to this important heading but the following remarks illustrate the general tendencies of the times. In the first place, a number of undertakings are making capital expenditures from revenue account. A notable instance of this policy is the Worcester Corporation station which has devoted $46,000 from revenue during the past 6 years to purposes which could be justly charged to capital. Such a policy increases the difficulty of securing a reasonable net profit at the time but certainly improves the ultimate stability and prosperity of the undertaking by limiting its capital burden.

Numerous supply authorities have raised loans up to $25,000 or more for the purpose of giving consumers "free" or "assisted" wiring installations. According to local policy, these installations remain the property of the supply company or may be purchased by the consumer or his landlord on the hire system. In either case, the consumer pays for the special benefits afforded him, by a temporarily or permanently higher rate per kw hour. In some cases, the wiring work is leased to an independent contractor who relieves the central station of all responsibility and receives payment from the consumer by an extra charge of 2 cents per unit levied on the latter, by a prepayment meter, till, say, 240 units per "point" have been consumed, this assuming an overall installation charge of $5 per point.

In outlaying residential districts and for the supply of small consumers of whatever class, strenuous efforts have lately been made to evolve cheaper supply and distribution systems. Bare overhead lighting lines are becoming relatively common and though, in some cases, there has been great local opposition to this construction, in at least one case, (Lydney, Glos.) it is stipulated that the lines be removable at six months notice. It has, elsewhere, been accepted as a matter of course. In many Worcester houses good grade flexible leads are run on cleats along the walls of passages and rooms. The wires are painted to match their surroundings and are thus very inconspicuous. No serious mishaps have yet been attributed to this simple construction, which is accepted by insurance companies.

PRICE OF CURRENT.

The whole object of rate modifications during recent years has been to popularize the use of electricity, particularly among power users and the masses of middle class householders. Off-peak loads have been eagerly sought as raising the load factor of the station. Beckenham, Leek and Wakefield are instances of the rare policy of raising the price of current to tide the station over the metallic filament lamp crisis. These stations recently found themselves compelled to raise the lighting tariffs by 1 cent per unit to meet the standing charges on the undertakings but, as a general rule, there has been a considerable, if retarded, reduction of rates. One of the most notable groups of low tariffs in this country is to be found at Southampton where current is supplied for lighting at from 5 to 7 cents per kw. hr.; for power at 1.5 to 4 cents per kw. hr. and for heating at 1 cent kw. hr. By the latter exceptional rate, it is hoped to develop a valuable day load. At Stokes there is now a restricted hour supply at 2 cents per unit for all purposes, providing the consumer installs a time switch to disconnect his circuits between sunset and 10 p. m. As another example of the special endeavors made to secure a heating load, Barrow-in-Furness supplies current for lighting at $60 per kw. installed plus 2 cents per unit; for power at $15 per kw., plus 2 cents per unit and for heating at a flat rate of 2 cents per unit. By the time of its usual occurrence a heating load is probably quite justly exempt from any standing charge.

Special terms, usually 1 to 3 cents per unit rebate, are generally granted for the supply of lamps lighting the outside of shops. In various London districts, the shop lighting tariff ranges from 5 to 6 cents per unit, conditional on electric lighting being also used inside the premises. At Ilford a composite charge of $15 per 500 hours is made for the energy supply, carbons and trimming of each 600 watt enclosed arc. Electrical contractors are frequently supplied at a reduced rate, say 2 cents per unit for display purposes, usually subject to a minimum annual charge of say $25. Such a concession is entirely in the interests of the central station.

Current supply for the recent Coronation decorations was usually at 2 cents per unit. Few undertakings charged over 1/3 to 1/2 of their ordinary lighting tariff for this purpose and, in at least two cases, (Barrow and Blackburn), the special supply was free providing consumers erected their own wiring and fittings to the satisfaction of the Electrical Engineer and paid 2/6 as a connecting fee. On the other hand, some stations arranged for a fixed charge per lamp of stated candle power and, though their intentions were doubtless amiable, the equivalent tariff per kw. hr. reached rather a ferocious level in some cases. Thus Taunton supplied 8 candle power lamps at 1 cent per night from 9 to 12 p. m. i. e. at 10.4 cents per unit assuming 4 watts per candle power lamps or 33.2 cents per unit assuming 1¼ watts per candle power for metallic lamps, such as should certainly have been used. In some instances a minimum number of lamps and minimum number of burning hours per evening were specified as the condition for acceptance at the reduced rates.

There has been a steady reduction or abolition of such irksome charges as levies for fuse renewals, meter rents, etc. The revenue derived from these sources is usually insignificant when allowance is made for the cost of collection and the irritation caused to consumers. Marylebone, (London), has recently abolished a charge of $10.50 per year to "telephone" consumers for supply for purposes other than lighting. This charge barred many business houses from adopting radiators, fans, etc. and its removal has been followed by a notable increase in business. A sliding rate is almost invariably arranged for power consumers and the limiting consumption beyond which further reductions in rates are available are continually decreasing. In the Newcastle-on-Tyne district, energy for power purposes is obtainable in bulk at 1 cent per unit.

The application of electric motors to the driving of various machine tools in factories is steadily expanding though the rate of development does not equal that realized in America. It must be remembered that many large English works have a very efficient steam driven plant in full working order; in such cases, it is difficult or impossible to show an economical case for electric driving, allowing for the cost of scrapping the existing plant. Electric motors are now widely employed in pumping and sewerage works, in refrigerating plants and in collieries, ironworks, cement works and general chemical works. An interesting special utilization of tramways is to be found in Accrington where the Post Office authorities pay $500 per annum for the conveyance of mails, postmen, etc. by the local tramways.

Electric lighting is now frequently employed, as the result of private or public enterprise, in the illumination of markets, slaughterhouses, goods yards, etc. Its use in schools and all public buildings is rapidly extending and for the illumination of bandstands, piers and so on, twin cable permanently fitted with lamp holders at intervals of 1 to 2 feet, is of unique value. Flash signs for advertising purposes are making steady headway but are not employed to anything like the extent common in the States.

Kinematograph theatres from an important load in many towns. These halls are supplied at the ordinary lighting or theatre rates for auditorium lighting; at theatre or shop rates for outside lighting and, usually, at specially low rates for the lantern arc supply. Kinematograph arcs require from 25 to 100 amps. at 50-70 volts.

In street lighting, flame arcs are very widely used in important thoroughfares while metallic filament lamps are carrying all before them in the lighting of smaller streets. In some cases all the street lamps are extinguished at midnight, while in other places, all burn till dawn. The most economical and satisfactory arrangement is to extinguish alternate lamps at about 11.30 p. m. or to extinguish all arc lamps at this time, replacing each by two 25 or 50 watt metallic filament lamps for the remainder of the night. In very small towns, it is common to supply public street lighting only for six months in the year, even then extinguishing the lamps at 10 or 11 p. m.

Developments in Interior, Special and Display Illumination.

(*Contributed Exclusively to* Southern Electrician)

BY WILLIAM S. KILMER.

IT SEEMS to be a prevailing practice of engineers and architects to devote the larger part of their energies in connection with store lighting to the general illumination and that of show windows, leaving cases, cabinets, and interior displays to the most convenient and old time rule of thumb method at hand. This practice, however, is gradually diminishing, more from the demand of the consumer than the development of the art. When we stop to consider that the average department store contains about ten times the lineal feet in show cases that it does in show windows, the problem should receive careful thought.

This is a problem which should interest the manager of every new business department of a central station, and be an entering wedge for closer relations and better illumination among the general and retail stores in their district. The subject is one which vitally interests the proprietor of the store, for the show case is in its true definition the interior show window. When by various means the proprietor has created an interest by general publicity or window display, sufficient to induce the purchaser to enter his establishment, he has paved the way to a sale. However, how often is the sale not made because the methods employed beyond the entrance do not correspond with those met with outside? The illumination of a display inside should be such as to show up the goods to the best possible advantage. There are several features which require consideration in dealing with this problem, and it is the purpose of this article to take these up from technical, commercial and economical aspects.

Fig. 1. A Difficult Form of Show Case to Illuminate.

First of all, a sufficient quantity and quality of illumination properly distributed is required; second, the units employed must be inconspicuous and neat and placed where they will not detract from the appearance of the case or interfere with the goods; third, the temperature must not be raised to such an extent as to harm delicate and perishable merchandise; fourth, the units must be so arranged that they can be readily removed, or must be such that the case may be easily cleaned; fifth, the operation must be economical. There are several other features to be considered, but the above mentioned are the most prominent. To the inexperienced engineer in this class of work, it might be advisable to state that photometric data and the point by point method cannot be followed out to any degree of accuracy in this character of illumination, although the characteristic distribution of light of the unit will materially aid to form a working basis. The distribution of light about the unit is so intensified and altered when placed in the case, by reason of the mirrors and lamp shelf, that mathematical calculations cannot be followed and the only real accurate measurement is obtainable from measuring instruments.

It will soon be found out in this class of work that four 25-watt units per eight foot case will give the desired effect, this, of course, varying with the standard in vogue. A very good rule to follow for the proper standard is that the proper illumination of the case should be approximately double the exterior general illumination. These two simple rules will enable the contractor and central station solicitor to make interior recommendations that may be relied upon as to results, and in this manner secure new

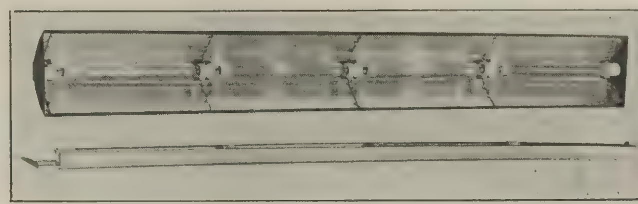


Fig. 3. The Linolite Unit.

business in a field which is unlimited and offers a vast future for both.

Various types of fixtures are used for show case lighting, however a system which lends itself particularly usually consists of four of the 25-watt Linolite units in a continuous shell reflector, which is attached to the case by two or three clips. These clips are readily adjusted to the interior and into these clips the shell is secured by means of a spring, the standpipe then runs through at one end of the case into an outlet box under the base or footboard, into which it is customary to place a single volt flush switch, this giving individual case control. The accompanying photographs and data describe the accessories obtainable for this class of work.

In Fig. 1 there is illustrated a difficult form of show case to illuminate. This case receives the identical treatment that a standard show case would receive, with the exception that the unit is turned on its axis to approximately fifteen degrees from the vertical. It will be noted that this case is glass on all four sides and the merchandise is so arranged that it is viewed to an advantage from any point. The case measures six feet long, four and one-half feet high and eighteen inches wide, the narrow width making

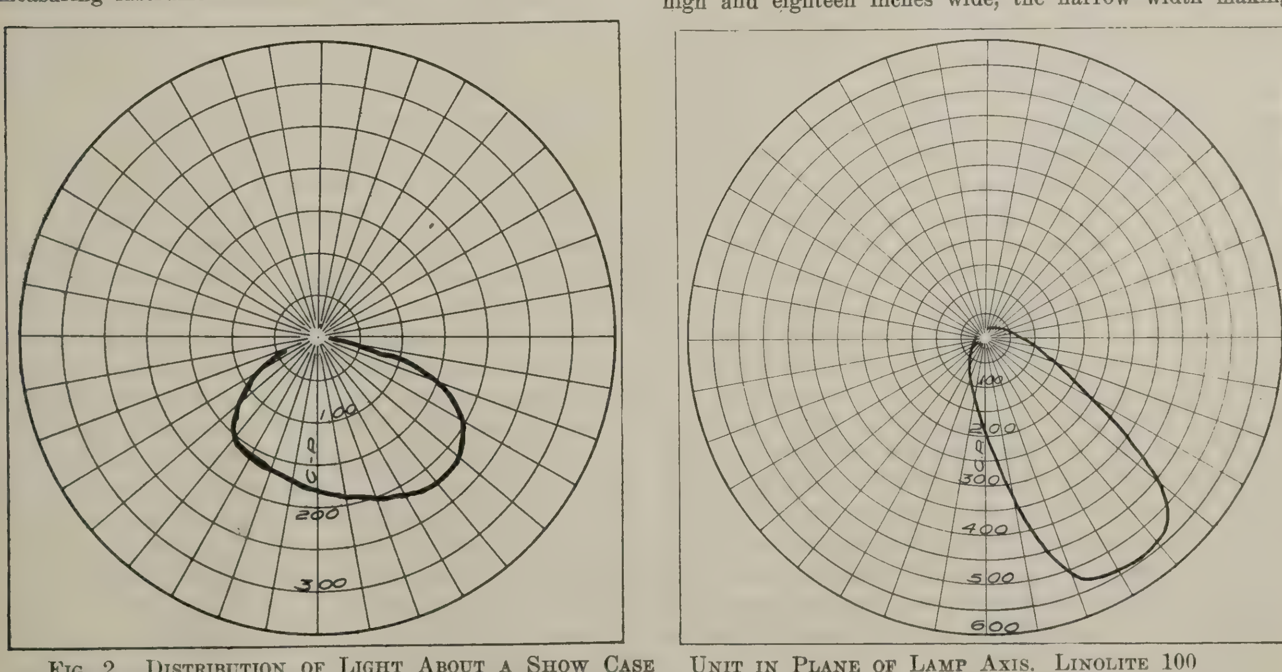


Fig. 2. Distribution of Light About a Show Case Unit in Plane of Lamp Axis. Linolite 100 and 140 Watt-Units.

it necessary to change the angle to the measurement of light. These cases are particularly popular in the shoe department of our department stores.

The distribution of light about a show case unit, consisting of four 25-watt Linolite lamps in the show case reflector, is shown graphically in Fig. 2. The unit when measured was placed so that the value is in a plane containing the axis of the lamp. It will be noted that an average illumination of seven to eight-foot candles may be maintained on a current consumption of 100 watts to a foot case. This at times may be raised to 100 watts to ten and twelve-foot cases, owing to the fact as previously stated, that the mirrors in the glass give an effect of being much higher. Therefore the variation is not so readily noticed.

FIG. 4. GENERAL ILLUMINATION AND SHOW CASE LIGHTING.

The control of all rays renders it possible to place on the merchandise an intensity of illumination which compares very favorably with the effect received from the common systems using two or three times the current. It will be noticed from the photometric curve that all the light is confined practically in a zone of 45 degrees, the balance of light being merely actual light from the lamp itself without any reflection. The effect of this class of illumination is very pleasant to the eye, and has a tendency to bring out the desired shadow effects on the merchandise, which is so important, and oftimes neglected by the engineer. The 35-watt unit used largely in window lighting and the photometric curve shows the distribution of light around four of these lamps, which constitute a unit. All lamps described in this article are the tungsten filament Linolite lamp, 1.25 watts per candle, burning four in series, on 110 volts, the individual voltage to the lamp being 27.5, with ampere variations not exceeding .05 between any two lamps. By maintaining this small variation, an equal intensity from all filaments is obtained. The above show window units should not be taken as a unit which is adaptable for all classes of windows, as each installation has to be treated as a distinct proposition, and the reflector designed so that the rays are confined to exactly the area where needed. This, of course, is sometimes possible by the use of a knuckle joint, which permits the unit to be adjusted to a certain extent.

In Fig. 4 an installation is shown where general illumination and case lighting is accomplished. The goods displayed are fountain pens which in themselves are not the most desirable goods to illuminate. It will be noticed that the cases are all of glass construction which permits a fair amount of light to pass through without shadows, and the reflector is so designed that the sufficient amount of illumination is received in the show room and at the same time a direct downward illumination is received for the show case.

While show case illumination in this article has been taken up generally, using for illustration one type of unit, this has been done principally to outline the nature of the problems involved rather than give the various details in connection with the individual solution of this class of illumination employing a variety of methods. The field is comparatively new and deserves careful attention not only to bring about good results but to provide economic operation. Our newer and larger stores provide a field for investigation and with the interest now taken in this class of illumination developments of interest are sure to be the products of the near future.

Hydro-Electric Development in Chile, South America.

Several hydro-electric power plants are being constructed, principally by German interests. So far as known there is but one plant in the country owned by American interests, and that is connected with the Braden Copper Co., near Rancagua, Chile. German interests control a large proportion of the electrical plants of the country and are reaching out for the most available sites for hydro-electric plants. A German company secured a concession last year for the location of a water power plant on the Aconcagua River above Valparaiso with a view to supplying power and light to the region above and about this city. They so dominate this business that it is difficult to introduce anything but German electrical machinery and supplies. It will take some hard work to get back what American interests have let slip from them in this line, and it would be well for Amercian manufacturers in other lines to take notice and see that other interests are not handicapped in a similar way, for German manufacturers are after business in Chile in earnest and every possible effort is made to capture the whole trade.

Some Views on Electricity.

The Fernie B, C., Free Press has recently had an electrical equipment installed and has consequently suddenly become electrically enthusiastic to the extent of printing the following definitions: A transformer is an apparatus that hangs on a pole on the street and grinds the volts into domestic sizes for adjacent consumption. A meter is an automatic case-keeper that is designed to keep the conscience of the consumer pure and untainted. A motor is a Christian Science medicine box that is influenced from the powerhouse by absent treatment. The method of operation is as follows: The armature amperes the rheostat at the switchboard by kilowatting the voltage, thereby transforming the resistance into two-phase electromotive ohms, with which the motor absorbs the peak load on the cut-off. The dynamo reduces the insulation of the series wound exciter producing multipolar generators on the direct current, and you pay at the city clerk's office.

Street Lighting by Metallic Flame and Series Tungsten Lamps.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

BY D. A. BOWEN.

THE field of lighting in American cities has witnessed the use of many types of units—including the open arc lamp, the enclosed arc lamp, the carbon incandescent lamp, the gas lamp and others. It is, however, only within the last few years that the leading arc and incandescent lamp manufacturers have, after extended research and development work, introduced units that will provide adequate illumination. Great advancement has been made in the mechanical and operating characteristics of lighting units and their efficiency has been greatly increased. The light distribution of such units has been improved to such an extent that our streets are illuminated by night in such a way that traffic can be carried on with as much ease and comfort as by day. The careful investigation and development has not been confined to the lighting unit alone, the station equipment and auxiliary apparatus have been greatly improved in design and efficiency.

Let us review briefly the development of the lighting subject since the introduction of the arc lamp for street lighting about 1880. The direct current series open carbon arc, consuming about 500 watts at the lamp terminals, was the first large unit used in street lighting. Until the development of the enclosed arc, the open arc was practically without competition, and while the enclosed arc was not so powerful or efficient as the open arc, it distributed the light more effectively, giving a greater illumination at points more distant from the lamp and was steadier and more reliable in its operation. The shadows of the lamp frame which were so objectionable with the open arc were practically eliminated by the enclosed arc and the economic feature of longer life per trim, reduced labor and expense of maintenance encouraged the change which in a short time resulted in the enclosed arc practically superseding the open arc.

The direct current series enclosed arc was first developed and like the open arc was operated from direct current arc machines. Later the series enclosed arc was developed for alternating current, but instead of operating from series arc machines they were operated from constant current regulating transformers, since the current for the constant current regulating transformer could be supplied from the large station alternators. From an operating standpoint, this was a great improvement as it eliminated the use of rotating machines for supplying the arcs, and thereby greatly reduced the operating cost. Arc generators are usually high speed machines of comparatively low efficiency and require considerable attention. It is usually necessary to have a spare generator to guard against prolonged interruption of service due to a burned out armature. This item in itself is very expensive without having to suffer the loss of revenue due to lamps being out of service, not to mention the inconvenience of being without light.

Carbon incandescent lamps equipped with suitable reflectors and operated from constant current regulators or from constant potential mains have been extensively used in suburban towns where the intensity of illumination required is not high. The extremely low efficiency of this lamp, together with the fact that the candle power decreased with the increase of life, were great handicaps to its success. Furthermore, the yellow color of its light after it had been in service a short time detracted materially from its appearance. But even under these conditions this lamp was until the last year or so, the only electric device for competiting with the gas unit.

The gas lamp with the Welsbach mantle, giving a greenish yellow light has been used for suburban lighting where low intensity of illumination is required. The rapid depreciation in candle power of the gas mantle as the life increases and the attention required to keep the system in good condition have greatly handicapped its wide use.

The old open arc gave its maximum candle power at an angle of 45 degrees below the horizontal and decreased very rapidly on both sides of this point. The maximum illumination was obtained at from 25 to 30 feet from the lamp, the points midway between lamps receiving very little light, rendering the lamp very ineffective for street lighting. Although the maximum candle power of the open arc was higher than that of the enclosed arc, the candle power of the latter at 15 degrees corresponded very favorably with that of the open arc and it was therefore more effective for street lighting.

Since the early days of lighting, conditions have greatly changed, cities are more densely populated, traffic has become more dense, making it necessary to provide sufficient illumination to see clearly throughout the length and breadth of the street. Where lights were used merely to indicate the course of the street, we now require an almost uniform illumination of the surface throughout its entire length. Good illumination favors travel and traffic increases where suitable illumination is provided, thus these two factors increase the demand for higher and more uniform intensities of illumination.

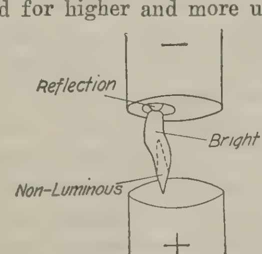


FIG. 1. ELECTRODE ARRANGEMENT FOR METALLIC FLAME SERIES ARC LAMPS.

To provide an absolutely even intensity of illumination is impossible in practice, since all lamps furnish the strongest illumination at points nearby. To approximate as nearly as possible an even intensity of illumination, the lamps should emit the strongest light at an angle of from 15 to 20 degrees below the horizontal and decrease rapidly above and below this angle.

Lighting may be divided into two general classes, one of high intensity, the other of moderate intensity. For business centers and busy thoroughfares, parks, mills, foundries, etc. the former is necessary, while for residence and suburban districts especially where shade trees abound, the latter is sufficient. For either class a light approaching daylight is most efficient and most desirable, for objects can be distinguished more clearly and the eye fatigue will be less.

For street lighting whether a high or moderate intensity is required, the illumination should be as uniform as possible, except at street intersections, where it should be slightly more intense. The operating and maintenance cost should be kept within reasonable limits. For good illumination the requirements may be considered briefly as high intensity or low intensity, uniform intensity and diffusion. We might also add that low operating and maintenance cost, simplicity and efficiency of the station equipment and distributing system is of great importance.

Having considered the most important requirements, we may state briefly the desirable characteristics of units and equipment as follows:: (1). The maximum intensity of light should be distributed at an angle of from 15 to 20 degrees below the horizontal and decrease rapidly above and below this angle. (2). The color of the light should approach daylight. For lighting of high intensity, a number of large units should be used. (3). For lighting of low intensity, a number of small units spaced at frequent intervals should be used. (4). Uniform candle power throughout the life of the uite. (5). Long life of the unit. (6). In the station equipment, absence of moving machinery is desirable. Among recent types of lamps designed to meet these requirements, two types of metallic flame lamps with the necessary station equipment and auxiliary apparatus have been developed and in successful operation. For the high intensity class of illumination the direct current series metallic flame lamp, operated from mercury arc rectifiers and sometimes from series arc generators, has been developed for street lighting. Later the multiple and series multiple metallic flame lamp operated from direct current constant potential mains has been developed for the lighting of mills, parks, train sheds, foundries, etc.

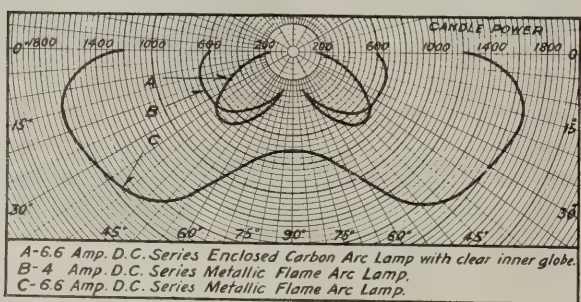


Fig. 2. Light Distribution Curves.

The equipment for a street lighting system of direct current series metallic arc lamps, consists of the lamps, a constant current regulating transformer with rectifier bulb, and the control panel containing the necessary auxiliary apparatus for properly controlling the regulator and lamp circuit.

The lamps show a marked improvement in design over the older types of arc lamps and are more accessible for inspection. The weight is approximately the same as the carbon arc lamp and as a light producer it is very much more efficient. The light is white in color and is emitted from the flame, instead of from the crater at the end of the positive carbon as is the case in the carbon arc. The large portion of the light comes from the flame of volatilized oxide which always surrounds the negative electrode, as shown in Fig. 1. A light distribution, indicated by the curves "B" and "C" in Fig. 2., which is exceptionally desirable for the illumination of streets and large areas, is obtained. The light is steadier and the illumination on the street is practically uniform when the lamps are spaced at ordinary distances and are suspended at the usual heights. Each lamp consumes 272 watts at the lamp terminals when operating at 4 amperes and gives the maximum intensity of light at about 15 to 20 degrees below the horizontal. At this point the intensity is more than twice that given by the direct current series carbon arc lamp consuming about 500 watts at the lamp terminals when operating at 6.6 amperes shown by curve A in Fig. 2. The 6.6 ampere direct current series metallic flame lamp consuming about 450 watts at the lamp terminals gives 5 or 6 times as much light at the effective angle as did the series carbon arc consuming 500 watts and operating at the same current.

A comparison of the different systems in use for street lighting and the amount of energy consumed by each system is shown in Fig. 3. It will be observed that the metallic flame lamp operating from mercury arc rectifiers at 4 amperes consumes at the busbars, less than one-half the energy consumed by the 6.6 amperes carbon arc operated from series arc machines and that it gives about twice as much light at the effective angle. When operated at 6.6 amperes from mercury arc rectifiers about three-fourths as much energy is consumed at the bus bars and about five or six times as much light is obtained. The 6.6 ampere metallic flame lamps can be operated from existing arc generators which are wound for that current, but for 4 ampere operation the arc gnerators must be rewound. Such an arc generator outfit will, however, be from 20 to 25 degrees less efficient than the rectifier system and will require considerably more floor space and attention on the part of station attendants, in addition to having a higher operating and maintenance expense when all of the points incident to practical operation are considered.

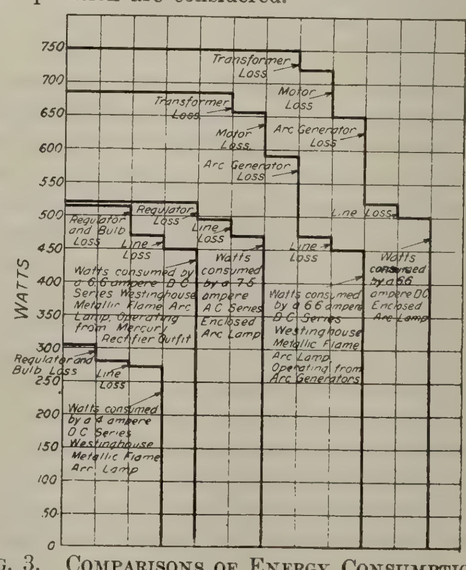


Fig. 3. Comparisons of Energy Consumption.

Daylight is the most natural light and it should be used as a basis of comparison for artificial illumination. It is with a white light approaching daylight in color that work can be done with the greatest satisfaction, comfort and with the least physical exertion. With artificial illumination in which the yellow or orange rays greatly preponderate eye fatigue is far gerater than with light approaching daylight in color.

SERIES TUNGSTEN LAMP SYSTEMS.

Probably the most marked improvement that has been made in the past few years in the effort to meet the demand for adequate street illumination has been the development of the series tungsten lamp. The introduction of the tungsten lamp has made available a highly efficient light source of correct color value for low intensities of illumination.

Fig. 4. Street Hood with Radial Type Reflector.

The high efficiency of the lamp permits the use of suitable shades and reflectors for deflecting the light rays from less to more desirable directions, and furthermore by the use of such screens and reflectors the intrinsic brilliancy of the light unit is so modified that the lamps may be conveniently and advantageously placed at heights sufficiently low to avoid interference with adjacent foilage, or in other words at the most efficient height from the street, without producing objectionable glare.

The long life of the series tungsten lamp, its white color and high efficiency in the smaller sizes combine to more nearly fulfill the requirements for street illumination. The lamps can be secured in a large list of sizes, and this eliminates the practice of using the same type and size of lighting unit throughout the entire city. The type of reflector and various auxiliary fixtures in most general use for this class of service are shown in Fig. 4. Between adjacent cross streets the lamps are spaced as close as local conditions will permit and at cross streets two or more units of the same size, or a larger unit with the same characteristic curve of light distribution are installed.

Series tungsten lamps are sometimes operated in series with arc circuits but more generally in a series circuit of tungsten lamps only. For the operation of series tungsten lamps two systems of distribution are employed, one is known as the, Adjuster Socket System and the other as the Regulator System. In the Adjuster Socket System, which was intended for operating a series of lamps on constant potential circuits, a small reactance coil is mounted in each street hood. This reactance coil is connected in shunt across the lamp terminal, and operates to maintain the continuity of the lamp circuit, and to maintain practically normal voltage on the remaining lamps of the series, in case one or more lamps burn out or become broken. As the lamps burn out or become broken, the reactance coils take their places in the circuit and the current variation will be very slight, as indicated by a curve. It will be observed from this curve that a large percentage of burnouts will tend to diminish the line current and will never result in injury to the remaining lamps.

Lamps of any candle power, but of the same ampere rating, are operated in series on the same circuit, and the operation is satisfactory, so long as the sum of the lamp voltages equals the voltage of the supply circuit. The system has a power factor of over 99 per cent. and an efficiency of about 95 per cent. It is adapted particularly where the number of lamps to be installed is quite small, on account of its low first cost of installation.

In the regulator system, series of lamps supplied have a constant current regulating transformer, which automatically controls the current of the lamp circuit. When a lamp burns out an insulating film cut-out device operates to maintain the continuity of the circuit. The regulators in most common use are of the repulsion coil type, having two moving coils suspended in such a way that they just balance each other when normal current passes through the secondary. Lamp current is maintained within 1 per cent. of normal for any load, and the system has a power factor of about 90 per cent. and an efficiency of 96 per cent. when operating at full load.

Series tungsten lamps have been found particularly desirable for both street and ornamental illumination in business sections, on account of rugged filiament and long life. It is very efficient, reasonable to maintain, and, when equipped with suitable shades and reflectors, has a low intrinsic brilliancy, and the units can be spaced sufficiently close to obtain excellent results in illumination. Each of the foregoing systems has its own peculiar merits, and may be selected for use according to local requirements.

Available Water Power in Canada.

According to official estimates made by the Department of the Interior, the available water powers of the Dominion of Canada are capable of developing energy representing more than 25,000,000 horsepower, which if produced from coal would represent a consumption of more than 562 millions of tons per annum, at the rate of 21.9 tons of coal to the horsepower. The Province of Quebec leads with an available water power of more than 17,000,000 horsepower, its present development of horsepower, however, being only 50,000; whereas, Ontario with a water power of not much in excess of 3,000,000 has a present development of more than 330,000 horsepower. At Chambly, 12 miles north of St. John's on the Richelieu River, just below the last of the series of rapids between the two places, is located a plant with a capacity of 22,000 horsepower, which furnishes power to St. John's and other towns in this section of the Province.

Census Data on Electrical Machinery and Apparatus.

A preliminary statement showing the general results of the thirteenth census of establishments engaged in 1909 in the manufacture of electrical machinery and apparatus has been issued by the Bureau of the census, an abstract of which follows: The report presents a comparative summary of the statistics of the industry for the censuses of 1909, 1904, and 1899, and shows the number and value of the different kinds of electrical equipment manufactured during each census year. The reports were taken for the calendar year ending December 31, 1909, wherever the system of bookkeeping permitted figures for that period to be secured, but in some instances where the business year of an establishment differed from the calendar year, they relate to the business year falling most largely within 1909.

The value of the machinery and apparatus manufactured for use in the generation and utilization of electricity increased from $105,832,000 in 1899 to $159,551,000 in 1904, and $243,967,000 in 1909, or 130 per cent during the decade. The value of products represents their selling value or price at the plants as actually turned out by the factories during the census year, and does not necessarily have any relation to the amount of sales for that year.

DYNAMOS.

Dynamos, dynamotors, motor generators, and similiar machines constitute the most important generic group of electrical machinery. The number of dynamos manufactured annually increased from 10,527 in 1899 to 15,080 in 1904, and 16,791 in 1909, an increase of 59 per cent for the decade. The value of the dynamos for each year was $10,473,000, $11,084,000, and $13,081, 000, respectively. As a rule much larger and more powerful dynamos were manufactured in 1909 than for the prior years, so that while the average value of machines manufactured was greater in 1909, they represented a lower cost for corresponding capacity. The average capacity per machine increased from 55 kilowatts in 1899 to 66 in 1904, and 84 in 1909. The value of the dynamotors, motor generators, boosters, rotary converters, and double current generators manufactured increased from $380,000 in 1899 to $3,155,000 in 1909, or 730 per cent.

TRANSFORMERS AND SWITCHBOARDS.

The value of transformers manufactured increased from $2,963,000 in 1899 to $4,469,000 in 1904, or 51 per cent, and to $8,801,000 in 1909, or 197 per cent. The value of the switchboards, panel boards, cut-out cabinets for light and power increased from $1,847,000 in 1899 to $3,766,000 in 1904, or 104 per cent, and to $5,972,000 in 1909, or 223 per cent.

MOTORS.

The total value of motors of all kinds, including supplies and parts, manufactured increased from $19,505,000 in 1899 to $22,371,000 in 1904, and $32,087,000 in 1909, or 64 per cent for the decade. The number of power motors manufactured annually increased from 35,604, valued at $7,551,000, in1899 to 79,877, valued at $13,121,000, in 1904, and to 244,123, valued at $18,306,000 in 1909, there being an increase of 586 per cent in number and 142 per cent in value for the decade. Many powerful motors were manufactured, but the number of small motors has increased so rapidly that the average capacity per machine has declined, the average horsepower per motor for the three census years being 14.5, 8.5 and 6.7, respectively.

The number of small motors for the operation of fans has increased very rapidly. There were 97,577 such motors reported in 1899. In 1904 there were 102,535, and in 1909, 199,113, an increase of 104 per cent for the decade. The value of these motors increased from $1,055,000 in 1899 to $2,451,000 in 1909, or 132 per cent.

STORAGE AND PRIMARY BATTERIES.

The value of the storage and primary batteries manufactured increased from $3,679,000 in 1899 to $4,244,000 in 1904 and $10,612,000 in 1909, or 188 per cent during the decade. Both storage and primary batteries consist of various elements which are not always combined and sold together as a unit by the same manufacturers, and yet it is not until these are brought together that a complete cell is consitituted. Many of the parts and supplies used are manufactured outside of the electrical field, and therefore the statistics shown in this report do not convey a correct idea of the importance of this branch of the industry.

ARC AND INCANDESCENT LAMPS.

The number of arc lamps manufactured increased from 158,187 in 1899 to 195,157 in 1904, and decreased to 123,543 in 1909. The decrease is accounted for by the fact that other varieties of lamps are now used for street light and for other purposes for which arc lamps were formerly used almost exclusively. The value of these lamps decreased slightly in 1904 ($1,574,000) as compared with 1899 ($1,828,000), but, owing to the introduction of more costly types of these lamps, such as flaming arcs, increased to $1,707,000 in 1909.

The group of incandescent lamps includes carbon filament, gem, tantalum, tungsten, glower vacuum, vapor and similar lamps used for lighting, advertising and decorative purposes. Some of these varieties were not manufactured in 1899 or 1904. A large number of decorative and miniature lamps, X-ray bulbs, vacuum tubes, etc., are now manufactured, but the varieties are so numerous that it is impossible to obtain accurate statistics of the number. The total value of the group increased from $3,515,000 in 1899 to $6,953,000 in 1904 and $15,715,000 in 1909. The value of the carbon filament lamps increased rapidly from 1899 to 1904, but there was a slight decrease in 1909, the value for the respective years being $3,442,000, $6,308,000, and $6,157,000. The manufacture of gem, tantalum, tungsten, and other metal filament lamps was reported separately for the first time at the census of 1909, when they were valued at $7,682,000. Some of these new varieties of lamps were not reported separately at prior censuses, and it is possible that they were included with the carbon filament lamps, thus accounting in part for the apparent decrease in that variety of lamp. Advertising, decorative, and all other lamps, including in 1909 glower lamps, vacuum and vapor lamps not separately reported in 1904, have increased in value from $645,000 in 1904 to $1,876,000 in 1909.

The total value of all lamps reported for 1909 was $15,715,000. This does not include sockets, receptacles, bases, etc., or lighting fixtures of any character.

LIGHTING FIXTURES.

The value of electric-light fixtures of all kinds manufactured in 1899 was $3,751,000; in 1904, $3,295,000; and in 1909, $6,128,000. Large quantities of combination gas and electric fixtures are now manufactured. At the census of 1909 it was ascertained that the value of these combination fixtures was about $12,884,000. Their value for prior censuses can not be ascertained, and there were undoubtedly large quantities manufactured in connection with the manufacture of gas fixtures which are not identified with the manufacture of electrical supplies, and their value is not included in this report.

TELEGRAPH AND TELEPHONE INSTRUMENTS.

The telegraph instruments include intelligence (key, sounder, etc.) of all kinds, police, fire, district, and miscellaneous instruments, wireless apparatus, also switchboards and telegraph parts and supplies. The total of this group of instruments in 1899 amounted to $1,642,000, in 1904 to $1,111,000, and in 1909, $1,957,000, an increase of 19 per cent in the decade.

Telephone apparatus includes transmitters, receivers, complete sets of instruments (not included in the separate parts), interior telephone systems complete, and central switchboards, private exchange boards, parts and supplies. The total value of this group in 1899 was $10,512,000 as compared with $15,864,000 in 1904, and $15,547,000 in 1909, a slight decrease during the last five-year period.

The report also shows the value of the total annual output of miscellaneous apparatus used in connection with the utilization of electric current. Principal among these may be mentioned electric measuring instruments, the output for which in 1909 was $7,800,000; magneto-ignition apparatus, sparks, coils, etc., valued at $6,080,000 electric switches, signals and attachments, $5,384,000; heating, cooking and welding apparatus, $1,003,000; lightning arresters, fuses, etc., valued at $1,942,000; therapeutic apparatus, $1,116,000; circuit fittings, $1,081,000; and electric flatirons, $951,000.

Southern N. E. L. A. News.

Georgia N. E. L. A. Convention.

The tentative program for the first convention of the Georgia section of the N. E. L. A., published in the September issue of SOUTHERN ELECTRICIAN remains practically unchanged. The convention at the time this issue leaves the press is in session at Columbus, Ga. The details of the two days' work as given in the following outline will appear in the next issue.

TUESDAY, September 26. At 11 o'clock the convention will be called to order and the address of welcome delivered by Mayor Rhodes Browne, of Columbus. The address by the president will then follow, together with reports by the committees on membership and finance and a paper entitled "Advantages of Co-Operative Effort by Central Stations With Insurance Inspections," by A. M. Schoen, chief engineer, Southeastern Underwriters' Association, of Atlanta.

The Tuesday afternoon session will be called at 2:30 o'clock, and the following papers presented. "Low Pressure Turbines," by E. H. Ginn; and "Supply of Electric Energy to Textile Mills," by G. K. Hutchins. During Tuesday evening from 8:30 to 10:30 o'clock an informal reception will be held at the Muscogee Club. There will also be an executive committee meeting during the evening.

WEDNESDAY. At the morning session the following papers will be presented: "Ice Making as Associated with Central Stations," by Burdett Loomis, Jr.; and "Electric Heating Utensils," by L. L. Warfield. Following the reading of these papers and the discussion, the members will go into executive session, considering reports of the various committees, including that of the nominating committee, after which the election of officers for 1911-12 will take place. After adjournment from executive session at 12:30, a special train will take all delegates and guests to Goat Rock to see the construction going on at the new dam.

Special preparations have been made for a Rejuvenation of the Sons of Jove at Columbus during the convention, by Mr. L. S. Montgomery, statesman for Georgia. This will be an excellent time to take advantage of the opportunity to become a Jovian. In the way of an explanation of this statement, we quote the following in abstract from a neat miniature Jovian Bulletin originated and published by Mr. Montgomery, which he chooses to call "The Columbus Booster." The following statements are to the point and suggestive of the proper spirit in which to accept the Jovian pledge and persue the good work after becoming a member.

"Some Georgia Central Station men seem to think that the Sons of Jove is an order more for the contracting and jobbing branches of the trade than for them, they are mistaken. President John Foster Gilchrist, of the N. E. L. A. is a Jovian and the following Past-Presidents of the N. E. L. A. are active Jovians: Charles R. Hundley, No. 486, Buffalo; Henry L. Doherty, No. 3208, New York; Arthur Williams, No. 1917, New York; W. C. L. Eglin, No. 3687, Philadelphia; Frank W. Frueaff, No. 1696, Denver, and W. W. Freeman, No. 1899, Brooklyn.

"At a recent rejuvenation in Atlanta forty-five electrical men were initiated into the order, among them being some of the most influential executives in the South. That Jovianism is helpful to any man, no matter what branch of the trade he specializes in, the diverse duties of the candidates at the Atlanta rejuvenation is positive proof. We are spending our lives in the electrical trade, let's get into the game and get the most out of it together.

"Outside of the social features of the order there is a practical trade advantage in knowing your associates and competitors, and if you join the Sons of Jove, you align yourself with men who are in the electrical business to make a good profit out of it, and who will individually be seriously interested in anything you may propose that will help better your branch of the electrical industry.

"The executives of the Georgia Section of the N. E. L. A. have endorsed the idea of having a rejuvenation at Columbus during the convention and arrangements are being made for this purpose. We are particularly anxious to have you take advantage of this opportunity to become a Jovian. You will find congenial company in the Sons of Jove. The order comprises men in your line of busineess, men who have the same problems to solve, the same obstacles to overcome, who live under conditions similar to yours. The idea of the order is not the "up-lift" kind—it's simply a good fellowship organization from which we get just exactly what we put into it, no more and no less."

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.

CAN GROUND WIRES FROM LIGHTNING ARRESTORS AND SWITCHBOARD BE CONNECTED TO SAME GROUND ROD?

Editor Southern Electrician:

(247) As a reader of SOUTHERN ELECTRICIAN, I desire information on the following questions: In our plant we have a ground wire from the electrolytic arresters running through the end of the building and insulated from same, out to ground. Outside the building we have a wire tapped from the ground lead to the switch board frame. Suppose a discharge came over the arresters to ground, would the lead connecting from the ground wire and switch board be charged at that instant or not? The frame work of the switch board is grounded to the building as well as the ground lead mentioned.

W. R. K.

INDUCTANCE OF CHOKE COILS.

Editor Southern Electrician:

(248) I would like to know the method to compute the inductance of a set of choke coils about 6 feet long by 16 inches in diameter, made up of 154 turns of No. 0 hard drawn copper wire, each turn spaced one-half inch apart. The capacity is 100 amperes, 10,000 volts and 60 cycles. The power factor of our system at present is 0.82 with 35 amperes normal current. How would this extra set of choke coils effect the power factor?

What is the highest voltage that can be impressed with safe working conditions on a transmission line with 36-inch centers between wires, circuit 3-phase? R. K. W.

SELF-STARTING SYNCHRONOUS MOTORS.

Editor Southern Electrician:

(249) I would like to see an explanation through these columns as to how polyphase synchronous motors are now made self-starting from the A. C. side. Kindly describe their action. A. L. C.

POWER-FACTOR AND PLANT CAPACITY.

Editor Southern Electrician:

(250) Quite often I have heard of central stations making contracts agreeing to maintain a certain voltage and frequency providing the customer guarantee his power factor to be high, not lower than 90 per cent. Suppose a hydroelectric company has a contract with a customer for 3000 horsepower, transmitting at 22,000 volts over 18 miles and then stepping down to 550 volts. What reasons will determine the demand that the power factor of the customer's plant be 90 percent to fulfill a contract as above stated?

H. A. S.

ROTARY CONVERTER OPERATION.

Editor Southern Electrician:

(251) I would like to know if a 50-kw. rotary converter can be operated as a double current generator and one half its rated capacity be supplied from each side without injury to the machine. What may be the overload capacity of the machine when operated in this way? Why are the readings of powerfactor meters affected when a rotary is cut off the A. C. bus-bars? C. T. W.

SIZE OF WIRE FOR ELECTRIC STOVES.

Editor Southern Electrician:

(252) Kindly publish information as to how to compute the size of iron, German silver, and Driver Harris wire necessary for an electric heater stove, 12 inches in diameter. Temperature to be raised from 40 degrees F. to 300 degrees F. in 15 minutes. Also the same data for a radiator of an average watthour consumption of 1,500 for a period of 30 minutes. The supply circuit to be 120 volts.

W. R.

Starting Induction Motors, Ans. to Ques. No. 226.

Editor Southern Electrician:

The standard practice today for starting motors of the capacity mentioned in Question 226 of the July issue is to have an electrically or solenoid controlled starter. Of course the manner of starting varies with the two different types of motors, the squirrel cage and the slip-ring. The starter for the small installations, where the motor is of the squirrel cage type, to be started under light load and thrown across the line without the intervention of a starting resistance, usually consists of a single solenoid. For single-phase systems, both sides of the line to the motor are controlled. For two-phase systems the circuit to the motor is controlled by a single-pole switch. For three-phase systems, the circuit from two of the three-phase wires to the motor is controlled, the other phase wire being connected directly to the motor.

When the starter is to be used on a single-phase circuit, it is necessary that the motor be of the self-starting type and develop the necessary starting torque. Standard two and three-phase squirrel cage types of motors are in general suitable for operation under these conditions.

For motors of the squirrel cage type where the starting torque necessary is considerably less than the normal full load torque of the motor and where the motor will accelerate promptly with a voltage at the motor not exceeding 50 per cent. of the line voltage, auto-transformers are used to reduce the voltage at the motor terminals for starting. Two auto-transformers are used for either two-phase or three-phase motors mounted in a common case and provided with proper terminals. For motors up to 50 horsepower there is one starting voltage, but for larger sizes there are two starting voltages. Extra taps are brought out from the transformers so that there is one adjustment of each starting voltage.

When the conditions require that the motor should start with full or partial load torque, the squirrel cage type of motor is entirely unsuited and a slip ring type should be used. Starters for two or three-phase motors of this type enable the motor to be started quickly with partial or full load, and are especially suited for conditions that require a starting current to be kept as small as possible and the line disturbance be reduced to a minimum. The starters are rated with the understanding that the motor is to be brought to speed under load conditions, and that the starting current will not be more than 150 per cent. of the normal full load current. The normal full load current in the secondary of the motor should not exceed 100 amperes per leg for 7.5 to 25 horsepower and 250 amperes per leg for 25 to 150 horsepower. These controllers or starters consist of a multiplicity of solenoid switches and relays mounted together on a slate board with a resistance. The motor is started and stopped by a switch in the primary circuit, which is double-pole for the smaller sizes. For the larger sizes, either two or three-phases, the motor is entirely disconnected from the circuit in the off position.

The acceleration of the motor is controlled by resistance in each of the three phases of the rotor circuit, which is cut out of the circuit, step by step, by two-pole, solenoid switches under control of the current relays in the secondary circuit. The starting switches are interconnected with each other and with the primary switch, so that they will close successively to accelerate the motor after the primary is closed. The rate of acceleration is controlled by three-phase current relays in the rotor circuit. Each is arranged so as to prevent the following step of resistance from being cut out of circuit when it is lifted by the starting current, but which will drop again after the motor has speeded up properly and will then permit the next step of resistance to be cut out. The starting current is limited to a predetermined and adjustable value by the current relays and the motor is brought to speed in the shortest time consistent with this starting current. G. I. Morgan.

Operation of Meters, Ans. to Ques. No. 232

Editor Southern Electrician:

In reply to question 232 in the July issue, the following is offered: To measure the frequency of a circuit or alternator, a small synchronous motor may be used, the principle of which is illustrated in Fig. 1. The motor field is supplied with current and the rotor rotates inductively, but in synchronism. To determine the speed, a speed counter or speed indicator is applied to the rotor axle. The frequency f = n p × Rs/2 where f = frequency in cycles per second; n p = number of poles and Rs the revolutions per second. The motor has to be revolving in synchronium with the circuit.

In the Westinghouse frequency meter, two voltmeter movements are employed so assembled that they tend to rotate the pointer in opposite directions. In one voltmeter circuit there is connected in series a non-inductive resistance, while an inductance is inserted in series with the other voltmeter circuit. The apparent resistance of the inductance circuit will vary with the frequency, which causes a variation of current taken by each circuit. Each different frequency will therefore cause the indicating needle to take

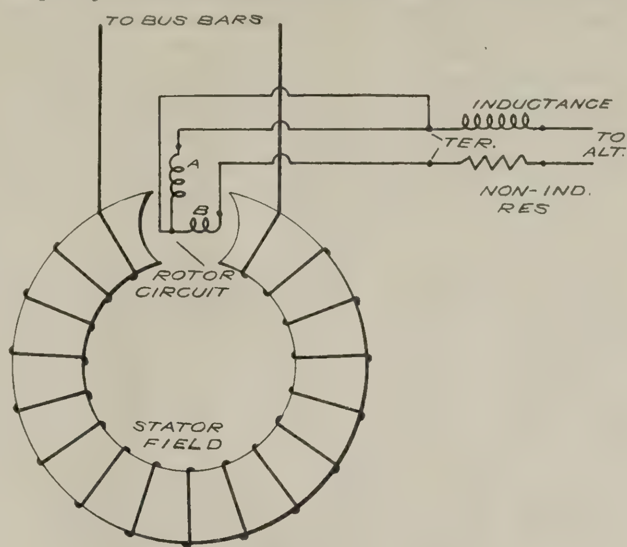


Fig. 3. Diagram of Oscillograph.

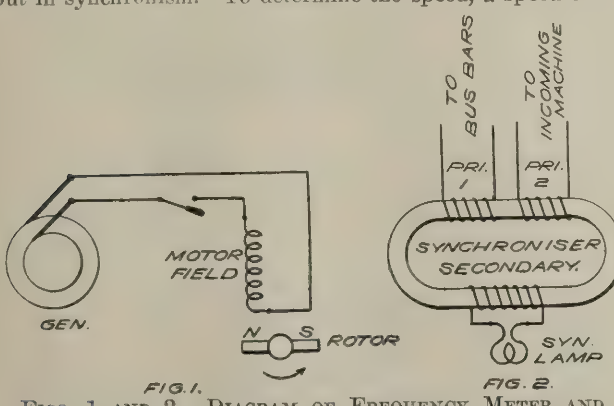
up a definite position, and for each position there is a graduated scale showing the frequency for any position of the pointer. A description of the Weston frequency meter is given on page 43 of July issue.

SYNCHRONISER.

A synchroniser provides a means of indicating when an incoming alternator or machinery is in synchronium and ready to be paralleled with an alternating current circuit. In its simplest form the synchroniser consists of a small transformer, which may be wound with two primaries and a common secondary as shown in Fig. 2.

The principle of action depends upon the mutual induction between the primary and secondary windings. Primary No. 1 is connected to the busbars of the alternating current circuit and primary terminals No. 2 to the incoming alternator to be synchronised. The secondary terminals are connected to a synchronising lamp. When the two circuits are in phase, the currents flowing through the synchroniser primaries act in harmony, and reacting upon the secondary circuit common to both primaries, cause the lamp to burn brightly without flickering, thus indicating the condition of synchronism. Along similar lines voltmeters may be used instead of lamps as indicators, and the combined indication of both lamps and voltmeters are much used.

In large stations a synchroscope is frequently used. An ingenious one possessing meritorious features being the "Lincoln synchroniser." This instrument is a small single-phase induction motor, the stator field of which is excited from the station bus bars and the rotor circuit supplied



Figs. 1 and 2. Diagram of Frequency Meter and Synchroniser.

with split-phase currents from the alternator to be paralleled or synchronised. To the rotor shaft is attached an indicating pointer which moves over a dial. When in the zero vertical position, it indicates the synchronous condition. A revolving field is produced in the motor and when the frequency of the circuits are the same and also in phase, the needle does not revolve but assumes a vertical position.

The principle of connections is shown in Fig. 3. The stator field circuit is connected to terminals that connect to the busbars and the rotor circuit windings, the coils of which are wound upon a laminated iron core and distributed 90 degrees apart, are connected to terminals as shown. One of these is connected through an inductance to one alternator lead, and the other through a non-inductive resistance to the other wire from the alternator. One winding of the rotor circuit is represented by coil A and the other by coil B. The whole is conveniently and practically assembled, so as to give the required electrical and mechanical condition for a practical working instrument. The diagram illustrates only the principle of electrical connections and not as practical assembled.

OSCILLOGRAPH.

The oscillograph of the Blondel type, is in principal a a mirror galvanometer. The current to be investigated flows through two small coils of wire and close to these coils is a very thin strip of iron freely suspended in a very strong magnetic field resulting in a polarized magnet. This strip of iron carries a small mirror and reflects a beam of light on a convenient scale device. With every variation of current in the coils, there is a resultant action upon the sensitive polarized magnet and the movement being one of very short period, it responds to these current variations, the beam of light reflected from the mirror being magnified in its movement upon a scale.

POWER FACTOR INDICATOR.

Fig. 4 shows the principle of connections of a Westinghouse two-phase power factor indicator. The currents in

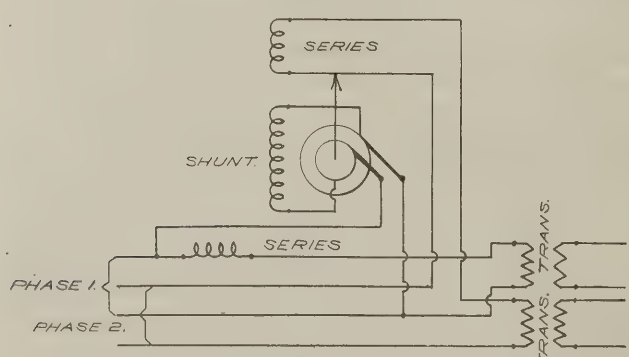


FIG. 4. DIAGRAM OF POWER FACTOR INDICATOR.

the series coils produce a rotating magnetic field, due to their axis being at an angular displacement and one coil in each phase. The current in the shunt coil which is free to move, produces an oscillating field, due to the alternating current reversals. The shunt coil is of fine wire and is the emf coil, while the series coils are the current coils. The shunt coil will take up a position in which its oscillating field will be in time phase with the resultant rotating field in that plane. The series circuits are equipped with series transformers so as to reduce the current to three to five amperes.

W. R. BOWKER.

Single-Phase Induction Motor, Ans. to Ques. No. 233.

Editor Southern Electrician:

In answer to question 233 on single-phase induction motors, I offer the following: A single-phase induction motor, when the armature or rotor is not revolving has no starting torque or turning effort. After the armature starts rotating, this rotation changes the magnetic field so that there is a continuous turning effort. While the motor can be started by giving the armature a start, the most common method of starting the single-phase induction motor is by the split-phase method. In this method the circuit supplying the motor is divided, one division crossing one winding of the motor and the other branch the second winding. These windings are called the starting

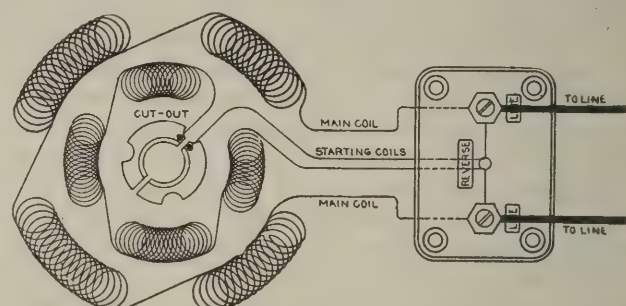


FIG. 1. STARTING ARRANGEMENTS FOR EMERSON SINGLE-PHASE MOTOR.

and running windings, the starting winding being placed at practically ninety (90°) electrical degrees with the running winding. This latter winding consists of a greater number of turns of larger wire, well distributed over the stator, while the starting winding consists of fewer turns and of smaller wire. The running winding remaining in the circuit at all times of motor operation, while the starting one only remains in circuit until the motor has reached synchronous speed or nearly so.

These windings are thrown on the circuit in parallel usually, although the Brown, Boveri & Co., of Baden, Switzerland, place the starting and running windings in series for small motors up to five horsepower. This arrangement causes the entire circuit to be broken when the starting winding is cut out, which gives a flash or arc. This arrangement is shown in Fig. 2. The same company uses the parallel arrangement for motors above five horsepower. In this arrangement only the starting winding circuit is broken when synchronous speed is obtained. Fig. 3 shows Brown, Boveri & Co. parallel connections for motors of over five horsepower. Fig. 1 shows the arrange-

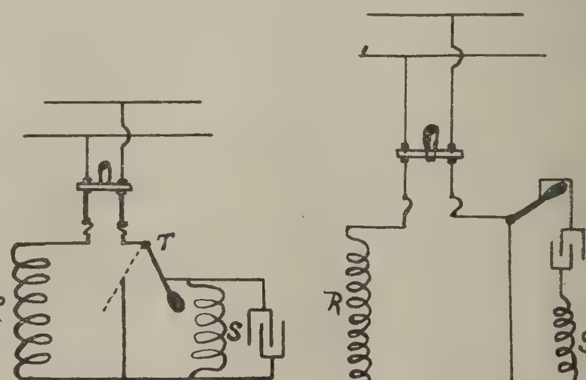


FIG. 2. STARTING WITH COILS IN SERIES AND IN PARALLEL.

ment used by the Emerson Electric Mfg. Co., of St. Louis, Mo., with ninety (90°) winding relations. This ninety (90°) degree relation gives a single-phase motor almost the two-phase motor starting effort.

The cut-out shown in Fig. 1 is an automatic device for cutting out the starting winding when synchronous speed is reached. Fig. 4 shows the General Electric condenser compensator method of starting single-phase induction motors. Patents are issued to Dr. C. P. Steinmetz, U. S. Patent Nos. 602,920 and 602,921, April 26, 1898. Two terminals of this stator winding which is of the standard three-phase construction, are connected to the supply mains.

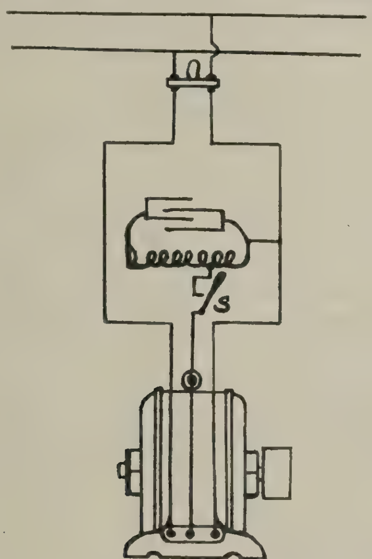


FIG. 4. CONDENSER COMPENSATOR METHOD FOR STARTING.

The third terminal of the stator winding which is of the standard three-phase construction, are connected to the supply mains. The third terminal of the stator winding is connected to the supply mains through an auto-transformer connection depending upon rotation desired, and a condenser is also connected across the transformer for capacity. Then when the motor has reached synchronous speed the starting winding may be cut out by opening switch S and the motor operates upon running winding only. It may be advantageous to keep the starting winding in circuit if wound of sufficient carrying capacity for the load as it increases the power factor at light loads and compensates for transformer losses.

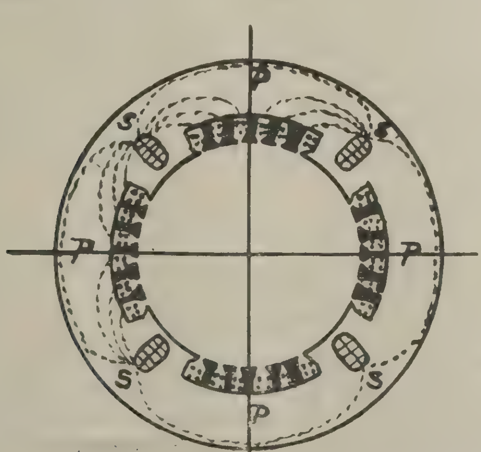


FIG. 5. AUXILIARY STARTING COILS FOR HEYLAND SINGLE-PHASE MOTOR.

In Fig. 5 we have a motor which is single-phase self-starting without any phase-splitting apparatus being used. This is known as Heyland's self-starting single-phase induction motor. In this motor the main windings P are distributed in semi-closed slots. The starting winding S is composed of coils of a high self-inductance and short-circuited upon themselves. The coils are placed in closed ducts as shown. The circuit formed by the coils has a high inductance which acts as a secondary of a transformer. The current induced in this secondary winding will lag about 90 per cent. behind the main current in the primary or main winding P. This action will produce a field component similar to a two-phase current. The starting torque of this arrangement is large but the power factor is low. Therefore the starting winding should be cut out as soon as the motor reaches synchronous speed. All motor windings for rotors are of squirrel cage or slip ring types. To change the speed of induction motors you may change the number of field poles, for frequency / poles = R.P.M. or for a four-pole, 60-cycle motor, and speed 1,800 R. P. M. 7,200/4 poles = 1,800 R. P. M., not allowing for per cent. slip. For a 6 pole it = 1,200 R. P. M. In practice the poles are often paralleled and the voltage divided. Therefore almost any speed may be obtained from the proper winding if the number of poles is correct and the wire in coils per pole of the proper size, so there will be no undue heating and inductive effects. This does not include repulsion types.

ARTHUR L. GEAR.

Operating Features of Potential Regulators, Ans. to Ques. No. 234.

Editor Southern Electrician:

In answer to question No. 234 in the August number of the SOUTHERN ELECTRICIAN I respectfully submit the following: The induction regulator is similar in its action and conforms in general to the same laws that govern variable ratio transformers. An induction regulator is shown in its elements in Fig. 1. The winding cut in across the circuit, is the primary or shunt winding. It acts as an exciting coil and is wound for the full transmission voltage. The secondary or series winding is connected in series with the line and is wound for the full load current.

In practice it has been found necessary to construct a short circuited winding placed at right angles to the primary winding to prevent the secondary from building up its own magnetic field by self-induction and acting as a choke coil in the circuit when the regulator is in its neutral position. It must be borne in mind that with the regulator in its neutral position, that is when the primary and secondary coils are at right angles, the primary has no effect

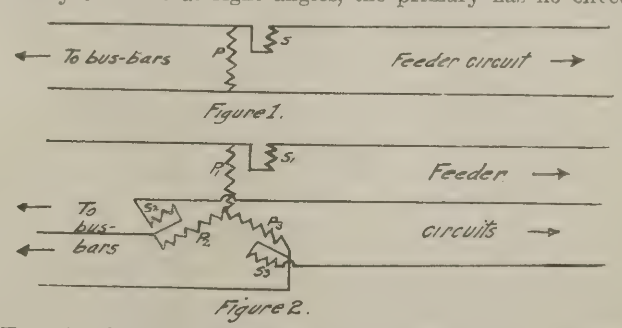


FIG. 1. SINGLE-PHASE INDUCTION REGULATOR DIAGRAM AND FIG. 2 THAT FOR THE POLYPHASE TYPE.

on the secondary and that if the short-circuited coil was omitted, the action of the regulator at this point would be analogous to that of a series transformer with its secondary on open circuit.

The action of a regulator is as follows: The voltage on the feeder circuit is varied by changing the position of the primary or exciting coil, thereby causing the magnetic flux passing through the secondary coil to vary, which in turn causes a variation in the secondary voltage. Of course the magnitude of such a change depends upon the strength and path of the flux. When the coils are in their neutral position, the feeder voltage is practically at the same value as the bus-bar voltage. When the position of the primary, however, is revolved in one direction, the feeder voltage is raised, due to the increased voltage induced in the secondary or series winding, while on the other hand if the position of the primary is changed in the opposite direction, the feeder voltage is lowered by the increased induced voltage of the secondary.

In the polyphase type of induction regulator there are as many sets of coils in both primary and secondary windings as there are phases in the circuit. One set of these polyphase windings, the primary set, is connected across the polyphase bus-bars. From this it is apparent that a rotating magnetism is produced that is in synchronism with the system to which the apparatus is connected. This magnetic field affects the secondary windings and the desired voltage regulation is obtained on the feeders.

One set of the windings is on a shaft or spindle, called the rotor or moving element, and is made so that it can be turned through an angle of 60 or 90 degrees by means of a hand wheel, or in the motor operated regulator by means of a small motor connected by means of gears to the shaft. When this rotor is in a position where the electromotive forces of both windings are in phase, the feeder voltage is raised to its highest point, but as the rotor is turned to a point where the phase relations are in exact opposition, the boosting effect of the regulator will pass through zero to its greatest negative value.

Regulators are generally designed for a 20 per cent. range, 10 per cent. above bus-bar voltage and 10 per cent. below. They are built for any capacity and frequency met with in practice. Fig. 2 shows the connections of a polyphase regulator.

A. H. Mitchell.

Delta vs. Y Connections. Ans. to Ques. No. 236.

Editor Southern Electrician:

Either the delta or Y connection is perfectly satisfactory for this purpose. The advantage of the Y or star connection is that it provides a neutral point for grounding the secondaries which is always advisable where possible. Fig. 1 shows connections for this with the values of the voltage and current for a load of 10 H. P., assuming 85 per cent. efficiency. Fig. 2 shows the same delta connected. The current per wire in three-phase, delta connected circuits, is equal to the watts divided by the voltage between wires divided by $\sqrt{3}$, ($C = W/V \cdot \sqrt{3}$). Therefore the statement of the questioner is correct. When connected in Y, each transformer will have more current and less voltage than if connected in delta in the proportion of (1) to $\sqrt{3}$

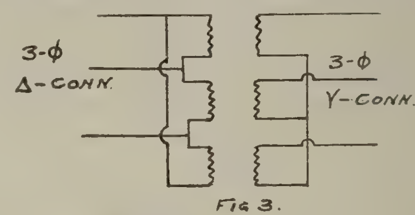
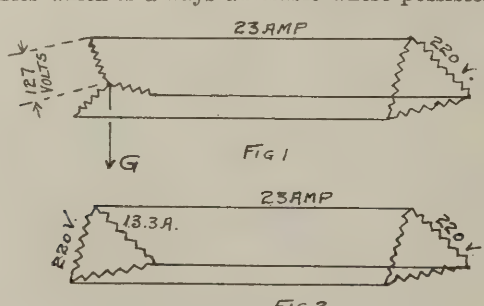


Fig. 3. Connections for Primary Delta and Secondary Star.

but since the transformer loss is about equally divided between iron loss and copper loss, it will make very little difference in the operation. Of course, it would be possible, if the voltage ratio were suitable to connect the primary coils of the transformer in delta and the secondary coils in star, as shown in Figure 3.



Figs. 1 and 2. Delta vs. Y Connections.

Lighting Circuits, Ans. Ques. No. 237.

In Fig. 4 is shown connections for house wiring circuit in which is included a pair of hall lights, one at the top and one at the bottom of a hall-way controlled by three-way switches so that either light may be turned off or on, either at the top or bottom of the stairway. This is a very common house wiring arrangement. The application of this principle is not limited to two points of control, but as shown in Fig. 5, a light A may be independently controlled from any number of points by using two three-way switches at B and C and any number of four-way or reversing switches such as at D and E.

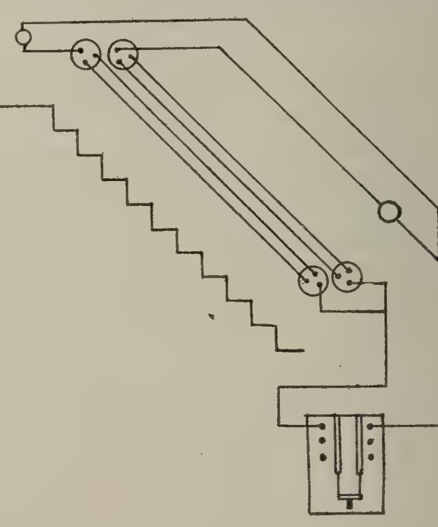


Fig. 4. Control of Lighting Circuit.

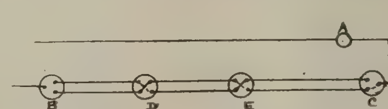


Fig. 5. Independent Control of Lamps.

A. G. Rakestraw.

Testing Auto Truck Engines, Ans. to Ques. No. 238.

Editor Southern Electrician:

Allow me to submit the following as a reply to question No. 238 by C. F. B.: In connection with this problem I should advise C. F. B. to belt his engine to the dynamo which he has available and load the latter through the medium of a water rheostat, unless extremely accurate results are desired. In case a test of more than commercial accuracy is desired, it would be advisable to apply the load by means of an absorption dynamometer of some form. It may likewise be remarked that the latter method of loading is one in general use in commercial, as well as laboratory testing departments. But for a test of but ordinary accuracy on only one or two units, it will be found much easier and less expensive to load same in the first mentioned manner. To load through the medium of the dynamo, the engine should be provided with a pulley and belted to the dynamo with such pulley ratio as to drive the latter at about its normal speed. While a lamp bank can be used for loading purposes, it will be found much simpler and less expensive to load with a water box.

A general rule for proportioning water boxes for continuous service is to allow about 500 cubic inches volume per horsepower of energy dissipated. Another rule is to allow one-half cubic inch per watt of energy absorbed. The terminal plates or electrodes may be of sheet iron with the current density not exceeding one ampere per square inch.

Applying the above data toward determining the size of water box required, we arrive at the following, assuming 40 H.P. as the power to be delivered from the engine shaft:

H.P. at engine shaft.............................. 40.0
H.P. delivered to water box by dynamo, assuming 85 per cent. efficiency over dynamo and belt drive $= (0.85 \times 40)$.............................. 34.0
Kilowatts delivered by dynamo, $34 \times .746$.......... 25.5
Amperes output at dynamo with 220 volts, $(25.5 \times 1{,}000)/220$ 116.0
Volume of liquid required, 500×34........14,000 cu. in.
or at 2 watts per cubic inch—25,500/2.......12,750 cu. in.
Area of terminal plates not less than 116 inches each.

The writer has often used an ordinary barrel or hogshead for temporary work of the above nature. In case a large enough barrel is not available two or more may be used, connecting same in multiple across the circuit. Insufficient liquid volume will of course be evidenced by undue heating and decomposition of the water. It will probably be necessary to add a small amount of salt or sulphuric acid to the water in order to increase its conductivity a sufficient amount to permit putting full load on the system. This should be done after the circuit is established and current flowing under normal voltage, and with the top electrode a few inches under water, say to about one-fourth the total depth of liquid. The amount of chemical to add can be determined by watching the ammeter while it is being added. Care must be taken during the test not to short circuit the electrodes in making load adjustments. The conductor leading to the bottom electrode must likewise be rubber covered or otherwise waterproofed. A sketch of the electrical connections necessary in making the test is shown in Fig. 1.

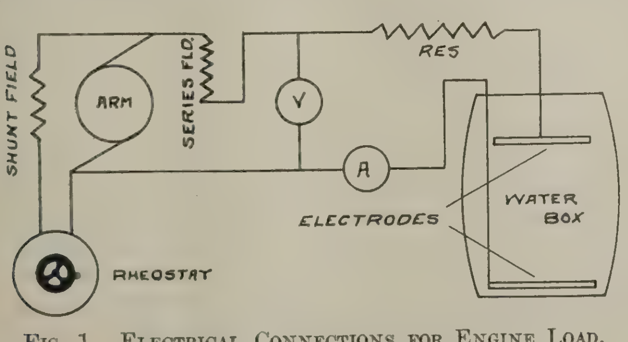


Fig. 1. Electrical Connections for Engine Load.

As already mentioned, if more accurate results are desired an absorption dynamometer should be used. Of the various types, the prony or band brake is probably best adapted to the purpose. This brake is shown in Fig. 2. Not knowing the speed at which the engine will run, no fixed size and width of pulley can be given, although one about 12 x 12 inches will probably give satisfactory results.

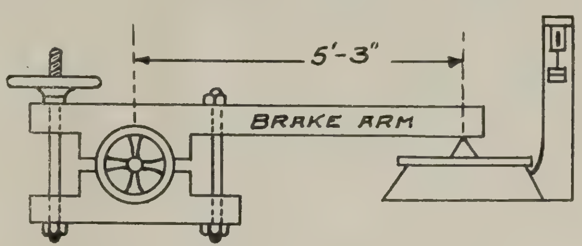


Fig. 2. Diagram of Prony Brake.

This should be provided with inner flanges so as to form an annular trough for the retention of water to keep it cool during service, at which time a small stream of water should be arranged to constantly discharge into the pulley, the overflow being removed by means of a waste pipe so inclined as to scoop up the water from the pulley.

The rubbing surfaces should be made from pine, poplar, or other soft wood, and well lubricated with some sort of heavy grease. The load is adjusted to the desired value by means of the hand wheel on the brake and the resultant torque weighed on the scale. It is of course necessary to deduct the dead weight of the brake beam from the total weight noted above, in arriving at the net, or unbalanced load on the scale. This dead weight is best obtained by first rotating the dynamo a partial revolution by hand with the brake slacked off loose and then weighing the beam. Then rotate it slightly in the opposite direction, stop, and again weigh the brake beam. An average of these two weights will be taken as the dead weight, as desired above.

With any given adjustment of the torque the horsepower at the engine shaft (B. H. P.) may be calculated by the formula, $\text{B. H. P.} = (2\pi \text{LNP})/33{,}000$. Where L is the length in feet of brake beam, from center of engine shaft to point of contact on scale, N is the engine rev. per min. (r.p.m.), and P the unbalanced pressure as weighed on the scale. Transposing the above formula we get the formula to be employed in determining the unbalanced pressure on the scale for a given output: $P = (33{,}000 \times \text{B. H. P.})/2\pi \text{LN}$.

It is obvious that if the beam length L be made equal to $33/2\pi$ feet, the above formula will reduce to $\text{B. H. P.} = \text{PN}/1{,}000$, and $P = (1{,}000 \times \text{B. H. P.})/N$. Hence it will be desirable to make the brake beam $33/2\pi$ feet (5 feet 3 inches) long.

In conducting the test, the engine should be in good order and everything running smoothly before applying the load. Then such load as may be desired may be added, after which it is well to run the engine for a few minutes before starting the test readings and observations, in order to insure that everything is in readiness for the time run. When ready to start the trial, measure the gasoline supply in tank, and take simultaneous readings of the current and voltage on meters I and E if a water box is employed, or of engine r.p.m. and scale reading P, in case the Prony brake method is used. The time of beginning test should also of course be noted. With water cooled engines it is also desirable to note the quantity of cooling water required, and its temperature rise, although this is not at all essential.

Readings of the above quantities should be taken about every fifteen minutes throughout the test in order to get a correct average of the conditions existing during trial. Two observers will be required, one of whom should watch the load constantly, and not allow it to vary any appreciable amount. It is not usual in the case of such small engines to measure the indicated horsepower. Hence the mechanical efficiency will not be considered. The efficiency may be expressed, however, in terms of pounds of gasoline per B. H. P. Furthermore, if desired, the calorific value of the gasoline in British Thermal Units, (B. T. U.) may be determined, or secured from manufacturers, and the thermal efficiency of the engine computed by the formula, $E = (2{,}545 \times 100)/WH$, where E is efficiency in per cent., W the pounds gasoline per B. H. P., and H the B. T. U. per pound of gasoline. (2,545 is the number of B. T. U. per theoretical horsepower hour.)

C. C. HOKE.

Testing Auto Truck Engines, Ans. to Ques. No. 238.

Editor Southern Electrician:

The writer thinks that the following apparatus and scheme of connections would be quite satisfactory if C. F. B. would care to go to the expense of arranging for such an equipment to test his auto trucks. He mentions the fact of having a 220 volt generator at his disposal and the first thing to do would be to determine the armature and field losses of the generator. When these have been determined, the generator should be belted or connected in some manner as to be driven from the engine under test. The connections outside the generator should be as shown in the sketch. A voltmeter is first connected across the brushes of the generator, and rheostat inserted in the shunt field circuit. In case the generator is a compound machine, the series coil may be either left in or cut out at the discretion of the tester. An ammeter is inserted in the positive lead from the generator, also the series contact relay and one side of water box, the other side of the water box load being connected to the negative pole of the machine. The series contact relay B can easily be made if a contact making ammeter is not at hand. It consists merely of a series coil with a movable core pivoted to a lever arm, which has contacts on the opposite end. After determining the maximum number of amperes which the engine will pull, the plunger in B shoud have weight put on or taken off, so that the effect of the current in the coil will just balance same, keeping the points at the opposite end from touching each other. C is a cylinder containing a piston, and connected with a pressure water supply through pipe P. S_1 and S_2 are solenoids operating valve V_1 and V_2. WR is a water rheostat made from a barrel or some other containing vessel and filled with a salt solution, proportions of about one hand full of salt per gallon of water. A coil of pipe through which cold water can be circulated is put in the solution for cooling same. The negative terminal is cone shaped and stationary. The positive terminal is of a similar shape and connected to the piston in cylinder C, A wooden block should be placed between the two terminals so as not to allow them to come together and cause a short circuit. The positive plate should have an area of about 4.5 square inches per kilowatt at 220 volts. This for one side of plate only.

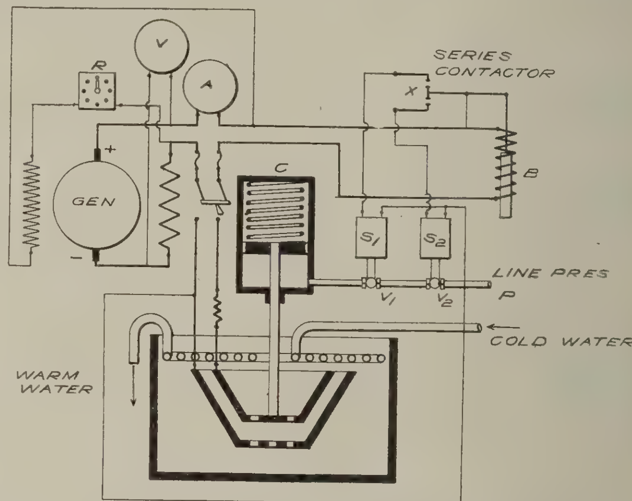


FIG. 1. CONNECTIONS FOR AN AUTOMATIC REGULATOR TO HOLD CONSTANT LOAD ON A GENERATOR.

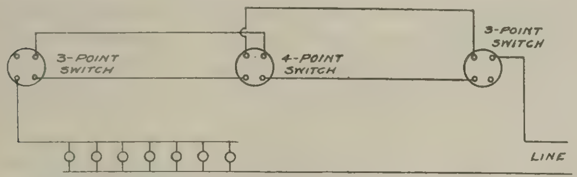
The operation is as follows: Assume the generator running, and the main switch closed. Current then flows through the circuit energizing relay B. The plates in the water box being held close together on account of spring in C pushing same down, there will be an excessive flow of current, this pulls plunger in B up, making contact with the lower points at X. This allows current to flow through solenoid S_2 opening valve V_2, and allows water pressure to pass cylinder C, raising the piston and moving the positive terminal of the water box further away from the negative. This decreases the flow of current, causing plunger B to fall back, opening the circuit through S_2, allowing V_2 to close and then making contact with the top points at X energizing solenoid S_1 and opening valve V_1. As this valve opens to the atmosphere, it allows water to flow from cylinder C to atmosphere letting the plates come closer together again. The above actions will repeat back and forth holding the output of the generator at a constant value, which may be predeterminated by adjusting the relay B.

I think that if C. F. B. will rig up an equipment similar to the above, he will find it an exceptionally good arrangement for testing truck engines. The brake H. P. of the engine would then be [(Volts × Amperes) + Armature losses]/746. Another method which would not furnish as constant a load as it would take more or less juggling of the field rheostat, is to make a coil of about 200 feet of No. 18 iron or steel wire immersed in a water box so arranged as to be cooled by a circulation of cold water. Since C. F. B. desires to run a 10-hour test, it would be necessary to make several of these coils so as to switch from one to the other, as they would probably not stand up to a 10-hour run. L. McCoy.

Control of Residence Lighting, Ans. to Ques. No. 239.

Editor Southern Electrician:

In answer to question 229 in the August issue, I offer the following: To control the lights from any one of more than two points, a four point switch will be required between the three point switches as shown in the diagram. This arrangement will allow making and breaking the circuit from any of the three positions. In regard to the



Circuits for Control of Lights From Three Points.

master switch, it is not plain what is required. It is supposed, however, that it is desired to operate the system from one point in the house. This can be accomplished by use of a remote control switch with wiring for control magnets separate from service wires. E. D. Dumas.

Loading Transformers, Ans. to Ques. No. 240.

Editor Southern Electrician:

In reference to question 240 of the September issue, if the transformers are of the same size, design, ratio, etc., they should possess the same regulation and therefore should when operating in parallel, each take one-third of the load. If, however, there is a difference in size, there is probably a difference in regulation, in which case there would be exchange currents and unequal distribution of load. I would suggest that Q. T. B. take this matter up with the manufacturer of the transformers, giving the full name plate rating including herial number. Their test records should give the desired information.

Generator Excitation Fails, Ans. Ques. 242.

This problem would be somewhat less difficult if more details were given as to alternator speed, power factor, exciter volts and amps., etc., at the time the failures occur. It may be due to several causes and it would be impossible to state from the information given, which would be the most probable. The line amperes are considerably above normal and probably accompanied by an unballanced condition and low power-factor. The exciter is probably overloaded. In this case the armature reaction of the exciter might be sufficient to cause the voltage to drop by weakening the field. As the exciter is shunt wound, any decrease in voltage would cause the field to become weaker, allowing the armature reaction to cause it to go from bad to worse very rapidly. The self-induction of the alternator field would prevent the armature current from droping with the voltage, thereby making the effects of armature reaction still worse. The commutator compound and vaseline perhaps have something to do with it by forming a non-conductive contact surface.

Other possibilities are those of loose open circuits. These may occur in the exciter field coils, the exciter field rheostat, the alternator field or field rheostat or in some of the wiring. Loose connections are sometimes hard to locate, as they do not always show up under test. I would test out the rheostats thoroughly for open circuits, subjecting them to some vibration while under test. I would also measure carefully the resistance of each exciter field coil. This resistance should not vary more than 9 per cent. I would also test the entire exciter circuit for grounds.

C. L. Hayward.

Loading Transformers, Ans to Ques. No. 240.

Editor Southern Electrician:

Referring to question No. 240, it is inadvsiable to connect transformers of different sizes in parallel, especially where the disparity is as great as in this case. Transformers in parallel having the same general characteristics tend to divide the load equally and not in proportion to their ratings. Therefore, the capacity of the bank in this case is only three times that of the smallest one, or 75 K. W.

It is only at very light loads that the division is nearly equal, for as the load is increased the voltages of the smallest one becomes less than the others, due to increased drop, and actually takes current from them. For this reason the actual load that such an arrangement will carry will be somewhat less than three times the smallest one under full load conditions.

Broken Lamp Filaments, Ans. Ques. 241.

Referring to question No. 241, it is not often that lamp filaments are known to have been broken during electrical storms, and this is largely due to the fact that, as a rule, nobody notices when lamps do get broken, especially in the larger cities. The writer has observed, in this connection, that filaments seldom break from shock, electric or mechanical, when hot, and hence such breakages occur when no attention is being paid to the lamp, so when the defect is discovered it is usually passed over as simply "burnt out." It is not often, either, that carbon filaments break during electric storms, but metallic filaments seem to be peculiarly susceptible to such damage. From the wording of the question I infer that the lamps were of the metallic filament type.

As to the trouble occurring with the switches open, there is no mystery in that, for all trouble men are familiar with the jumping of sparks across the switches during lightning storms and have had to allay many a cutsomer's fears over this phenomena. C. H. Broward.

Placing Telephone Lines Across a Stream.

Editor Southern Electrician:

A somewhat novel method of getting wires over a one-thousand foot channel of water was recently employed by the Home Telephone Co., at El Monte, near Los Angeles, Cal. The lines had been torn down by a severe rain-storm, resulting in numerous floods. A projectile, attached to a long coil of rope to which in turn the wire was fastened, was fired across the torrent from the mouth of a cannon. The rope was then unfastened and the lines pulled across. This device is familiarly used by life-savers, and it would appear that it can profitably be employed in line construction work. L. R. W. A.

New Apparatus and Appliances.

The Sign Flasher and the Central Station

BY E. REYNOLDS DULL.*

Eight years ago a representative of a flasher concern solicited the patronage of a central station. The central station man, after listening to the argument for a few minutes, replied that he had current to sell, not to save, and could not use the apparatus. Today that central station has over 500 machines on its service, of which it owns about 50. This indicates a change in sentiment that has universally grown all over this country.

There are several things that can be said in favor of the flasher, and there are several things that can be said against it. Against it, there is a line of annoyance, due to the inexperience of men handling this class of apparatus, which can truthfully be said to be at least peculiar. The only way troubles due to inexperience can be dispensed with, is by the trouble man learning to handle the flasher. This takes time, patience and money. The flasher further gives the customer another excuse for holding up an account, and while the customer wants to hold back an account wherever he can anyhow, if he does not have a flasher on his premises, it is certain that one less excuse would exist for him to use. In addition to these facts, the central station man is confronted with his choice of a dozen different flashers, and the only way he can form his opinions is from the literature sent him. He hesitates about accepting risks, for he is on the other end of the telephone and gets the brunt of every complaint on every piece of apparatus to which his lines are connected, whether it is his fault or not. Naturally he is going to avoid as many cases of complaint as he can in the beginning. But there is another side to the case. The flasher is here to stay, on account of its economy, the merchants will demand it. They will demand it, on account of the increased advertising value that it creates. Here it is necessary to quote from Grover Cleveland who said, "It is not a theory which confronts us, it is a condition." Theoretically, flashers are objectionable. As an actual matter of fact and condition, they are successful and a necessity.

In view of the fact that it is the condition that confronts the central station man, the proper way is to grasp the situation with a firm hand, master it, and be done with it. Any man of ordinary intelligence will master the flasher situation in a few weeks time, half a dozen machines and a little patience. Any reputable flasher builder knows his business, but the construction of his apparatus is only half the battle. The other half is the man who installs and looks after the apparatus. If either side is negligent, failure comes to both. When you stop to consider that a flasher working five hours per day for 30 days, makes the same number of flashes as a knife switch on the wall worked twice a day for 412 years, you can see what the flasher builder has to contend with, and when you consider that he gives a written guarantee on his device for one or two years, it stands to reason that he is confident of his apparatus, provided the central station man will back him up.

*President of Reynolds Dull Flasher Co.

The flasher maker contends that there are five times the number of people who can afford a sign with a flasher at $20.00 a month where there is one who will afford a steady burning sign at $40.00 a month. The greatest stumbling block in closing a contract for an electric sign is the cost of current, which continues as long as the sign is in use. The first cost is of small consideration. Naturally, if a customer can be shown that he can operate his sign for one-half the regular rate, and increase the advertising value of his sign by making people look at it, a far better chance is presented for selling current to that man than as if he was only quoted the high rate, with a steady burning sign. When you succeed in convincing a merchant of these facts, he is not going to keep it to himself, but he is going to tell his neighbor, and when he tells his neighbor, you have a chance to put up a sign for that neighbor, which would have been impossible had the first customer been compelled to pay the full rate.

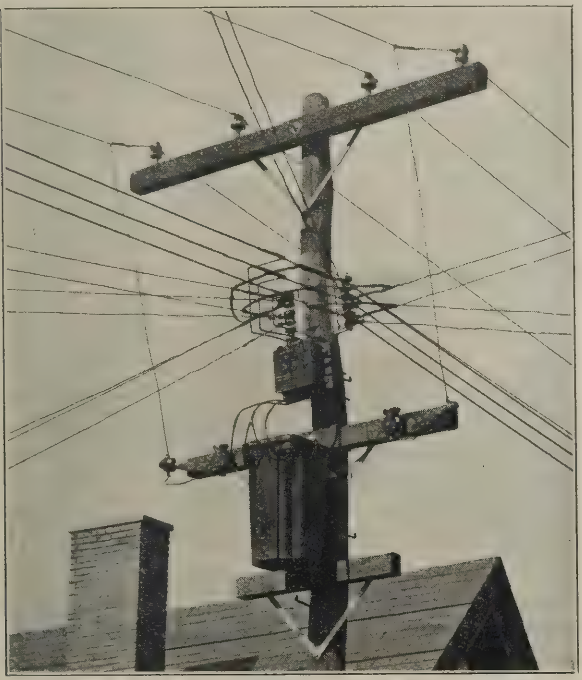
It may be claimed that one good customer is better than two poor ones, but this is not so. Suppose a merchant has a small sign burning steadily that has cost him $40.00 a month for several months. Then you place a flasher that reduces his bill on that sign to $20.00 a month. Your customer is then pleased, for you have actually shown him how to reduce his expenses, human nature does the rest. It is often a fact that this merchant orders another sign put on another portion of his building, on the strength of the saving shown by the first. If he doesn't do that, he will add more lights to his show window. The central station is getting just as much for current, and he is getting more advertising than he ever got before, for the same amount of money.

When a customer complains that his sign bills are excessive, he threatens to shut off the sign altogether, it is poor policy to let him do so. Give him a flasher, if necessary, if not rent him one. If a customer's sign is costing him $20.00 a month it is an easy matter to get him to sign a contract for two years with the understanding that his light bill, by the addition of a flasher, will be reduced 40 per cent. By this process you are going to sell $288.00 worth of current in the two years, where you would have otherwise sold none. The flasher saved you 50 per cent., you gave the customer 40 per cent., and the remaining 10 per cent. has more than paid for your flasher and you still own it, ready for the next job where it costs you nothing.

The saving effected by flashers can always be correctly determined by the maker. Meters register within 2 per cent of the actual saving claimed for the flasher. They can be so arranged that the meter will read in favor of the customer or against the customer and in favor of the light company, but there is no process known in ordinary flashed signs where a deviation of more than 3 or 4 per cent. manipulation by special setting. The current consumed by the motor for operating the flasher averages 30 watts for direct current and 90 watts for alternating, while a sign flashed on alternate sides saves fully 50 per cent. On and off as a whole they are generally set to save 55 per cent. On signs spelled out one letter at a time they save about 33 per cent. With the crawling snake border they save about 80 per cent. Falling water, traveling borders, smoke, and similar spectacular effects, save about 26 per cent. Large spectacular roof signs generally save about 60 per cent., as compared with the entire sign burning steadily.

The Pierce Rack for Secondary Distribution.

The accompanying illustration shows an arrangement which represents a development toward simplicity in secondary distribution. The top cross arm carries the primary and arc circuits of a distribution system, while on the secondary rack below the secondary circuits are strung. The close spacing of the wires reduces the inductive drop and because of the vertical alignment, services may be taken



The Pierce Secondary Rack as Installed.

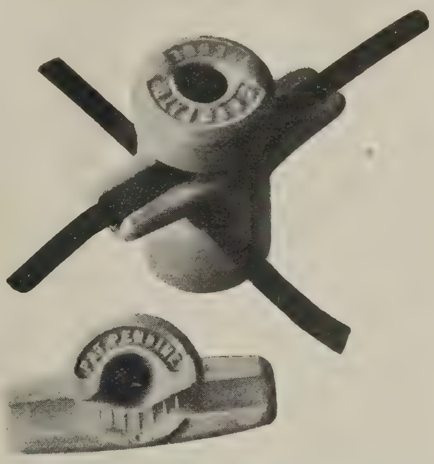
off without crossing wires or the possibility of their whipping together. The first cost is less than that of cross arms only, and the strength of the construction is greatly increased, besides simplifying connections. With telephone lines on the same pole, greater safety is secured, as the grounded neutral may be strung on the top knob protecting falling wires, and protecting secondary wires themselves from falling high tension wires, and from lightning discharges.

The above illustration shows the system as installed at Pittsburg, Pa., where it has not only given excellent success, but shown up further possibilities. The arrangement is known as the Muller Vertical System of distribution, using Pierce secondary racks. These racks as shown are made of hot rolled steel angle and channel hot galvanized. The knobs used are of a high grade porcelain with uniform brown glaze. The strength of the racks is equal to that of the pole as they are designed to be fastened with bolts or lag screws.

These racks are designed by C. L. Pierce, Jr., and manufactured by Hubbard and Company of Pittsburg, Pa. This company makes a specialty of pole line hardware all possessing the Pierce features of design, namely channel steel construction with spiral spring and corrugated metal threads on insulator supports.

The Wedge Crossover.

In installing electrical wiring, electricians generally use a tube where wires cross and it is necessary to slip this tube over the wires and then secure it by firmly tapeing on both ends. On account of the fact that this is a rather slow process, a special device has been designed by the Cook Pottery Company, of Trenton, N. J., which is used with a wedge knob and replaces the taped tube. The crossover fixture is used in connection with a 5½ split wedge



The Crossover.

knob and is held in place by a single screw. The accompanying illustration shows the nature of the crossover, indicating clearly the insulation features of the fixture.

New Office Building for H. W. Johns-Manville Campany.

A new twelve-story office building to be occupied by H. W. Johns-Manville Co., is now being erected on the Southwest corner of 41st Street and Madison Avenue, New York City. The company expects to occupy it in its entirety about May 1st, 1912, as general offices and New York salesroom. It was the desire of the owners to have a distinctive building, and the early Italian Gothic architecture was selected. This style of architectural treatment has not heretofore been employed for buildings of this character, and in this respect the edifice will be unique. The building has been designed so that all four sides will be attractive. It will be known as the "Johns-Manville Building," and will have the distinction of being one of the few twelve-story structures to be entirely occupied by a manufacturing concern for office purposes only.

An unusual feature connected with this building will be the fact that the tenant manufactures and will furnish a considerable part of the equipment of the structure. Among the various materials which the H. W. Johns-Manville Co. will install will be the following: J-M Asbestos Roofing, J-M Asbestos Plaster, J-M Linolite System of Lighting, J-M Conduit for wiring, Flushometers, J-M Sanitor Seats, Electrical accessories, Waterproofing, Keystone Hair Insulator, J-M Asbestos Wood, Fire Extinguishers, J-M Asbesto-Sponge Felted and J-M Asbestocel Pipe Coverings, etc. Fireproof materials will be used throughout the structure. Modern systems of heating and ventilating will be employed, and the building will rank, architecturally and otherwise, among the handsomest and most substantial office structures in New York. This is but one of a chain of branch stores, warehouses, offices, and factories scattered throughout the United States and Canada, which are under the supervision of the executive officers of the Company, whose headquarters will be in this new building.

New Moisture-Proof Dry Battery.

Where considerable moisture is present it sometimes happens that the cardboard cartons of dry cells absorb so much moisture that when the cells are placed side by side or on a metallic base, they become short-circuited. This causes them to run down and deteriorate quickly, thus necessitating frequent renewals and an attendant maintenance expense. The Western Electric Company, on this account, have recently placed on the market a moisture-proof dry battery. This cell has been designed especially for use in mine, railway and general telephone service where the batteries are subjected to moisture. The cell has the same high efficiency, long life, high voltage and great recuperative power which characterizes the standard "Blue Bell" battery. It differs from the standard cell in that the cardboard carton has been treated with a special impregnating compound which effectually prevents moisture from reaching the cell proper. This will give sufficient protection so that the life of the batteries used in damp places will be as great as that of the batteries used in any other magneto service under ordinary conditions.

High Efficiency Incandescent Street Lighting Units.

The incandescent lamp has played an important part in the new street lighting because of its divisibility into small high efficiency units and its simplicity of operation. Appearance, however, demands that the lamp be covered with some sort of diffusing globe which will glow with a low brilliancy over its entire surface. And economy demands that as large a percentage of the light from the lamp as possible be directed toward the street. To accomplish the first result, opal globes and sand blasted balls have been used, which are often lacking in meeting the requirement of economy. Below are pictured two units for street lighting which combine both requirements. These units have been developed by the Holophane Company along lines in keeping with the engineering requirements of street illumination and have met with popular and engineering approval.

The unit shown in Fig. 1 is designated as No. 591, and intended for use on ornamental posts, primarily for business districts and boulevard lighting. It consists of a specially designed Holophane glass reflector surrounded by an opal envelope. The two are held together by a suitable holder, as indicated in the cross-section diagram. The lamps used with this unit are the 40-watt, 60-watt, 100-watt multiple, and the 32 candle power and 60 candle power series Mazda or tungsten.

The most popular type of ornamental street lighting standard seems to be one in which four units hang pendant with one central unit supported above the rest in an upright position. The unit in Fig. 2 is intended for use as the top upright unit on posts where the units in Fig. 1 are used pendant. It is a diffusing opal globe constructed to harmonize in contour and appearance with the other units, and is made up of the same opal glass as the envelope of the unit in Fig. 1. It is used solely for ornamental effect, not intended as a source of illumination. The 40-watt multiple or the 32 candle power street series of Mazda or tungsten lamp is used with this globe.

The following table shows clearly the high efficiency of the units mentioned as compared with others:

Equipment.	Per cent. of light given below horizontal.
12-inch opal ball	45
12-inch sand blasted ball	50
Holophane 591 Unit	70

Not only do Holophane units give 25 per cent. more useful light than the ordinary enclosing types of glass-glassware, but the opal envelopes, glowing softly over their entire surface, give an installation of the units a remarkably artistic effect. The opal envelope has still other functions than that of light diffusion. It has long been known that brilliant light sources in the field of vision cause discomfort to the eyes and greatly decrease one's ability to see things clearly. Numerous investigations have shown that in street lighting where the line of sight is normally along the horizontal or a little below that this effect of glare is produced solely by the light radiated by the light units between the angles of 65 degrees (approx.), and 90 degrees, measured upward from the vertical. The opal envelopes in the Holophane units suppress this undesirable

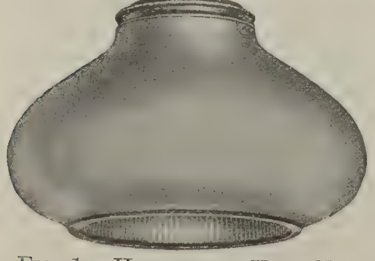


Fig. 1. Holophane Unit No. 591.

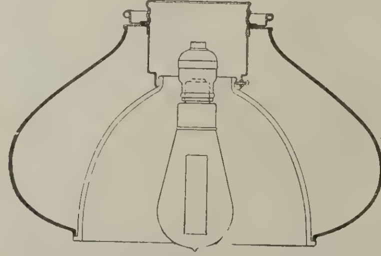


Fig. 2. Diagram Showing Construction of No. 591.

Fig. 3. Holophane Unit No. 271.

light and thus reduce glare as far as possible in commercial lighting equipments.

The envelope also protects the prisms of the inner prismatic reflector from dust deposits and reduces to a negligible amount the loss from dirt usually found in street lighting equipment. Complete instructions on the best methods of installing these units, together with a great deal of matter of general value have been published by the Holophane Company in Bulletin No. 101. This bulletin can be secured by addressing the Holophane Company, sales department, Newark, Ohio.

Indirect Illumination.

Since the article in the January issue of this publication, referring to the installation of the Eye Comfort system of indirect illumination in churches and other large interiors, as well as in the home, the field for this method of lighting has proven to be considerably larger than even then seemed possible. Many installations have already been made this year in all sections of the country, in hotels, stores, offices, restaurants, theatres, banks, and hospitals. In the next few years it is expected by the advocates of this system of lighting, that direct lighting installations where a brilliant light source is in the range of vision, will be an unusual installation. In many sections of the country, where indirect illumination has been very generally installed, the public has been quick to realize the advantages of an even distribution of light with no irritating glare from the light source. The school boards of Norfolk, Va., and New Orleans, La., were the first to realize the necessity of protecting the pupils' eyes, and furnishing special illumination. The high school of the former city and the Davy school of the latter, have been equipped with these indirect fixtures as supplied to the electrical trade by the National X-Ray Reflector Company, of Chicago, the originators of this system of lighting.

Fig. 1. A Single Unit Fixture.

The illumination of school rooms, libraries, and reading rooms, has heretofore not received the serious consideration due to so important a subject. The eye, that most sensitive and delicate organ of the body, has been subjected to the constant glare of the direct light rays on white paper. Nervousness and headache among children and students are therefore common disorders due to poor illumination. It may be interesting to know that a committee appointed by the German Government to investigate the proper illumination of schools has reported that indirect illumination is the most desirable.

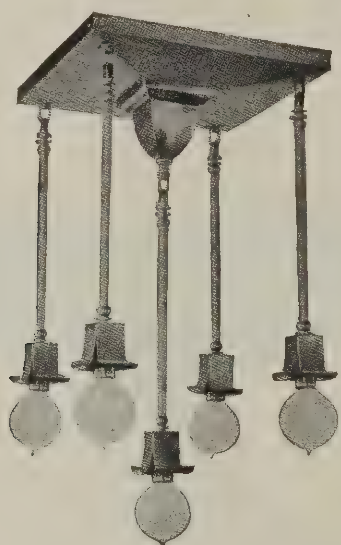
Fig. 2. A Fixture Designed for More than One Lamp.

Shewmake-Hall Company, of Dublin, Ga., have recently made an installation of indirect lighting fixtures in the Methodist church at that place. Perhaps of the Southern States, Florida dealers have most appreciated this new field that has opened up to the electrical trade, many banks, residences, etc., having been recently equipped. For this class of interiors, in fact every place where the public gathers in large numbers, indirect illumination has solved this difficult illuminating problem, the efficient and yet beautiful lighting of large interiors. The Majestic Theater of Fort Worth, Texas, and the Plaza Theater, of San Antonio, recently placed orders for the complete equipment of their places. The possibilities for artistic treatment by the manufacture of these fixtures are indeed quite as wide as for any other form of lighting. In fact, this system has attracted attention not only on account of its eye-saving merits, but also on account of the beautiful fixtures which are, and can be, designed for its use.

A single unit fixture, one made from spun brass, and which takes any finish desired is shown in Fig. 1. This fixture contains either the concentrating or diffusing type of reflector, the pure silver plating of these reflectors giving great efficiency, and their corrugations illuminating shadows and streaks on the ceiling. With a 100 watt lamp this fixture lights an ordinary sized residence room. A composition fixture is shown in Fig. 2, which is made of various sizes and takes either three, four, or five of these reflectors, and as many Mazda lamps. This latter type of fixture, being of composition, takes any metallic finish, and when erected cannot be distinguished from the solid metal fixture of approximately three times its cost.

Wakefield Shower Fixture.

Showers seem to be a popular type of fixture. To get this effect a large ceiling plate is advisable from which can be dropped a number of lights. To make a plate in one piece such as is commonly used entails considerable expense, as the size of metal necessary is very large and the handling amounts to a considerable item. To eliminate this extra cost and still give the same effect with a neat appearance, The F. W. Wakefield Brass Co., of Vermilion, Ohio, have made a plate from a number of similar pieces of smaller sized metal so joined together that the places of joining form ribs on the inside of the fixture, giving it additional strength and rigidity and reducing the cost to a very nominal amount.



Wakefield Shower Fixture.

The fixture is supported by a special method which permits of a regular crow foot or insulating joint attachment. It also provides for placing the fixture in position against the ceiling without turning, a feature worthy of consideration, when it is is realized that this eliminates the possibilities of marring the finished ceiling. This method reduces time in handling and installing to a minimum, and the interchangeable feature, allowing a large variety of different designs by using different standard Wakefield material, make this a very popular line and one very profitable to handle.

The Janette Automatic Air Compressor.

During the past few years there has been a constantly increasing use of compressed air for a great variety of purposes, including its use by doctors, dentists, in laboratories, by air brush artists, in factories, and for pressure for drawing liquids. Particularly is this true with reference to the smaller types of compressors, where a light motor is capable of safely carrying a working pressure of 50 pounds to the square inch for continuous duty. To meet the present demands the Janette Manufacturing Company, of Chicago, has perfected a compressor which is built in extremely compact form and is a self-contained outfit. The machine is rugged in construction, reliable in operation and occupies minimum floor space. It excels in compactness and ready accessibility of parts.

Janette Automatic Air Compressor.

It is a self-evident fact that the reliable operation of an electrically driven intermittent service air compressor largely depends upon the controlling device. The Janette automatic circuit breaker is positive and reliable in its action under severe service, being compact and substantial. One of the chief merits is its simplicity of design. It maintains the air pressure within a range of 8 pounds, by automatically starting the compressor when the air pressure falls to the predetermined minimum and stopping it when the desired maximum pressure is reached. The regulator can be set at any desired pressure from 5 to 50 pounds. The Janette compressor will fill a 5½-gallon tank up to a pressure of 30 pounds, in 6 minutes.

Refillable Cartridge Fuse Shells.

A type of fuse shell which can be filled and refilled is now manufactured by the A. F. Daum Company, of Pittsburg, Pa. These refillable fuse shells are of the cartridge design and as their name implies are holders or containers for suitable fuse wire. They are made in all sizes to conform to the National Electric Code standards and fit any switchboard. In plants where a large number of fuses are in use, the saving in the use of refilled shells is considerable and sufficient to give this product careful consideration.

Daum Refillable Fuse Shell.

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.

ANDERSON. It is understood that the Anderson Realty Company is planning to build a park and extend the electric lighting system to it. H. W. Williamson is interested.

BIRMINGHAM. The Birmingham, Ensley and Bessemer Railroad Company has plans for the construction of the power plant.

BOAZ. It is understood that the city is contemplating the construction of an electric light plant. The cost is approximately $8,000. The mayor can give other information.

CEDAR BLUFF. An electric light plant for Cedar Bluff is under consideration. W. T. Lassiter is interested.

COLUMBIANA. The franchise granted to G. L. Carlisle and associates sometime ago has been acquired by the Mountain Dixie Sanatorium Land and Investment Company and an electric light plant will be constructed.

DAUPHIN ISLAND. The Dauphin Island Railroad and Harbor Co., is to construct an electric light plant. The chief engineer is T. W. Nicol with address at Bank of Mobile Bldg., Mobile, Ala. He desires prices on equipment for the plant.

DOTHAN. An issue of $70,000 in bonds has been voted for the construction of a municipal electric light plant. J. D. Baker is mayor and can give other information.

EUFAULA. The proposition of installing an electric light plant, reported as under consideration in the August issue, has been decided. On August 21st a vote was made to issue $40,000 in bonds to be used to purchase the electric light plant and overhaul the present gas plant.

GADSDEN. It is understood that the plant of the Southern Mfg. Co. has seriously been damaged by fire.

GANTT. It is understood that the city is contemplating the establishment of an electric light plant.

MOBILE. It is understood that an electric railway will be constructed between this city and Alabama ports and between that place and Coosa, a distance of about 50 miles. The installation will be made by the Mobile West Shore Traction Company, to cost about $500,000. H. Austin is president and R. Levy is chief engineer at Mobile, Ala.

STEVENSON. The J. B. McCrary & Company, of Atlanta, have been engaged to prepare plans for a municipal electric and water system.

TUSCALOOSA. The construction of a power plant is being contemplated by T. H. Friel, president of the Birmingham Light and Power Company, Birmingham, Ala. The location will be at Lock 17 on Coosa-Alabama River. It is proposed to construct a dam 65 feet high at the shoals and generate about 15,000 horsepower, to be transmitted to Tuscaloosa, Birmingham and Gadsden.

Florida.

FORT McCOY. The installation of an electric light plant and waterworks system is reported under consideration. G. Rentz is interested.

HIGH SPRINGS. An electric light plant is under consideration by the local ice company, in connection with its ice plants. The company has applied for a franchise to supply electricity in the city.

JACKSONVILLE. The city has voted bonds as follows: For electric light plant and water works system, $35,000; for sewers, $195,000; for park improvements, $20,000; for street improvements, $100,000; for water works and electric light plant in 1912, $50,000.

JACKSONVILLE. The city contemplates the erection of a municipal power plant. The Schofield Engineering Company, of Philadelphia, is preparing the plans.

NEW SMYRNA. A bond issue for electric lighting, waterworks and sewers is under consideration. The chairman of the committee is A. D. P. Smith.

SOUTH JACKSONVILLE. It is understood that bids are out by the Board of Bond Trustees for installing electric lighting equipment and the electric transmission systems. W. W. Lyon is consulting engineer at 305 Duval Bldg., Jacksonville, Fla.

ST. PETERSBURG. Plans are now under way by the St. Petersburg Railway & Electric Company to begin work as soon as possible on the extension from St. Petersburg to Coffee Pot, Bayou Line. W. H. Fuller is manager at St. Petersburg.

TAMPA. According to reports Judge Bulloch, of Ocala, Fla., is interested in a project to build a hydro-electric plant on the Wekiwa River. It is understood that plans are under way to form a company to operate the plant.

Georgia.

BLUE RIDGE. The Toccoa River Power Company has been chartered with a capital stock of $300,000. The incorporators are G. A. Browning, of Greenville, S. C.; W. R. Coke, Jr., of Atlanta, Ga., S. J. Hall and Sam Allen, of Blue Ridge. The purpose of the company is to construct a hydro-electric plant.

CHITLEY. The city council is contemplating the installation of an acetylene lighting plant. Estimates are being supplied by James Low, of Hammond, Ga.

CORDELE. Bonds to the extent of $30,000 have been issued and will be used for the purpose of buying or building an electric light plant. W. D. Dorris is mayor and can give other information.

DAHLONEGA. The Etowah Valley Railroad has made application to build an electric railroad from Ballground through to the north of the State in Towns county by the Forsyth, Lumpkin, Dothan, and White counties. It is understood that the company will furnish energy for lighting and heating purposes. The capital is $15,000 and the incorporators are G. R. Glenn, H. D. Gurley, P. H. Moore, all of Dahlonega.

DALTON. The Georgia Power Company has petitioned the council for permission to run power lines into Dalton. J. F. Joerissen, of Atlanta, is reported interested.

LAWRENCEVILLE. An issue of $35,000 in bonds has been voted for the construction of a waterworks system. J. B. McCrary & Co., of Atlanta, are engineers.

NEWNAN. The contract for rebuilding the power house of the Virginia-Carolina Chemical Company, of Richmond, Va., has been secured by C. T. Clifford, of Columbus, Ga.

TIFTON. Prices are desired on electric fixtures by O. C. Griner.

JACKSON. On September 7th the city voted $12,000 in bonds for the extension of electric transmission system and waterworks system.

SAVANNAH. The Seaboard Air Line Railroad intends to rebuild the shops recently destroyed by fire. W. L. Seddon is chief engineer at Portsmouth, Va.

WAYCROSS. A contract has been awarded to the Ware County Light & Power Company by the city for the installation of a "Great White Way" system.

Kentucky.

HARLAND. The Harland Commercial Club is developing a plan for the organization of a company to erect and construct a waterworks plant and system.

HAZZARD. The Hazzard Light & Water Company has been organized with a capital of $25,000 by Jesse Morgan, J. H. B. Hoge and T. F. Ward.

LEXINGTON. The Kentucky Traction and Terminal Company, which company is now making improvements in its central Kentucky traction properties, will build two new sub-stations, one on the Nicholstown and one on the Georgetown line. The sub-stations on the Frankfort and Paris lines will be rebuilt. The vice-president is S. C. Bacon and can give information.

LOUISVILLE. The Louisville Herald Company, W. K. McKay, manager, desires prices on electric motors.

LOUISVILLE. The Norman Lumber Company has increased its capital stock to $75,000 and is contemplating the installation of a planing mill. The machinery will be electrically operated.

LOUISVILLE. The Kentucky Public Elevator Company is preparing to expend approximately $100,000 in enlargements and additions to the plant. Power and conveying equipment will be required. The president of the company is Oscar Fenley and address National Bank of Kentucky.

MIDWAY. The Midway Lighting Company is making improvements to its plant. It is understood that the changes will be completed in the near future.

NEWPORT. The contract for supplying electricity to the city of Newport has been awarded by the city council to the Union Light, Heat and Power Company. The contract provides that the city shall pay $58 per lamp for arc lamps and $27 for tungsten lamps.

OWENSBORO. The city council is contemplating the enlargement of the municipal lighting plant.

PADUCAH. A power plant equipment is desired by the Paducah Water Company which is now constructing a new boiler house adjoining the pumping station.

WHITEBURG. Electrical equipment for a store and office is desired by R. F. Fields.

North Carolina.

CHARLOTTE. Reports state that the Southern Power Company, of Charlotte, is planning to connect with the Carolina Power & Light Company, of Raleigh. The transmission lines of the Southern Power Company have been extended as far as Durham and it is proposed to extend the line to Raleigh. It is understood that the connection of the lines is for cases of emergency. A sub-station will be erected near Raleigh by the Carolina Power & Light Company and transmission lines will be erected to Henderson and Oxford.

LENOIR. A project to construct a hydro-electric plant on the Fatawba River near Lenoir is being promoted by H. L. Milner, of Morganton, N. C.

LYDE. A generator for a small plant to operate 50 to 100 electric lights is desired by W. H. Woodall. Also prices on an engine and pump.

OXFORD. A company has been organized to erect a hydro-electric plant on the Tar River, about eight miles from Oxford.

RED SPRINGS. Bids will be received until September 21st at 11 o'clock at the Mayor's office for the purchase of $35,000 in bonds of the town of Red Springs, N. C. These bonds are to be issued for waterworks and sewerage, etc. For further information address A. B. Pearsell, chairman of the Board of Public Works, Red Springs, N. C.

RUTHERFORDTON. A power plant will be constructed by the city 13 miles from this place with a capacity of approximately 150 horsepower. Energy will be transmitted at 11,000 volts and used for lighting and operating the pumping plant of the waterworks system. E. P. Rucker, of Charlotte, N. C., is the engineer.

SHELBY. The purchase of the Shelby Light & Power Company by the city is under consideration. If the plant is not bought it is understood that the city contemplates constructing a plant.

Oklahoma.

COLLINSVILLE. $45,000 in bonds has been issued for the construction of an elecvtric light plant. Further information can be obtained from the city clerk, W. N. Gresham.

PAWHUSKA. Plans are being prepared for additions to the electric light plant, and the waterworks system. The cost is estimated at $10,000 for the improvement of each system. The city clerk can give other information.

South Carolina.

AIKEN. The Farmers Fertilizer & Storage Company has purchased a tract of land on which to erect a fertilizer factory. The proposed building will be two stories, electrically operated and equipped for electric lights.

CAMDEN. A company has been incorporated with a capital stock of $70,000 known as the Camden Water & Light Company. H. G. Garrison and W. M. Shannon, of Camden, E. C. Brainard, of Chicago, Ill., are the incorporators.

CHARLESTON. It is understood that the Charleston Railway & Light Company is planning to install three new 1,000 k. w. turbo generators.

CHARLESTON. Bids will be received by the city electrician of Charleston until 12:00 noon October 18th for lighting the streets of Charleston, for a term of one, two or four years. The bids may include lighting by electricity, gas, or other illuminating power equivalent to either. Specifications will be furnished to bidders upon application to the city electrician, Ion Simons, of Charleston.

LEXINGTON. It is understood that the Lexington Electric Light & Power Company is planning the installation of an auxiliary steam plant in its power house.

McBEE. The city is to construct a waterworks system and erect a pumping plant.

SPRINGFIELD. The Springfield Electric Light & Power Company has been incorporated with capital stock of $20,000. The incorporators are J. McBean, Michael Chattin, and J. B. Smith. It is understood that a plant will be constructed 2½ miles from Springfield on the Deans Swamp Creek. The engineer in charge is S. E. Boby, of Leesville, S. C.

Tennessee.

BRISTOL. The Ordway chair plant has been leased by H. A. Herb and will be equipped with machinery for manufacturing bank fixtures, show cases, etc. Apparatus will be electrically driven.

BRISTOL. A municipal lighting plant to cost approximately $200,000 is under consideration by the city. The Mayor is L. H. Gamon.

CLARKSVILLE. A site for the water works pumping station has been purchased by the municipality and the station will be transferred. Some changes in equipment will be made when the apparatus is installed in the new location.

CHATTANOOGA. The Georgia Power Company has decided to extend its transmission lines to Chattanooga to supply electricity for power purposes. It is also understood that the company will supply electricity to the small towns along the lines.

DAYTON. Bonds have been voted for the purpose of installing a system of waterworks. The issue is approximately $25,000. Euclid Waterhouse, J. A. Denton, and W. A. Ault are commissioners in charge.

ETOWAH. It is understood that the Etowah Water & Light Company will build a hydro-electric plant. The general manager is W. H. Price. A concrete dam will be constructed and the company is in the market for equipment.

JACKSON. The Jackson Ornamental Iron & Bronze Works is contemplating the erection of a plant.

JOHNSON CITY. The plant of the Johnson City Power Company is to be improved by the installation of a considerable amount of power equipment. A new boiler room is to be built and two new boilers are to be purchased.

MARYVILLE. The Maryville Electric Light, Heat & Power Company has recently incorporated with a stock of $100,000. The incorporators are I. B. Celgler and J. A. Goddard, of Maryville, and W. Sterchi, of Knoxville. It is the purpose of this company to erect a generating plant at Abrams Falls on Abrams Creek at a distance of 25 miles from Maryville. The electricity will then be transmitted to Maryville furnishing light and power for manufacturing purposes. Transmission lines will also extend to other towns.

Texas.

AUSTIN. The city has ratified the contract made with W. B. Johnson, of New London, Conn., representative of the Hydraulic Properties Company, of 60 Broadway, New York City. The contract calls for the construction of a dam across the Colorado River and the installation of a hydro-electric plant. It is understood that the dam is to be 500 feet long by 65 feet high, of hollow reinforced concrete. The hydro-electric equipment will be sufficient to develop 7,200 horsepower. F. S. Taylor, of the Hydraulic Properties Company, is the engineer.

AMARILLO. The Amarillo Water, Light & Power Company has increased its capital stock and will construct a power plant.

BRYAN. The Bryan Power Company has been incorporated with a capital stock of $50,000. The incorporators are J. L. Lawler, H. T. Lawler, and H. T. Lawler, Jr.

BRYAN. A bond issue of $20,000 will be voted on in the near future for the purpose of enlarging the electric light and waterworks system.

HARLINGTON. Vote will be taken September 26th on a bond issue for $22,000. The purpose will be to improve the electric light and water systems and also the streets.

HALLETTSVILLE. Material for the United States postoffice at Sulphur Springs, Tex., is desired by J. S. McKnight at this place. The material includes plumbing, gas piping and electrical work.

MELISSA. The Melissa Waterworks Company, C. R. Osborn, manager, desires an electric or gasoline motor.

SEA DRIFT. Information is desired by J. D. Powers on telephone systems, the cost of installation, and equipment.

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CONTENTS.

A Lesson in Engineering.

The recent failure of the concrete dam at Austin, Pa., is a good example of what may be the result of the apparently inherent tendency of nearly all financial men to keep first cost at an absolute minimum. A great many capitalists are unwilling to pay out money in beginning a project even when they know that such money paid out will without a doubt bring them suitable returns in the end. Naturally enough they are also very unwilling to pay for what they cannot see they are getting, and many capitalists cannot see that they are getting the worth of their money when they pay for expert engineering assistance. Furthermore, it often happens that when they do decide to pay for engineering help they, themselves, to a large extent destroy the value of it by refusing to do absolutely what is recommended.

In the case of the Austin dam an engineer was employed, but according to authentic reports mentioning the subject, the owner refused to pay the additional expense of building a cut-off wall under the dam. The lack of this cut-off wall was the direct cause of the partial failure which took place in January, 1910. After this partial failure it is said that the owners asked their engineer what should be done, and he, to reinforce his own judgment, secured advice of another engineer, they together recommending essentially what had been recommended in the first place. The owners after receiving this report proceeded to do nothing apparently, though the engineers had recommended the cheapest safe thing that could be done. Furthermore, on September 30, 1911, the water was allowed to fill the reservoir to the top of the dam and this, notwithstanding that nothing at all had been done to the dam after it had previously partially failed. The owners had apparently therefore been guided by their own judgment against the judgment of the engineers, notwithstanding the fact that there were 2,000 people living just below the dam. Under these conditions the reservoir was again allowed to fill to the top of the dam and almost immediately it failed with the result published in the daily papers.

The conditions presented by this disaster and the lesson to be learned can be equally well applied to other fields of engineering and in fact to all fields. Every piece of engineering work should have behind it the reputation and standing of a thorough engineer and further, when such an engineer is employed he should be left absolutely free to determine the character of the project throughout. To impose a cost limit on any proposition is not only to tempt thorough engineers to play fast and loose with the ethics of their profession, but to imperil the safety and cripple the proposition as a source of revenue. It is not the aim of the engineer to spend money uselessly but in the end to save it.

It is too often urged by owners and those financially responsible for large projects that they have only so much money to spend and that if a proposition must cost more than that amount, they cannot carry it out. In that case the thing to do, of course, is to abandon the proposition. As a matter of fact this condition never occurs, for if a proposition is worth doing at all, a report on it by a reliable expert will make it possible to get all the money needed. Besides, this same report will in most cases go a long way toward discovering a better proposition than was contemplated by the promoters. The only objection to this method of procedure is that it involves an initial expense and makes it necessary for the owners to pay for something which many of them cannot understand the value of.

Is not the reason why this method of procedure is often impossible, because owners have absolute confidence in their own judgment and little confidence in that of others? Does it not seem that this condition prevails much more often than it should when it is a well known fact that practically all really successful manufacturers have succeeded, not because they knew, but because they knew that they did not know, all of the details of all parts of their business? What they did know was how to get the right kind of assistance and advice to properly carry out all of the various parts of the project for which they were responsible. The field of engineering is rapidly being extended, and we must admit that the general tendency is toward careful and reliable engineering advice on all undertakings, large and small. Too often, however, does it require the awful calamity to accelerate this tendency and place the proper importance on successful planning as well as execution.

World Electrotechnical Congress.

The International Electrotechnical Congress which was held at Turin, Italy, September 7 to 12, is now being discussed in the engineering world. It is generally remarked that this meeting is notable in more ways than one. It was attended by presidents of American, German and British electrical institutions, together with representatives of various other countries, making it truly an international gathering.

The one important feature if such can be designated, was the placing of the work of the congress under the control of the International Electrotechnical Commission. This Commission will decide when and where the congress is to hold its future meeting and generally certify for the future of the congress. This step will give the meetings world wide importance, as the International Electrotechnical Commission is the administrative authority in regard to electrical matters throughout the world.

The official language of the congress was French and all discussions were supposed to have been, but were not universally conducted in that tongue. Dr. Clayton H. Sharp, consulting engineer and electrical expert for the Electrical Testing Laboratories at New York City, and one of the five American representatives at the meeting, has the following to say in regard to it: "I may say that the meetings of the commission were very interesting indeed. They were characterized by harmony and good feeling. The proceedings of the congress were somewhat hampered by the many different languages employed in discussion. Discussions on the section of electric railway were particularly animated and brought out the opinions of some of the world's leading engineers in this field. The social features of the congress and of the commission were most pleasing. The entertainment furnished by the Italians both privately and officially were decidedly profuse and in exceptionally good taste. The American delegation was made particularly welcome and had the pleasure of meeting many old friends who had been in attendance at the St. Louis congress."

It may be well to state here in the way of a review, that when the Commission was formally constituted in London in 1906, and, indeed, up to 1908, only 10 countries could be counted as active adherents, but now twenty countries are taking an official part in the proceedings, financial support being in most cases lent by the respective Governments. An unofficial meeting of the Commission was held in Brussels, August, 1910, under the presidency of Prof. Eric Gerard, the head of the Institut Montefiore at Liege, and the work then accomplished brought within practical range the solution of many problems upon which international agreement had become an increasing necessity but which could not until recently be satisfactorily dealt with owing to the lack of a permanent organization for their quiet and continuous study. One of these problems was the establishment of international symbols for the various electrical quantities. Full co-operation in this difficult question was secured through the adherence recently obtained, of the Elektrotechnischer Verein of Berlin, an association representing all German-speaking nations, and now through the action of the Commission at Turin, the symbols I, E, and R will be universally accepted for the simple algebraic representation of Ohm's law.

Another subject of great importance to electrical engineers and manufacturers is the action on the rating of electrical machinery. Although this is of a highly techinical nature, there are may points on which international agreement is likely to be reached at no distant date, thanks to the energy of American Engineers. This question of rating, it may be explained, has nothing to do with commercial regulation, but deals rather with the tests to which electrical machinery has to conform before being put into actual use.

In the address which Mr. Balfour delivered to the foreign delegates in 1908, on the occasion of the first council meeting of the Commission, he remarked that the terminology employed in the electrotechnical industry has different meanings in different tongues. This terminology has now been carefully studied, and as a result a small international committee which met at Cologne in May last agreed in the official languages of the commission, French and English, to some 50 industrial terms and definitions, which, being more conventional than those in the scientific vocabularies that various communities are drawing up, lend themselves more readily to international agreement. This may not appear a great achievement in view of the time that has already been devoted to the subject, but this "Industrial list of terms," as it grows larger, must prove of considerable advantage to the electrcial industry in all countries. The favorable action on this point seems to deserve quite as much credit as that on others.

Through President Dunn of the American Institute of Electrical Engineers, an invitation was extended to the congress to meet in 1915 at San Francisco. This invitation was accepted and the meeting will take place in conjunction with the Panama opening festivities and the San Francisco World's Fair.

Hydro-Electric Plant on Big Sioux River, Sioux Falls, S. D.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

BY H. B. MCDERMID.

THERE are few subjects that have commanded a wider attention during the last decade than the utilization of the power hitherto running to waste in our streams and water falls. Naturally, those propositions which offer the least difficulties are first to be developed; but later when the demand becomes more insistent, those which are less attractive must come in for their share of attention. In accordance with this latter statement, therefore, a description of what has been done at the falls of the Big Sioux river in southeastern South Dakota should be interesting not only to engineers, but to prospective promoters, and not because it could be readily developed to a commercial success, but because of the fact that the engineering problems there solved are typical of those which will be met in many other hydroelectric propositions.

The town of Sioux Falls, in which the plant under consideration is situated, although of but 16,000 inhabitants, is the largest city in the state, and is entered by six railroads. It thus naturally becomes an important distributing center, supplying immense tracts of agricultural country and numerous small towns with products of the Eastern manufacturing districts. The main streets are well lighted by a large number of electric display signs, which cause the town to resemble a large city in this respect.

The engineering difficulties here met with in supplying the trade with electrical energy are as follows: First, a widely varying river flow, ranging from occasional extremely high flood water, to almost no water in the dry months; second, a violently fluctuating load, due to the operation of a comparatively small number of street cars, and of passenger elevators in the hotels and department stores, which, together with hoisting apparatus in the large red granite quarries of the town, combine to produce a load that often fluctuates from minimum to maximum in a few seconds. These conditions render close regulation, such as is required for the lighting load, very difficult to obtain. The conditions were met, however, so far as river flow is concerned, by a special design of power house to enable the electrical apparatus to be at all times above flood water. Water storage is provided in sufficient quantities at the plant to enable the carrying of the evening peak load with ease during times of natural flow. The proposition is also being considered of turning the lakes found many miles upstream into reservoirs, to aid in supplying the plant when the river flow is diminished. As a further safe-guard, a steam stand-by plant, containing both Corliss engines and a modern steam turbine unit, is provided to take the load when the stream flow becomes entirely inadequate.

FIG. 1. VIEW OF POWER HOUSE, SHOWING PIPE LINE AND SURGE TANK.

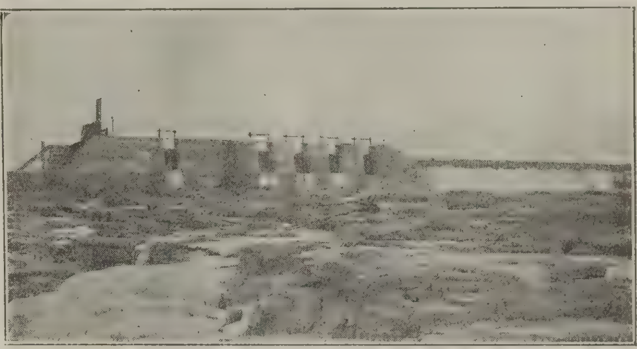


FIG. 2. VIEW OF DAM.

The regulation problem was met by a specially designed governing system, constructed with very close attention to mechanical details and with special provision made to give it great flexibility, so that any conceivable operating condition can be met without interruption to service. How well the problem has been solved is shown by the fact that a momentary speed variation of only eight per cent is produced when full load is suddenly thrown off, as in the case when a circuit breaker goes out, instantly freeing a unit of all load.

The hydraulic power house shown in Fig. 1 is favorably situated at a distance of about one mile from the business district, where most of the load is absorbed, and only about seven miles from the quarries, where a smaller portion of the current is used, so that transmission at generator voltages is entirely feasible. The apparatus is placed in a building constructed of concrete and the close-grained red granite from the vicinity, sufficient granite having been quarried in the excavation of the basement from the extensive ledges in which it is placed, to furnish ample material for the superstructure.

THE DAM AND STORAGE ARRANGEMENTS.

The dam, together with part of its retaining walls is constructed of concrete on a bed rock foundation for its entire length of 600 feet. As shown in Fig. 2, it is supplied with flashboards which raise the head three feet and very materially increase the storage capacity of the pond. It has an area of 16 acres at low water, while at maximum high water about 21 acres are covered by the mill pond proper. Another dam a short distance up the river furnishes 65 acres of storage capacity, the two together rendering the handling of the evening peak load a simple matter when the river is at its normal flow. The dam is supplemented by aproximately 2,000 feet of retaining wall on each side of the river. That on the west side is of concrete, while the east wall is of solid granite masonry 4 ft. thick. The fore-bay is designed to prevent interruption from ice formed by the excessively low temperature sometimes encountered. This result is accomplished by means of a slow movement of the intake water, there being no opportunity to get rid of the ice problem in any other way. There is also an additional safeguard in the use of a submerged arch under which all intake water must pass before entering the penstock. This plan has given entire satisfaction, there having been no interruption from ice during the three years the plant has been in operation.

On passing through the head gates, the water is conveyed to the power house through 700 feet of 7 foot plate steel penstock, having at its lower end a surge tank, 16 feet in diameter and 62 feet high, which amply takes care of any sudden pressure changes due to the violent fluctuations of the load. This tank is shown in Fig. 1, in front of the station. Flange diaphragm expansion joints are used in the pipe line, which absorb the expansion changes due to variation in temperature, such changes have been found to be several inches.

POWER HOUSE EQUIPMENT.

Reaching the power house, the water is led in by a 10 foot header, from which are taken the 54-inch feeder pipes to supply the three main units. These are 850 H. P., 300 R. P. M. 30-inch single vertical Francis turbines, enclosed in plate steel spiral casings. This type was adopted as a part of the means necessary to properly meet the high flood water conditions sometimes occurring, and because of the high efficiencies obtainable with this type of turbine under the moderate head of 60 feet, which is the usual operating condition.

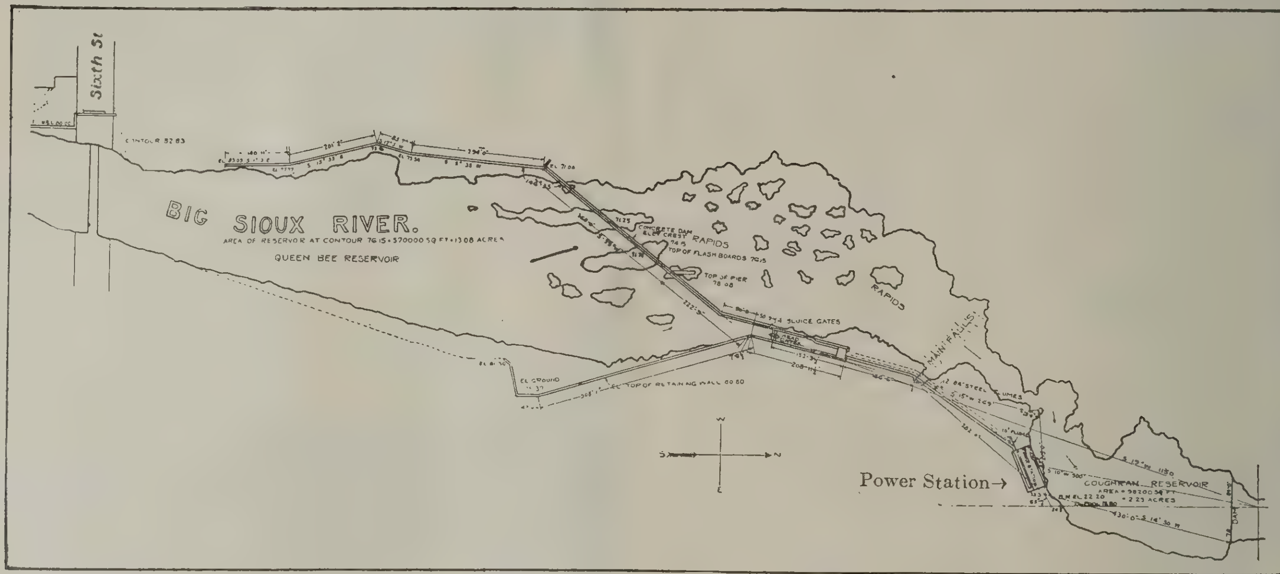


FIG. 3. MAP OF THE HYDRO-ELECTRIC DEVELOPMENT AT SIOUX FALLS.

Each turbine is direct connected by clamp couplings to a 500 K. W. alternator of the mushroom type, delivering 60-cycle 3-phase current at a pressure of 2,300 volts to the main bus-bars. All revolving elements, including generator rotor, shafting and fly-wheel, as well as the turbine runner, are supported on a thrust bearing of the plain collar type running in a simple oil bath, kept cool by water cooling coils immersed in oil. In practice, this method has proved

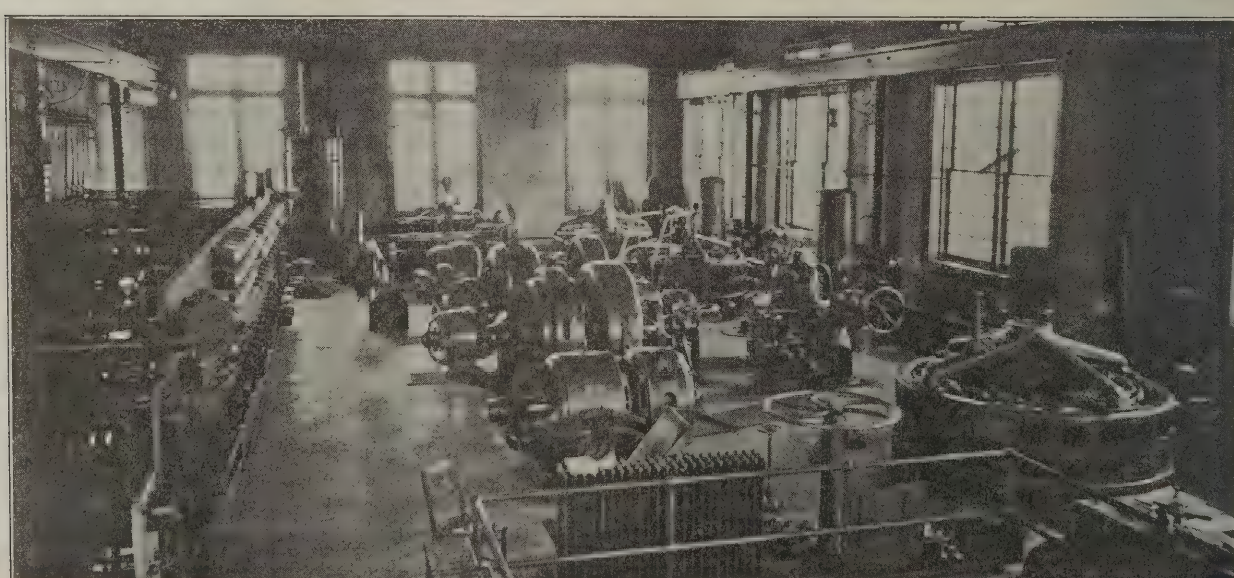


FIG. 4. INTERIOR OF THE POWER HOUSE OF SIOUX FALLS LIGHT AND POWER COMPANY.

safe and economical, requiring no pressure pumps, or other auxiliary apparatus, and in every way giving entire satisfaction in service.

In addition to the main units there is an exciter unit, driven by a 100 H. P. turbine of the same general type as the main units. This is direct connected to a vertical generator, capable of delivering 400 amperes at 125 volts, under normal rating, while running at a speed of 600 R. P. M., a sufficient speed to fully excite the three existing units, and a fourth for which space has been provided. In case this exciter unit should be disabled, its duty can be taken by a motor generator set, taking current from the main busbars at 2,300 volts, and delivering direct current of the same characteristics as the turbine driven unit. It has, of course, the disadvantage of varying in speed with the main units in case of violent load fluctuations, its delivered excitation current must vary accordingly. This renders commercial regulation much more difficult to be obtained than is the case with the turbine driven unit, which is entirely independent. All the turbines are controlled by oil pressure speed governors, which are of an unusually efficient design, as evidenced by the fact that there is a momentary speed rise of only 8 per cent, in case the load is suddenly thrown off, as when a circuit breaker puts a unit out of service.

The oil system has been arranged to provide for any conditions of operation which can arise, except those caused by entire neglect. Each unit has its own governor, and the three main units are each supplied with a rotary oil pump, thus rendering each entirely independent. A steel pressure tank capable of holding two to three barrels of oil at any pressure up to 250 pounds per square inch, is provided with each pump, and normally has its top half filled with air under pressure. This acts as a reservoir of energy to aid in rapidly accelerating the oil in its outward flow in case of sudden changes of load and a consequent heavy demand for oil pressure to open or close the wicket gates of the turbine. The pressure tanks of the pumps are provided with an automatically operating relief valve, which can be

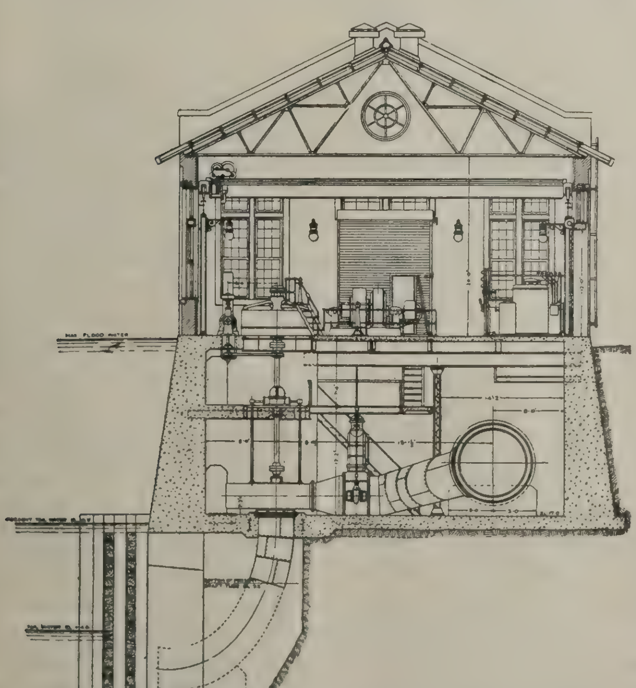


FIG. 5. END ELEVATION OF THE POWER HOUSE.

set at any predetermined pressure, and which allows any excess oil to escape when necessary.

After the installation was completed, some simple tests were run to determine the capacity of the oil system. It was found that with all outlets closed, pressure could be raised in the tank by any pump from atmospheric to 150 pounds gage in one minute from the starting of its individual motor dirve. With the three pumps and pressure tanks, together with about 50 feet of 3 1-2 inch pressure header thrown together in parallel, pressure was raised on the whole system to 150 pounds gage. The pumps were then stopped and one of the main units was started and kept running under no load with governor regulation for 9 minutes, when the gage still registered 65 pounds pressure.

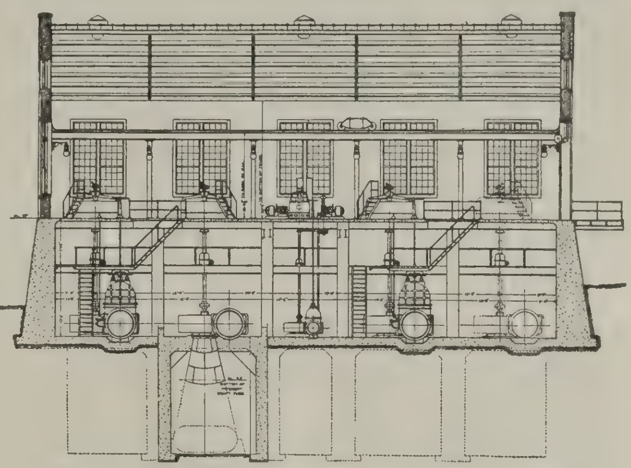


FIG. 6. SIDE ELEVATION OF THE POWER HOUSE.

A similar test with the exciter unit only running, showed the system to have sufficient capacity to keep that unit operating for 20 minutes with a like drop in pressure. These simple tests show that enough storage capacity is provided in the oil system to give any good operator plenty of time to cut in another pump in case of failure of the one operating, without in any way interfering with the normal running of the plant, a condition certainly to be desired in handling ordinary commercial loads.

The remaining apparatus of the station consists of three motor generator sets of some 350 K. W. normal aggregate capacity, taking alternating current at 2,300 volts and delivering direct current at 550 volts, for the street car and elevator service about town. The usual switchboard apparatus, together with a Terrill regulator, lightning arresters, constant current transformers for arc lighting, etc., is furnished, and together with the main units above described, comprise an up-to-date installation.

The plant is heated by a small steam boiler and the condensation water is returned from the lowest point in the system by an automatically controlled motor-driven pump. A combination of arc and incandescent lights serves to illuminate the station at night, while abundant windows furnish good daylight illumination.

Some of the operating conveniences are worthy of mention. The basement is entered by a stairway at either end, thus saving many steps for the operators. Two 12 by 12 foot wells, one at each end of the building, enable a hand crane of sufficient capacity to handle any required lift in the dismantling of any apparatus, and to serve the basement as well as any point upon the generator floor. This is a point of economy and convenience only fully appreciated when one has had experience in similar stations where galleries, etc., made important generator floor lifts impossible, and a tightly closed basement filled with the heaviest machinery was inaccessible to the crane, except after the exercise of much ingenuity and the use of numerous pulleys and ropes.

THE STEAM STAND-BY PLANT.

This is the original plant of the combination and is situated on the river bank about three-quarters of a mile above the hydraulic plant. It contains two Heine Safety boilers of about 400 H. P. each, generating steam at 135 pounds pressure. These formerly supplied steam to two 20 by 42 inch Corliss steam engines, which are belted to a jack shaft from which the generators are driven by long belts. These engines were originally built for 85 pounds steam pressure and are now operating at a steam pressure 60 per cent in excess of that for which they were desigend, and have also been speeded up. The fact that under such decisive changes in working conditions they have continued satisfactorily in service, is abundant proof that their original design was correct and liberal.

For those times when the load becomes too heavy for these units to carry it, an 800 K. W. 3,600 R. P. M. steam turbine unit was installed, together with a barometric condenser and two exciter sets, one driven by a modern high-speed steam engine, the other a motor generator set. The erection of this unit has recently been completed, and forms a good example of modern tendencies in power plant work. The old engine room, with its 40 by 80 feet of floor space, filled with engines, jack shafts, and long heavy belts, expensive in first cost and subsequent upkeep, capable of delivering but 600 K. W. when forced, looks superannuated indeed, beside the new generator room, with but 20 by 27 feet of floor space housing a high-speed machine capable of easily delivering 1,000 K. W., with but a trifling increase in steam consumption, and very small upkeep cost. With all other improvements, a better speed regulation has come about since the installation of the turbine unit, as it has been found that operating either alone or in parallel with the hydraulic plant, the variations in voltage are so slight as to be imperceptible. This is a decided improvement over the old conditions, as when the engines alone were in service, it was possible to count their R. P. M. by watching the flicker of any incandescent lamp on the circuit, but, in justice to the engines, it should be stated that they were designed many years ago, when the use of electricity was in its infancy, and when the need of accurate regulation and uniform angular velocity in electrical work was not as clearly recognized as it is to-day.

The hydraulic plant of this combination stands as a good example of what modern engineering may do in the face of none too favorable circumstances, and as such may prove worthy of study by those who are to handle developments of a similar character. The prime movers in these two plants, including the two Corliss engines, the steam turbine with its exciter sets, its barometic condenser and centrifugal circulating pumps, the direct connected turbo-generator, the three hydraulic turbines with their direct connected generators, and all governors, oil pumps and other auxiliaries, were built and installed by Allis-Chalmers Company. The belted generators in the steam plant are of General Electric make, and formed part of the original equipment. The hydraulic plant was built under the supervision of H. M. Byllesby Co., who are responsible for the convenient design of the building.

Conditions, Practice and Developments in English Central Stations.

(*Contributed Exclusively to* Southern Electrician.)

BY CECIL TOONE, AN ENGLISH ELECTRICAL ENGINEER.

Boiler House Practice and Fuel Economies.

IN the recently completed articles on Central Station Practice and Developments in England, appearing in the February to May issues of this year, the writer endeavored to review, as completely as possible within a limited space, the general developments of central stations in England, as regards their upgrowth, expansions, general supply conditions and rates. Such a review had inevitably many shortcomings and, treating as it did mainly of electric supply to domestic and small power consumers and of electric street lighting, those stations having traction load were omitted from consideration. The writer, therefore, proposes to deal in greater detail and for both traction and non-traction stations with the following topics: Plant equipment, station layout, distribution features and operating costs. This article is the first, coming under the first topic.

Many difficulties appear in an endeavor to present an adequate condensed treatment on these subjects, however, the writer will place American readers as closely and as accurately as possible in touch with the present status and practice of central station engineering in England.

The central stations of Great Britain and Ireland will be divided into two main groups, those supplying lighting and power loads alone being referred to as L, and those also supplying tramways or light railways as M. Stations supplying tramways or light railways alone will be considered in a separate section as they are relatively few in number. The stations in each main group will be further subdivided according as their generator capacity as: (a) less than 100 kw.; (b) 100 or over and less than 250 kw.; (c) 250 or over and less than 500 kw.; (d) 500 or over and less than 1000 kw.; (e) 1000 or over and less than 2500 kw.; (f) 2500 or over and less than 5000 kw.; (g) 5000 or over and less than 7500 kw.; (h) 7500 or over and less than 10,000 kw.; (k) 10,000 or over and less than 15,000 kw.; (l) 15,000 or over and less than 20,000 kw.; (m) 20,000 or over and less than 30,000 kw.; (n) 30,000 or over and less than 40,000 kw. The fine subdivision of the smaller stations is considered advisable, since 35 per cent of the lighting and combined lighting and traction stations in the United Kingdom have a generator capacity of less than 500 kw. By the reference letters given here the various groups are hereafter quoted.

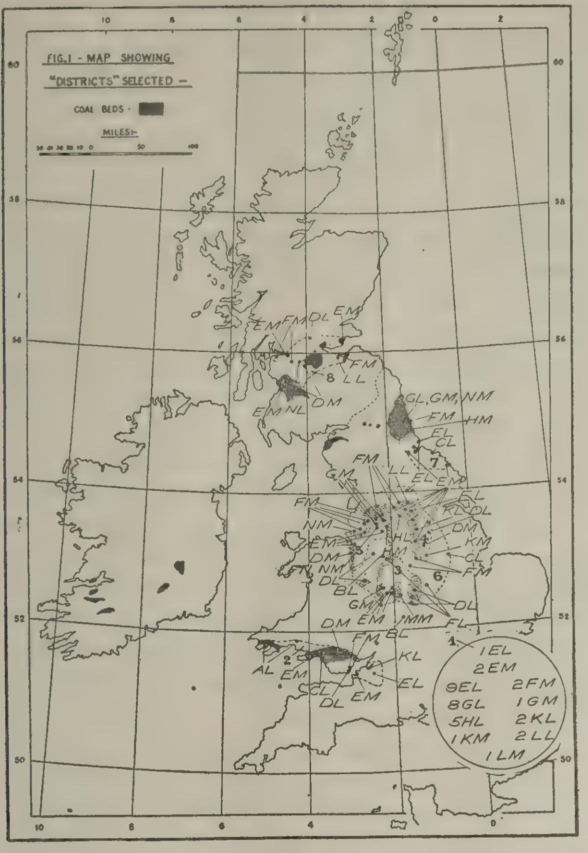


FIG. 1. DISTRIBUTION OF CENTRAL STATIONS IN ENGLAND.

In addition to the above kilowatt classification, it will be interesting, in many cases, to consider separately the central stations lying within the great industrial and mining districts of this country, since these naturally operate under different and more favorable conditions than those, for instance, supplying a lighting load in an agricultural town. To delineate the proposed district classification, the author has prepared the map shown in Fig. 1. It is unnecessary, for the present purpose, to attach names to all the dots which may be identified by reference to any ordinary atlas, but two code letters have been inserted in each case. The first letter refers to the kilowatt group to which the station belongs, as given above, while the second letter, L or M, indicates that the station has no tramways or has tramway in addition to a general load, as the case may be. It is important to note that although the stations in group L have no traction load, the towns in which they are situated may have an important tramway system, fed from a purely traction station, Glasgow being a case in point. A separate map dealing with purely traction stations and bulk supply areas will be presented in a later section. Before going further, it will be convenient to present a brief analysis of the more important factors relating to the stations in each of the groups now adopted. Tables 1 and 2 present leading data concerning stations.

BOILERS, FUELS AND BOILER HOUSE PRACTICE.

In the present section are considered the types and capacities of boilers, the classes of fuels, the supply and treatment of feed water and the more important of the auxiliary plant and operations involved up to the engine stop valve,

TABLE 1. PARTICULARS OF STATIONS HAVING NO TRAMWAY LOAD.

	STATION GROUP.											
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(k)	(l)	(m)	(n)
No. of Stations	38	55	54	53	37	17	10	4	4	7	1	1
Ditto with D. C. Supply	37	45	43	45	24	7	2	2	1	1	--	1
Ditto with A. C. Supply	1	7	6	5	10	7	7	1	2	2	--	--
Ditto D.C. & A.C. Supply	--	3	5	3	3	3	1	1	1	4	1	--
TOTALS												
Population (1000's)	138.4	3837	740.6	1210	2080	1839	1654	330.3	949.3	837.1	City of London	803
Consumers (1000's)	4.23	12.24	19.41	38.71	55.14	31.51	25.25	10.04	15.44	36.1	13.9	19.52
Supply Area (sq. mls.)	100	51	190	304	146	112	87	22	33	133	--	18
Kilowatts Connected (1000's)	4.83	15.91	31.35	65.85	224.1	119.0	98.71	36.35	60.08	140.9	37.39	52.77
Kilowatts Plant (1000's)	2.02	9.12	19.65	34.04	65.88	60.38	62.62	35.59	48.78	100.4	25.00	39.44
Mean Year of Opening	1900	1902	1901	1897	1899	1895	1896	1894	1897	1895	1891	1893
AVERAGES												
Population (1000's)	3.64	7.38	13.72	22.84	56.22	108.2	236.2	165.2	316.4	418.6	--	803.0
Consumers (1000's)	0.11	0.23	0.37	0.73	1.46	2.18	2.81	3.31	5.15	9.03	13.9	19.5
Supply Area (sq. mls.)	9.0	2.5	7.0	7.2	5.0	6.2	10.9	7.3	11.1	19.0	--	18.0
Kilowatts Connected (1000's)	0.13	0.31	0.63	1.22	6.06	5.95	10.97	12.12	20.04	23.47	37.39	52.77
Kilowatts Plant (1000's)	0.05	0.16	0.36	0.64	1.78	3.55	6.26	8.90	12.20	16.74	25.00	39.44

TABLE 2. PARTICULARS OF STATIONS HAVING LIGHTING AND TRAMWAY LOAD.

	STATION GROUP.									
	(c)	(d)	(e)	(f)	(g)	(h)	(k)	(l)	(m)	(n)
No. of Stations	4	26	63	25	11	2	3	--	1	3
Ditto with D. C Supply	3	22	43	5	2	--	1	--	--	1
Ditto with A. C. Supply	--	1	17	1	1	--	--	--	--	--
Ditto D. C. & A. C. Supply	1	3	3	19	8	2	2	--	1	2
TOTALS										
Population (1000's)	90.3	840	3323	2690	1634	246	922	--	548	1880
Consumers (1000's)	1.60	10.2	51.5	41.4	19.6	1.68	9.38	--	4.25	23.0
Supply Area (sq. mls.)	12.5	134	403	248	60	18.8	26	--	20	419
Kilowatts Connected (1000's)	2.07	20.3	124.4	126.6	65.8	16.6	37.8	--	26.4	189
Kilowatts Plant (1000's)	2.17	20.3	102.3	84.3	66.1	17.5	32.3	--	20.5	148
Mean Year of Opening	1903	1903	1899	1897	1896	1900	1895	----	1891	1888
AVERAGES.										
Population (1000's)	22.6	32.3	51.6	101.6	148.6	122.9	307.2	--	548.0	626.8
Consumers (1000's)	0.40	0.38	0.82	1.73	1.96	0.84	3.13	--	4.25	7.67
Supply Area (sq. mls.)	6.25	8.0	7.6	11.0	7.5	9.4	13.0	--	20.0	209.0
Kilowatts Connected (1000's)	0.52	0.85	1.63	5.25	7.31	8.32	12.62	--	26.4	63.1
Kilowatts Plant (1000's)	0.43	0.78	1.62	3.37	6.00	8.75	10.75	--	20.5	49.3

in British central stations using steam boilers for any purpose whatever—whether for the supply of steam engines or turbines, as is the case in the majority of stations, (see Table 3), or for supplying steam to gas producers, etc. The number of stations employing steam driven prime movers, oil or gas engines and water turbines respectively is shown in Table 3. It will be seen that steam stations are enormously preponderant in this country, while water turbines are practically confined to stations of less than 300 kw. capacity. Gas and oil engines are gradually finding application in larger stations and in some of the private generating stations of colliery groups, many thousands of kilowatts are provided by blast furnace gas engines. Such stations lie beyond our present consideration and a detailed treatment of prime movers will be postponed to a later article.

TABLE 3. STATIONS USING BOILERS, GAS OR OIL ENGINES OR WATER TURBINES.

Station Kilowatts Group	Steam Boilers	Gas Engines	Oil Engines	Water Turbines.
(a)—L	13	19	3	7
(b)—L	32	19	7	7
(c)—L	44	9	4	2
—M	4	--	1	--
(d)—L	54	2	5	--
—M	28	--	1	--
(e)—L	39	--	--	--
—M	69	2	--	--
(f)—L	19	--	--	--
—M	25	--	--	--
(g)—L	8	--	--	--
—M	15	--	--	--
(h)—L	9	--	--	--
—M	4	--	--	--
(k to n)—L	14	--	--	--
—M	7	--	--	--
Totals;—L	232	49	19	16
M	152	2	2	--
L & M	384	51	21	16

BOILER HOUSE BUILDINGS.

Great improvements have been made of late years in the design of boiler house buildings. It is now considered good practice, in both private and central station work, to provide light and airy boiler houses with plenty of room for the accessory plant required, enabling easy inspection and maintenance of every part of the equipment and allowing the boiler staff to work comfortably. The increasing complexity of boiler house auxiliary apparatus, including overhead conveyers and fuel hoppers, further favors the construction of more elaborate boiler houses.

The chief advances which have been made during recent years in smoke stack construction concern the use of steel and reinforced concrete structures. Steel plate stacks are used in a considerable number of industrial installations, but their well known limitations, coupled with the very unfavorable climatic conditions generally obtaining in this country have led to their restricted use, especially in large stations where the higher capital cost of brick chimneys is of less serious importance. Undoubtedly the brick stack is still the most popular type in this country, though reinforced concrete will be widely used in new installations.

Many as are the varieties of boilers used in English central stations, they may be classified, for the present purpose, as belonging to one or other of the following main types: Cornish, Lancashire or Galloway; Locomotive or Vertical; Marine or Dry-back; Water Tube. Each finds its special application and each is more or less widely used in English central stations, but by far the commonest types now in service are the Lancashire and Water-tube boilers.

Principles of Illuminating Engineering.

(*Contributed Exclusively to* Southern Electrician.)

BY A. G. RAKESTRAW.

Discussion of Lamps Employing a Filament in Air, Including the Nernst.

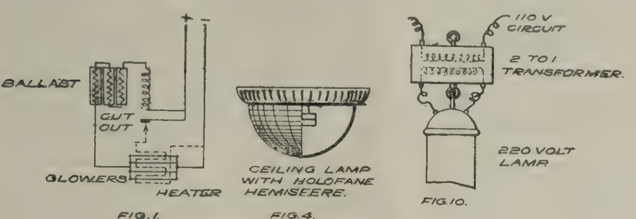
IN what follows, that class of lamps will be taken up which are denoted as filaments in air, as distinguished from those described in a preceding article, which were constructed with filaments operating in a vacuum. The reason or necessity of operating nearly all filaments in a vacuum is that at the temperatures employed for efficient operation, the material would rapidly oxidize, and consequently be soon destroyed. If, however, a substance can be used which is unaltered at such temperatures in the presence of oxygen, a vacuum is unnecessary for its protection.

The only commercial example of the "filament-in-air" type, as the Nernst lamp, which uses a filament composed of certain rare earths, mixed into a clay and moulded into shape. One peculiar characteristic of this is that it is non-conducting when cold and, therefore, some means must be provided by which the temperature of the filament shall be raised to a sufficient point to render it conducting. After which the heat generated by the passage of the current through the filament itself will keep the temperature constant. In the first experimental forms of this lamp, the external heat was applied with a match, which was thus a rather curious anachronism. In the commercial type of lamp, however, this heating is performed electrically.

Since the Nernst lamp forms a class by itself, presenting some interesting and peculiar characteristics, without which a study of illumination sources would be incomplete, we shall devote some space to describing it in detail, and will illustrate the remarks with manufacturers cuts, not with any idea of advertising the lamp, but in order to furnish information which may not be familiar to the majority of readers. We will, therefore, consider the commercial forms in which this lamp is made, and also the characteristic features which it possesses.

The Nernst lamp consists simply of a filament or filaments, which are termed glowers, a heater for bringing the glower to incandescence, and an automatic device for cutting the same out of circuit when this purpose has been accomplished. Since the resistance of the golwer decreases rapidly as it is heated, it is also necessary to use a steadying resistance or ballast, which is composed of very fine iron wire enclosed within glass tubes—filled with an inert gas to prevent oxidation. The resistance of this ballast increases rapidly with the temperature, thus compensating for the decrease in resistance of the filament and putting a limiting value on the current. Fig. 1 shows the internal connection of the lamp, in which G is the glower, H the heater, B the iron wire ballast and S, a solenoid in series with the glower, which opens the heater circuit when the current through the glower has reached a self-sustaining value.

The ordinary multiple-glower type of lamp is shown in Fig. 2. The single-glower type is similar, being designed to be screwed into an Edison socket. The cylindrical part of the lamp case contains the ballast and cutout mechanism,



Figs. 1, 4 and 10, Showing Features of Nernst Lamp.

below which is mounted the heater and glower or glowers, on a piece of poreclain, as shown in Fig. 3. This part of the lamp is termed the burner and is provided with prongs which serve as conductors of the current, thus facilitating the removal of the burner for the purpose of renewing burned out glowers or heaters. The mounting of the glower on the burner itself requires considerable skill and is not usually attempted, except by large consumers, who can employ some person who is skilled in this work. The multiple glower lamps are made with two, three, four and five glowers. The globe used is not air-tight, but is necessary for the purpose of screening the eye from the intense brilliancy of the filament. The globe is either white or blue alabaster, sand-blasted or dense opal, acording to the degree of absorption required. No reflector is used with these lamps, since the white poreclain support serves as the reflector, throwing nearly all of the light in the lower hemisphere.

Besides the form of lamp shown in Fig. 2, another form is illustrated in Fig. 4, which is used where it is desired to mount the lamp directly on the ceiling. While this may be fitted with the same glassware as used with the suspended type, better results can be secured by the use of a Holophane reflector, which gives more efficient distribution as well as a beautiful sparkling radiance. In the case of high ceilings, where it is desired to drop the lamp some distance, it may be suspended on a chain or pipe. The mechanism also lends itself readily to ornamental effects.

In all of the foregoing instances, we have considered that type of construction in which the heater, glower, ballast and cutout mechanism were combined in the same case. We have, however, already noted the fact that the replacing of the heater and glowers requires considerable mechanical skill, and in order to aid the use in this respect, as well as to vary the design of the lamp and improve it from an ornamental point of view, the idea was conceived of enclosing the balast and cutout mechanism in an independent case, and providing one or more screw receptacles, into which a small lamp or burner, as shown in Fig. 5, could be inserted. This burner contains a single glower with its necessary heater enclosed in an alabaster globe, and can be removed or inserted in its receptacle as easily as an ordinary

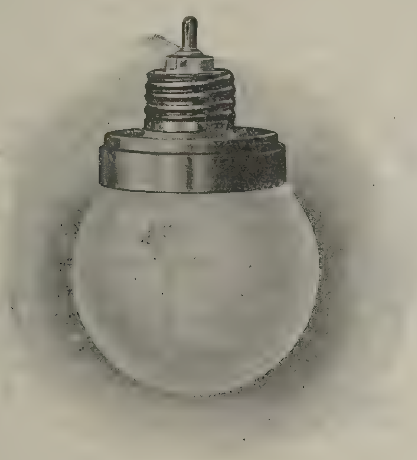


Fig. 5. Heater and Glower as a Unit.

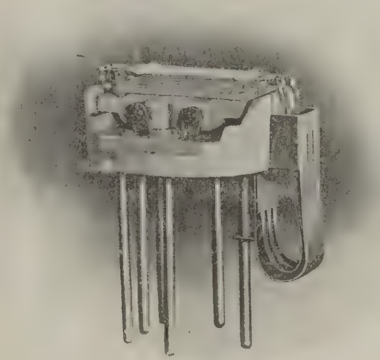


Fig. 3. Heater and Glower of the Nernst Lamp.

incandescent lamp. The customer need, therefore, only provide himself with extra burners and return the burned out ones to the factory for renewal.

This type of construction is illustrated in Fig. 6, representing a chandelier arrangement, and can, of course, be used for showers, shop clusters, and in fact, nearly any design for incandescent lamps. And where individual lamps are required for local illumination, there are single glower drop cords, as illustrated in Fig. 7.

As regards the characteristics of this lamp from an illuminating standpoint, it has several peculiarities which attract attention. Prominent among these is the slowness of the lamp to light when the current is turned on, due to the preliminary heating process already described, taking about 45 seconds. For commercial work, this is not a

Fig. 2. The Multiple Glower Lamp.

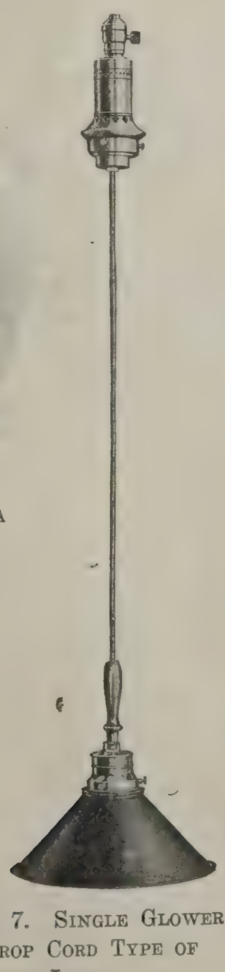


Fig. 7. Single Glower Drop Cord Type of Lamp.

serious objection, but for residence use there should be some other sources in the same room, which will produce light immediately.

Another distinctive feature of the Nernst Lamp is that of its multiple glowers. If one or two glowers on a multiple glower lamp burn out, the lamp may still remain in service with a proportionate reduction in candle power, until such time as they can be conveniently renewed; whereas, with other types of lamps, failure of the filament may produce serious inconvenience.

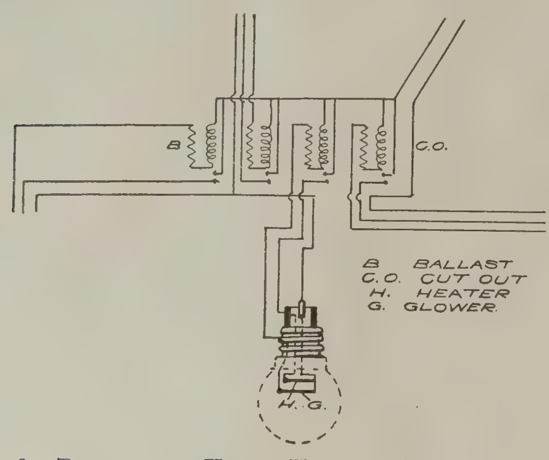


Fig. 6. Diagram for Use of Units as Shown in Fig. 5.

The intrinsic brilliancy of the filament is very high, and must, therefore, be very carefully screened from the eye. In fact, these lamps should be used only where persons cannot conveniently look long at them. The alabaster or sand-blasted globes used with them reduce the brilliancy considerably, and yet it is still so high that the lamps are suited only for general illumination and placed high over-head. The color of the light given by the naked filament is very nearly white, with possibly a slight yellowish tinge. The color of the light is, of course, modified by the glassware which strengthens the proportion of red and yellow rays. However, the light is much more nearly white than the ordinary carbon incandescent lamp, and it is therefore suitable for offices, stores, and in fact for general illumination anywhere. As already stated, the distribution of the light is practically confined to the lower hemisphere. Fig. 8 gives a characteristic distribution curve for the multiple glower lamp. While this may be modified if necessary by the use of a reflector, yet since it is adequate for the ordinary requirements of general illumination, reflectors are hardly ever used.

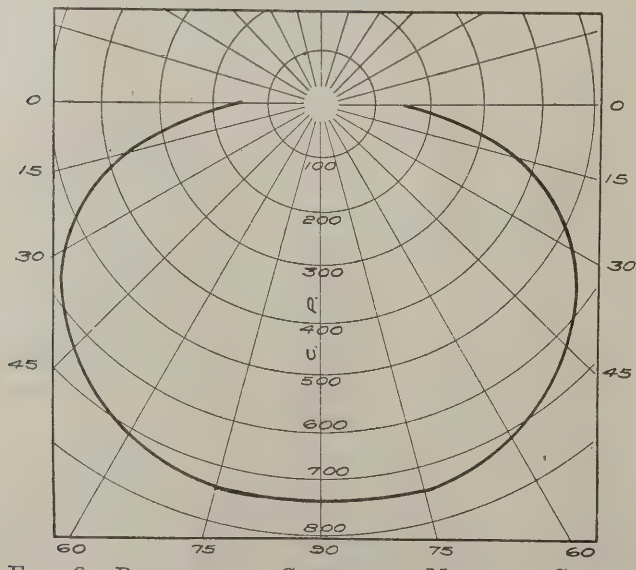


Fig. 8. Distributing Curve for Multiple Glower Lamp.

As far as actual efficiency is concerned, this varies somewhat with the local conditions. The lamp is about double the efficiency of the ordinary carbon filament, used without reflector and on the basis of the total flux of light. When used without a reflector, the ordinary incandescent lamp is at a disadvantage, since so much of the light is not usefully directed. Therefore, when making a comparison between the Nernst Lamp and incandescent lamp, the performance of the latter when equipped with a reflector should be used. The following table gives the commercial sizes, together with the watts consumed, the mean lower hemispherical candle power and the approximate mean spherical candle power.

Data for Nernst Lamps.

Glowers	Watts	M. L. H. C. P.	Watts per M. H. C.P.	M. S. C. P.	Watts M.S.C.P
1	66	50	1.38	36.3	1.82
1	88	77	1.2	55.9	1.66
1	110	96.4	1.2	72.3	1.66
1	132	114	1.2	82.8	1.66
2	264	231	1.2	167.7	1.66
3	396	359	1.15	261	1.59
4	528	504	1.09	366	1.50
5	660	630	1.05	457	1.45

It will be noted that the watts per candle is not the same for sizes of lamps, but that the efficiency is greater with the increase in number of glowers. This relationship is shown in Fig. 9, which gives the variation of the candle power with the input. This effect is no doubt produced by the fact that the close association of the glowers causes them to run at a slightly higher temperature than they otherwise would. In this connection it is interesting to know that the protection of the filament is not the only advantage to be gained by using the vacuum, but that a vacuum increases the efficiency by preventing heat loss from convection, or circulating air currents. It has been shown that if the Nernst filaments were enclosed in a vacuum, instead of being operated in the air, that the efficiency would be much greater than at present.

In regard to the upkeep of the Nernst lamp, reliable

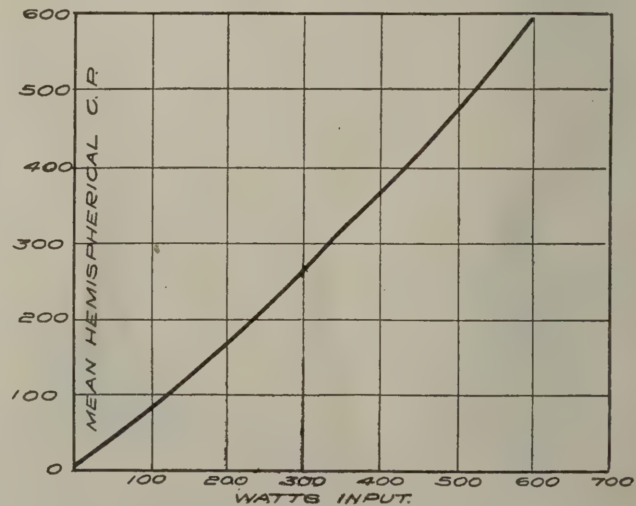


Fig. 9. Variation of Candle Power with Input.

figures are hard to obtain, and show considerable differences among themselves. There are three renewal elements, the glower, the heater, and the ballast, the lives of which may be figured at about 800, 3,000 and 15,000 hours respectively. A good estimate of the maintenance charges may be made by taking 5 cents per glower per month and adding to it for direct current lamps, 4 1-2 mills per K. W. H. and for A. C. lamps, 3 1-2 mills per K. W. H. At these prices the manufacturers of these lamps agree to keep them up within the territory which they serve. The depreciation in candle power during burning hours is about the same as that of the incandescent lamp, or about 20 per cent. Here, also there is some advantage in using the multiple glower, since in ordinary operation some of the glowers will likely be new and others about worn out, so that the average depreciation in candle power for the lamp will only be about one-half that of the individual glowers. The Nernst lamp is manufactured for both alternating and direct current circuits, but succeeds better on the former. It is disigned primarily for 220 volts, but is used on 110 volt circuits in connection with a small transformer coil, as shown in Fig. 10.

In general, we may say that the Nernst lamp has succeeded quite satisfactorily in places where it can be given expert attention. For small installations, it has given place largely to the tungsten lamp, which is somewhat higher in efficiency, has about the same upkeep cost and is certainly much smipler in the matter of replacement.

Electrical Energy in Textile Mills.

BY GEORGE K. HUTCHINS.
Commercial Agent of Columbus Power Co.

A SUBJECT of ever increasing interest and importance to the central station in the South is the application of electric power to the textile industry. Considerable material has been written on this subject, yet we feel that the author of this article has given the old facts such vital significance and added new ones in such valuable form that all will be generally interesting. The following is published nearly in the form as read before the Georgia section of the National Electric Light Association at Columbus, Ga., September 26.

The earliest record of an electric installation in Columbus is that of the Muscogee Manufacturing Company, which began its use January 1, 1898, and is now using the electric drive in all four of their mills, having relinquished a water power in exchange for this kind of service. This is not the first mill to use electric power, it was simply one of the pioneers. From the information I have been able to gather, there were installed in textile mills on December 1, 1903, 1,053 motors, aggregating 64,313 h. p., the average size of a motor being more than 61 h. p. By February 1, 1905, there were installed 1,740 motors aggregating 87,-614 h. p., the average size being slightly more than 50 h. p. The total increase in h. p. in 14 months being 36 per cent. On January 1, 1910, there were installed 10,491 motors aggregating 302,199 h. p. The average size again declined to less than 29 h. p.

The total increase in h. p. in four years and eleven months being 245 per cent. On June 1, 1911, there were installed 16,450 motors aggregating 387,975 h. p. The average size of motors again being reduced to 23 h. p. The increase in h. p. in the year and five months being 28 per cent.

A most remarkable growth is shown in the seven and a half years under consideration. The total increase in horse power during this period amounts to 603 per cent, while the increase in the number of motors installed is 1,562 per cent. These figures, while they constitute but a partial record of the industry, serve to demonstrate two salient facts: First—That the electric drive is fast growing into popularity with the textile industry, for the requirements of which it is pre-eminently fitted, and Second—That the tendency is towards the use of smaller units.

On December 1, 1903, there were 14 central stations supplying electric power to textile mills; by February 1, 1905, this had grown to 23 central stations, and of these two were operated by steam, seventeen by water wheels and four by steam engines and water wheels combined. On January 1, 1910, there were 79 central stations supplying electric power to textile mills, of which 39 were operated entirely by steam, 26 entirely by water and nine by steam and water combined. Five we have no record as to the source of power. These figures serve to emphasize a growing tendency towards shifting the power problem from the shoulders of the mill man to that of the central station. The most remarkable feature about these figures, however, is the fact that, while in 1905 there were only two steam stations supplying this class of industry, there were thirty-nine supplying textile mills by January 1, 1910. This fact implies the ability of steam operated central stations to supply electric power upon a competitive basis as to cost with power generated by the mill, a rather startling idea when it is borne in mind how very low this cost is estimated to be by many of our textile friends, or else there are other compensating advantages that offset increased cost.

Among the distinctive features of the electric drive may be mentioned the great flexibility, constant and uniform speed, better quality of product, a substantial increase in product, conservatively estimated at an average of 10 per cent. The elimination of shafting and belting is in itself desirable, for it not only means the saving of expense, but reduces the chance of accidents, saves annoyance and delay in repairing broken belts, and adds to the general appearance, hygienic conditions and available light.

A test recently made in a mill having a mixed installation consisting of one 300 h. p. 5,500 volt 2-phase synchronous motor with rope transmission, running cards and most of the preparatory machinery, together with all looms and a group of four frame drive consisting of nine 20 h. p. 550 volt induction motors driving spinning frames, and one 5 h. p. elevator motor, showed the following results: The test was made from the switch board situated about 30 feet distant from the primary synchronous motor and an average of about 300 feet distant from the induction motors. Indicating wattmeters being used and readings taken every minute.

The maximum load observed on the synchronous motor was 196.2 h. p. The total losses in motor, shafting and belting running idle with all machinery on loose pulleys, was 62.4 h. p., equivalent to 31.62 per cent, based on maximum load, or 20.68 per cent, based on the rating of the motor. The induction motors were supplied through two 150 k. w. transformers, the power being measured on the primary side, and consequently including the losses of transformation through transformers of about twice the necessary capacity. The maximum load observed was 128.7 h. p. The electrical and mechanical losses with all machinery stopped and motors running on loose pulleys was 26.94 h. p., equivalent to 21 per cent based on the maximum load, or 14.56 per cent based on the rated capacity of the motors. The power loss in the transformers, with no load, was found to be 5.36 h. p., or 1.33 per cent of the capacity of the transformers. Even with this handicap, the group drive shows saving of about 33⅓ per cent in frictional and electrical losses.

In the case of a new mill about to be built, where there is a choice of central station service or the installation of its own plant, the mill can afford to purchase power at a very much higher price than that at which it can produce its own steam power, and the mill that is so far-sighted as to select for its location the vicinity of a large hydroelectric development where power is usually sold at a lower price than steam power can be generated, is indeed fortunate. To illustrate, a steam plant including the necessary engines, boilers, stack, reservoirs, ropeway, buildings, extra heavy shafting and sidetrack for coal, will cost from $70.00 to $90.00 per horse power, the mean of these two figures, $80.00, being about the cost for a 1,000 h. p. plant. An electrically equipped mill of the same size, with group drive fairly well divided into small units, will cost approximately $25.00 per h. p. The initial saving in non-producing investment will therefore be $50,000. There will also be a saving in space in the main building which can be so designed as to provide for a larger installation of producing machinery. Assuming that this $50,000 is invested in producing machinery thus adding approximately from 12 to 15 per cent to the capacity of the mill, you will then have 112 per cent of the productive machinery as compared with 100 per cent for the steam driven mill. Now, if to this be added say an average of 7 to 8 per cent in increased output, to be conservative, due to the uniform speed of the electric drive, we have a mill whose power of production as compared with steam is in the proportion of at least 120 to 100, an advantage so great that it becomes economical to purchase power at a very much higher price than steam power will cost to produce.

A steam driven mill of 20,000 spindles working on medium size yarn will require about 1,000 h. p. It will usually be capitalized at about $500,000 and will have invested in plant about $400,000. The gross output when under full operation will approximate $1,000,000 per annum. In the case of the electrically driven mill the increase in gross output would be $200,000 more, and assuming a profit of 10 per cent would enable the mill to pay $20,000 more for electric power per annum than for steam, without suffering any actual disadvantage in so far as power costs are concerned. In the case of an old mill already equipped with a steam plant the advantages are less because in addition to the investment already made it will require the further investment in motors. But notwithstanding this additional investment, the advantages derived from improved quality and increased output quite offset the interest and fixed charges, while the elimination of shafting and belting reduce frictional losses and fully offset the increase in power required for additional output.

That a distinct advantage results from the electric drive is very well illustrated by the growing practice of converting many steam driven mills into electrically driven ones by the installation of motors and generators where central station power is not available. Up to January 1, 1910, my incomplete statistics show that there was installed in textile mills a generator capacity of 234,000 horse power. The electric motor as a prime mover for textile mills affords the only known means for readily, definitely and accurately measuring the average energy consumption over any considerable period or throughout the year. The power delivered by all other types of prime movers can only be measured momentarily, and usually over short periods. The results thus indicated only approximate the average energy required. It is largely due to this fact that economies in steam engine operation are not infrequently claimed that are quite astonishing. The problem is further complicated when an ambitious engineer, starting out with his theoretical horse power based on the maximum indication of his engine, arbitrarily sets aside a liberal percentage of the coal consumption to the account for heating and slashing, and figures out a fine economy. It is, however, logical to reason that the management of a mill will gauge its operating costs by the total annual expenditure in dollars, without reference to the number of horse power estimated to have been used, and it is upon this basis that central stations may approach the problem with some reasonable expectation of interesting him in central station service.

The information given at the end of this article will be found sufficiently full for both the business man and the technical expert to obtain a fairly good idea of the power requirements in the various kinds of mills cited, and will serve to illustrate certain characteristics that appear to be common to all. The monthly load factor shows the ratio of the average load to the maximum demand for the month based on the actual hours of operation. The yearly load factor shows the ratio of the average load to the maximum demand for the year based on the total number of hours operated during the year. The 24 hour or station load factor is given in the last column and is also based on the maximum demand for the month or year respectively. The method of calculating load factor is explained at some length because the practice is not uniform throughout the country. In some instances theoretical 10 or 12 hour days are used, and in others 24 hours are taken, and unless the method is clearly set forth, the figures become meaningless and consequently useless. There is also another variant factor adopted, sometimes from choice and sometimes from necessity, that is the rated capacity of the motors installed. In the absence of instruments for determining the maximum demand it becomes necessary to use the horse power of the motors installed as a basis, and in the smaller installations, this method is usually practiced, but the method used herewith is the more exact one.

An average of the maximum demands taken for a 12 months period shows the following ratio of demand on the motor capacity installed: Cotton Mill "A" 71 per cent; Cotton Mill "B" 81 per cent; Cotton Mill "C" 85 per cent; Cotton Mill "D" 96 per cent; Cotton Mill "E" 80 per cent.

This does not necessarily mean that the mills are over motored, but rather demonstrates the fact that at all times some machinery is idle, or some motors are closed down.

COTTON MILL "A."

Character of buildings, two stories, brick, mill construction. Three separate buildings are used. Character of product, tickings, denims, cottonades and cheviots, finished and dyed. Raw stock dyeing yarns range from 8's to 20's. Number of producing spindles, 9,000; number of looms, 276; weaves from 25 inch to 37 inch cloth; consumption of cotton, about 3,000 bales.

The motor installation was: One 300 h. p. 5,500 v. 2-phase synchronous motor; one 50 h. p.; one 25 h. p.; one 5 h. p.; nine 20 h. p. 550 v. 2-phase induction motors. A total motor capacity of 560 h. p.

This mill uses the 50 and 25 h. p. motors for running openers, pickers and dye house, the 300 h. p. motor runs the main mill by rope transmission to a main line shaft driving cards and other preparatory machinery, except spinning frames. It also drives all the looms. The spinning frames are all in an adjoining new building and are driven by 20 h. p. four frame motors. The measuring instruments are connected on the primary side of the transformers. Primary voltage, 5,500; 2-phase, 60 cycles and secondary voltage, 550. The 300 h. p. synchronous motor is used directly on the primary voltage.

This mill was formerly driven by a compound condensing Corliss engine of 300 h. p. rating, for which the 300 h. p. synchronous motor was substituted. Additional machinery has been added from time to time. The new building is placed at right angles with the old mill and contains spinning machinery, beamers and slashers. This arrangement would have been impossible with mechanical drive except by adding another steam plant. The installation of electrical for mechanical drive was adopted despite the fact that not only were heating and slashing required but dyeing also. The maximum demand is ascertained by a graphic recording wattmeter, but disregards starting current and momentary fluctuations of less than one minute duration. The starting current does not usually exceed the maximum given in the table. The k. w. hr. consumption is determined by integrating wattmeters.

The following tabulation gives a record for 12 months in detail:

TABULATION FOR MILL "A."

DATE 1910	K. W. hours used regular run	Hours regular run per month	Maximum demand in K.W.	Maximum demand in H.P.	Monthly load factor	Load factor based on 24 hours day
April	53,200	243	290	388	75.21%	20.94%
May	55,400	231	280	375	85.65%	22.58%
June	56,400	243	300	402	77.36%	21.46%
July	58,700	249	280	375	84.19%	23.93%
August	69,900	276	300	402	84.42%	26.59%
September	58,900	250	280	375	84.18%	24.01%
October	62,500	255	295	395	83.08%	24.18%
November	66,100	254	303	406	85.86%	24.90%
December	62.900	254	310	416	79.88%	23.16%
1911						
January	70,400	265	330	442	80.50%	24.35%
February	61,100	243	305	409	82.44%	22.87%
March	66,400	276	300	402	80.19%	25.23%
Total	741,900	3039	......	......	......	......

Yearly load factor based on total hours of regular run, 73.97%.
" " " " " 8,760 " per annum, 25.66%.

Load factor is calculated on maximum demand and not on installed capacity.

COTTON MILL "B."

Character of buildings, brick, four stories, mill construction, one story weave shed. Character of product, mitcheline spreads, colored cotton cloth, ticking, denims, checks, covert cloth and cottonades. Dyeing and finishing. Average No. fourteen yarns. No. of producing spindles, 18,000. No. of looms, 414 narrow. No. of looms, 32 broad. Annual production, 2,650,000 lbs. of cloth. The motor installation was one 535 h. p. 5,500 volt-2 phase-60 cycle synchronous motor and one 200 h. p. 5,500 volt-2 phase-60 cycle synchronous motor with a total motor capacity of 735 h. p.

The mill is divided into three sections, two of which are driven through rope transmission by motors, a part of the weaving being driven by a Corliss engine developing 110 h. p. That portion of the mill now driven by motors was formerly operated by a twin engine. No records of the maximum demand are available previous to December 1910, at which time a graphic recording meter was installed. The horse power given for July to November 1910 being the average of 44 hours, i. e. the four highest daily runs during the months. The power factor is maintained at unity. The motors are started and synchronized and the mill load then thrown on by means of friction clutches.

The following tabulation gives a record for 12 months in detail:

TABULATION COTTON MILL "B."

DATE 1910	K. W. hours used regular run	Hours regular run per month	Maximum demand in K.W.	Maximum demand in H.P.	Monthly load factor	Load factor based on 24 hours day
July	95,000	227		622		
August	112,400	277		622		
September	109,300	255		625		
October	113,300	261		631		
November	107,300	266		634		
December	110,400	255	520	697	83.25%	28.53%
1911						
January	115,000	266	505	677	85.61%	30.61%
February	109,800	244	515	690	87.37%	31.64%
March	126,400	277	510	684	89.47%	33.31%
April	100,200	239	510	684	82.20%	27.28%
May	109,700	260	495	663	85.23%	29.78%
June	107,200	266	495	663	81.41%	30.08%
Total	1,226,000	3,093	......	......	......	......

Yearly load factor based on total hours of regular run, 76.96%.
" " " " " 8,760 " per annum, 27.11%.

COTTON MILL "C."

This mill operates preparatory machinery and spinning frames, the product from which goes to another mill of the same corporation and statistics as to production were not available. The power factor is maintained at or above 90 per cent by a 200 k. w. synchronous motor running idle. The power is furnished at 11,000 volts-3 phase-60 cycles and is stepped down to 550 volts.

The motor installation is as follows:

1-2 H. P. Total 2 H. P. -550 volt-3 phase induction motors.
7-5 " " 35 " " " " " "
10-7½ " " 75 " " " " " "
10-10 " " 100 " " " " " "
9-15 " " 135 " " " " " "
2-20 " " 40 " " " " " "
3-50 " " 150 " " " " " "
1-75 " " 75 " " " " " "
1-150 " " 150 " " " " " "

Total capacity, 762 H. P.

The total capacity for driving the mill proper is therefore 612 h. p. Owing to physical conditions the spinning machinery is run by four frame, two frame and single frame motors as required by the space available. The maximum demand was ascertained by a graphic recording wattmeter.

TABULATION COTTON MILL "C."

DATE 1910	K. W. hours used regular run	Hours regular run per month	Maximum demand in K.W.	Maximum demand in H.P.	Monthly load factor	Load factor based on 24 hours day
July	62,700	218	372	499	77.31%	22.65%
August	69,400	241	395	529	72.90%	23.61%
September	80,100	245	390	522	83.83%	28.52%
October	81,700	250	395	529	82.73%	27.80%
November	80,100	263	405	542	82.71%	30.21%
December	87,300	255	400	536	85.58%	29.33%
1911						
January	88,800	263	400	536	84.41%	29.83%
February	76,000	242	360	482	87.23%	31.41%
March	84,200	273	380	509	81.16%	29.78%
April	72,600	240	390	522	77.56%	25.85%
May	82,900	263	400	536	78.80%	27.85%
June	77,100	263	380	509	77.14%	28.18%
Total	950,900	3,016	......	......	......	......

Yearly load factor based on total hours of regular run, 77.84%.
" " " " " 8,760 " per annum, 26.80%.

SPINNING MILL "D."

Character of building three stories, brick, mill construction. Character of product—Nos. 5's to 12's. yarns. Single, twisted and multiple ends, on cones, tubes and skeins for hosiery and weaving. No. of producing spindles, 12,778. No. of twister spindles, 1,600. And all necessary preparatory machinery.

The motor installation is as follows:

2-2 h. p. Induction Motors, total	4 h. p.
1-5 h. p. " " "	5 h. p.
12-15 h. p. " " "	180 h. p.
7-20 h. p. " " "	140 h. p.
3-50 h. p. " " "	150 h. p.
2-30 h. p. " " "	60 h. p.
2-100 h.p. " " "	200 h. p.
Total installation	739 h. p.

This mill uses the four frame and group drive, one of the above 100 h. p. motors is direct connected to fire pump, and is not generally in service when the mill is in operation. The peak demands indicate an overload on the motors at times. The "regular run" customarily allowed is not exceeding 66 hours per week, between the hours 6 a. m. and 6 p. m. Any additional use is considered over time. The integrating and graphic meters are connected on the primary side of the transformers. Primary voltage 5,500-2 phase-60 cycles. Secondary voltage 550.

TABULATION TEXTILE MILLS "D."

DATE 1909	Total K. W. hours used	K. W. hours over time	K. W. hours regular run	Hours regular run	Maximum demand K. W.	Maximum observed power factor	Monthly load factor regular run	Load factor based on 24 hours day
January	112,700	5.500	107,200	264	470	84%	87.1%	32.2%
February	103,900	3,700	100,200	244	462.5	84%	88.7%	34.5%
March	111,800	1,300	110,500	277	487.5	84%	81.9%	30.8%
April	100,800	200	100,600	266	438	83%	86.3%	31.9%
May	94,500	200	94,300	239	425	82.5%	92.8%	29.9%
June	100,800	100	100,700	266	425	82.5%	[illegible]9%	32.9%
July	103,500	600	102,900	266	450	82.5%	85.9%	30.9%
August	102,800	100	102,700	262	443	82%	88.4%	31.2%
September	100,700	100	100,600	266	450	83%	84%	31%
October	109,800	400	109,400	261	480	83.5%	87.3%	30.7%
November	111,400	......	111,400	254	495	84.5%	88.6%	31.2%
December	111,400	3,500	107,900	238	510	85%	88.8%	29.3%
Total	1,264,100	15,700	1,248,400	3,103	.....	......	......	......

Yearly load factor based on total hours of regular run, 78.88%.
Yearly load factor based on 8,760 hours per annum, 28.29%.

The over time use ranged from 2 hours to 198 hours each month with one exception; illustrating the flexibility of the individual and group drive, and the ease with which the various processes may be kept balanced.

TABULATION TEXTILE MILLS "D."

DATE 1910	Total K. W. hours used	K. W. hours over time	K. W. hours regular run	Hours regular run per month	Maximum demand K. W.	Maximum observed power factor	Monthly load factor regular run	Load factor based on 24 hours day
January	121,200	1,900	119,300	261	518	83.5%	88.2%	31.4%
February	109,000	500	108,500	244	538	84%	82.6%	30.1%
March	117,900	2,100	115,800	272	495	83%	86%	32%
April	101.500	1,800	99,700	250.5	495	84%	80.4%	28.4%
May	100,200	1,600	98,600	253.5	518	84.5%	75%	26%
June	97,500	2,200	95,300	263	470	84%	77.1%	28.8%
July	82,800	1,900	80,900	240	480	85%	70.2%	23.2%
August	82,500	....	82,500	262	455	86%	69.2%	24.3%
September	91,500	600	90,900	243	460	86%	81.3%	27 6%
October	104,400	1,400	103,000	250	505	87%	81.5%	27.7%
November	116,900	1,700	115,200	260	480	87%	92.3%	33.8%
December	102,700	......	102,700	252	470	87%	86.7..	29.3%
Total	1,228,100	15,700	1,212,400	3,051	...	....	......	.....

Yearly load factor based on total hrs. of regular run, 73.86%.
Yearly load factor based on 8760 hrs. per annum, 26.06%.

Yearly load factor based on total hours of regular run, 73.86 per cent. Yearly load factor based on 8,760 hours per annum, 26.06 per cent. The power factor ranged from 80 to 87 per cent. The k. w. hours used for overtime were the same as for 1909. The maximum demand each month was ascertained by the use of a graphic recording wattmeter. Demands for less than one minute being disregarded, as also demands occurring within 30 minutes of starting. The starting current was not excessive. The production in 1909 was 3,189,118 lbs., amount produced per k. w. hour 2,523 lbs. The production in 1910 was 2,900,442 lbs., amount produced per k. w. hour 2,362 lbs. The falling off in production in 1910 was due to curtailment equivalent to 272 hours of the regular run and an estimated lessening of the annual production by 286,960 lbs.

SPINNING AND HOSIERY MILL "E."

Character of building, two stories, brick, mill construction. Character of product Nos. 6's to 18's yarns averaging about No. 12's. No. of producing spindles, 9,000. No. of twister spindles, 300. 57 cards and preparatory machinery. 260 knitting machines. 50 ribbers. 20 loopers. 5 sewing machines. Annual production, 2,000,000 lbs. yarn and 600,000 dozen pairs 84 needle hose and half hose. This mill uses the four frame drive for spinning frames and group drive for the balance of the mill and dye house. The maximum demand is ascertained by a graphic recording wattmeter. The following tabulation gives one year's record in detail:

DATE 1910	K. W. hours used regular run	Hours regular run per month	Maximum demand in K.W.	Maximum demand in H.P.	Monthly load factor	Load factor based on 24 hours day
July	40,500	132	350	469	87.66%	15.55%
August	70,700	249	365	489	77.79%	26.03%
September	74,300	258	372	499	76.61%	27.74%
October	59,600	234	370	496	68.83%	21.65%
November	51,500	224	310	416	74.16%	23.07%
December	61,200	240	350	469	72.85%	23.50%
1911						
January	87,600	262	380	509	87.98%	30.98%
February	75,900	241	380	509	82.66%	29.72%
March	92,100	277	375	503	88.66%	33.01%
April	70,200	238	395	529	74.67%	24.68%
May	81,800	268	397	532	76.88%	27.69%
June	81,600	262	378	507	82.39%	29.98%
Total	847,000	2,885	......	......	......	......

Yearly load factor based on total hours of regular run, 73.95%.
" " " " " 8,760 " per annum, 21.48%

The motor installation was as follows:

1-	100 h. p. 550 V.-2 phase induction motor—total	100 h. p.
3-	50 h. p. 550 V.-2 phase induction motor—total	150 h. p.
4-	35 h. p. 550 V.-2 phase induction motor—total	140 h. p.
10-	20 h. p. 550 V.-2 phase induction motor—total	200 h. p.
1-	13 h. p. 550 V.-2 phase induction motor—total	15 h. p.
1-	5 h. p. 550 V.-2 phase induction motor—total	5 h. p.
1-	2 h. p. 550 V.-2 phase induction motor—total	2 h. p.
21	Totals	612 h. p.

In addition to above a fire pump is equipped with one 75 h. p. induction motor and one 100 k. w. synchronous motor is run idle to maintain power factor at or above 90 per cent. Previous to the installation of this synchronous condenser, the power factor ranged from 61 to 77 per cent.

Alternating Current Engineering.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

BY WILLIAM R. BOWKER.

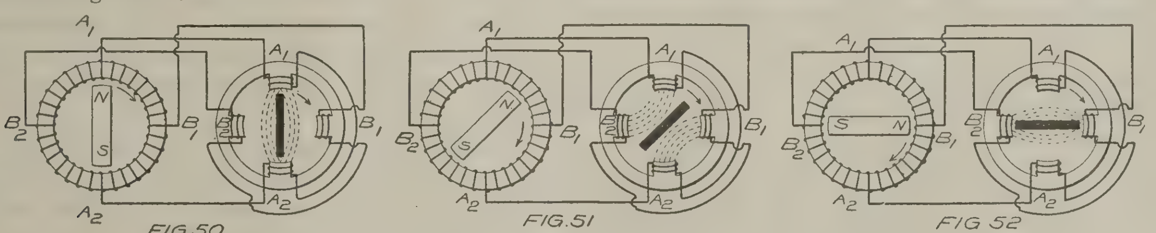
Explanation of Rotating Field and Discussion of Methods of Starting and Controlling A. C. Motors.

AN explanation of the theory of producing a rotating magnetic field has previously been given in connection with diagrams 46 and 47, and this reference to the designing of motors with poles, a simple outline of which is given in Figs. 50, 51 and 52, may, with the following description, make the previous explanation a little more clear.

When the generator and motor bear the relation as shown in Fig. 50, there will be induced a magnetic field in the motor (stator field) as represented, which acts upon the free to rotate rotor, represented in the diagram by a freely suspended magnet capable of revolving. As the generator field magnet continues to revolve, it will at different locations, induce a magnetic field in the motor stator, as outlined in Figs. 51 and 52. Clearly these fields (in the stator windings) revolve in sympathy with the currents induced in the generator armature by the inductive action of its revolving magnet, and transmitted to the motor stator primary. The magnitude and direction is determined by the relative positions of the generator armature coils and its revolving field.

difference is that in the rotary practically built and assembled as a continuity of conductor bars embedded in an iron core, we get a practically continuous and constant field magnet effect (a multiple magnet action) throughout the whole periphery of the rotor core. When simply assembled, however, as an experimental rotor magnet, as in Figs. 50, 51 and 52, the reaction and resulting magnetic drag between it and the stator field is pulsating, being practically confined to the very limited sphere of magnetic influence represented by the two poles of a magnet of comparatively small polar end area.

In polyphase generators, the armature must be wound with two for two phase, or three for three-phase, separate conductor circuits, each separate and distinct winding or groups of winding, must be so spaced and assembled on the armature core that each is subjected to inductive action, by mutual induction with the generator field magnets, in regular periodic succession or time intervals. This circuit arrangement will obviously give two (two-phase) or three (three-phase) separate and independent equal voltage circuits, the result of each being subjected to similar and equal inductive action, due to design and construction, which can be connected for transmission and power or service requirements, either in star or delta groupings.



FIGS. 50, 51 AND 52, ALTERNATING CURRENT MOTORS AND THE ACTION OF POLES

The motor stator magnetic field will revolve in a direction as shown, and the mutual induction that takes place between its rotating field and the rotor magnetic field, will exert a magnetic drag or pull, causing the rotor to revolve in the same direction. The action that takes place with this simple rotor is exactly similar to what occurs if the rotor is built of a number of conductors or windings, assembled on an iron core, because the current induced in the rotor windings (by the stator circuit) will in turn magnetize the iron core on which it is assembled. This results in a rotor magnet, which by mutal induction acts and reacts upon the rotating magnetic field, induced in the stator windings by the alternating current supplied, and cause the rotor to revolve in a similar manner to the simple two-pole magnet, as outlined in Figs. 50, 51 and 52. The only

It is advisable to point out that a synchronous motor need not necessarily be designed to run at the same speed as the alternating current generator. Practical service requires motors of different sizes to run at different speeds, that is revolutions per minute. These motors must, however, run in synchronism, that is, at the same frequency or synchronous speed. The speed in revolutions per minute is only one of the factors that determines the frequency, the other factors being the number of poles and groupings of windings. The speed of the synchronous motor, under normal load conditions, cannot change unless the generator speed varies.

The speed of the motor, in revolutions per minute, will only be the same as the generator speed, when it is designed and assembled along similar lines, that is the number of poles numerically the same in each machine, and windings similarly grouped. If the poles of the generator and motor are equal in number, any speed variation of the generator will result in the same speed variation of the motor; but if the motor is constructed with one-half the number of poles as the generator, its speed will be twice that of the generator. Any speed variation in the generator armature would cause a ratio (in this instance twice as great) speed variation in the motor, that is a ratio in relative proportion to the number of poles.

STARTING AND CONTROLLING MOTORS.

The essential requirement for synchronism is that the frequency, periodically or cycle speeds must be the same. The number of poles is one of the factors involved in the frequency factor, the rotating speed to fulfil the condition of synchronism then will obviously be affected by the relative number of poles on the generator and motor, the speed being in an inverse ratio to the number of poles.

In the everyday practical employment of polyphase induction motors, conditions require special starting devices and speed regulation. For some classes of work, speed regulation is a desirable condition, thus necessitating some practical method of controlling it. The usual methods are either to vary the impressed voltage at the stator (primary) terminals by means of an auto-transformer, the torque of the motor then decreases as the square of the voltage applied. The second method is by the insertion of a variable resistance in the rotor (secondary) circuit. Whichever method is adopted is determined by the type of rotor, there being two kinds of rotor design, one the short circuited squirrel-cage type, and the other the coil wound rotor. Each type is specially applicable to fulfil certain practical requirements; and it is very important that the choice and adoption of one type in preference to the other, should receive careful consideration from the standpoint of practicability and resulting satisfactory working.

So far as speed control itself is concerned, the more satisfactory method found in practice, is to insert a variable resistance in the rotor circuit. Under these circumstances a coil wound rotor would be utilized, for by employing this method of speed control, the power factor and likewise the electrical efficiency of the system in general is higher than with the auto-transformer, compensator or equivalent device inserted in the stator circuit.

However, for the present, we will delay the consideration and methods of speed control, and deal with the starting of induction motors, a very important condition demanded in practice. When an induction motor has to start under load, thus demanding a large current in response to the great starting torque required, practical devices become necessary and essential to prevent excessive flows of current, both in the motor electrical circuits (both stator and rotor circuits) and the supply circuit. Such excessive currents create electrical disturbances in the line and are generally undesirable, due to detrimental effects upon the motor itself. The method of starting will depend largely upon the type of rotor, owing to the fact that polyphase induction motors are self-starting and in a majority of cases are required to start under load.

Polyphase induction motors are, generally speaking, of two types, the stator winding usually being the same in each type. The rotors differ in the winding. There are: (a) the short-circuited squirrel-cage type, in which the conductors consist of stout copper bars or rods embedded in the rotor core, and short-circuited at the front and rear ends; (b) the coil-wound type, which consists of a core with slots, in which are placed coil-wound conductors. Although the fundamental principle of inductive action and reaction resulting from a rotating magnetic field is identically the same in each type, still in practice the resulting electrical effects are somewhat different in each, when required to start under load. With the object of avoiding an excessive demand and resulting rush of current which occurs at starting, there is (when the rotor is of the squirrel-cage type) adopted, a starting device inserted in the stator primary circuit, known as an auto-transformer or compensator. When the rotor is coil-wound, the starting device consisting of a variable resistance or rheostat inserted in the rotor (secondary) circuit, which necessitates the use of slip rings and brushes fixed on the rotor shaft, the ends of the rotor coil windings being electrically connected to the slip rings. In this case there is no starting device in the stator, primary circuit. The line wires of the electrical supply are connected direct to the stator terminals of the stator windings.

In the outline diagrams accompanying the description of these two different methods of preventing and controlling the excessive demand for current when starting under load, it will be noticed in the auto-transformer method that the supply lines or delivery circuit is connected directly to the stator primary circuit through the intermediary of the auto-transformer. The current at starting is controlled by varying the impressed voltage across the stator windings, by the electrical connections on the auto-transformer, or we get a current control by the variation of the impressed voltage. Such result is attained by inserting the controlling device in the primary stator circuit, this method being employed when the induction motor is built with a short-circuited squirrel-cage type of rotor. In the second method, the primary electrical supply circuit is applied directly to the stator at full line voltage, but the current in both the primary and secondary circuits is controlled by inserting a variable resistance in the rotor circuit. The starting current in the rotor (secondary) winding is prevented from attaining an excessive amount by the resistance itself interposed in the rotor circuit, which current by the mutual induction and reaction on the primary stator current, keeps it in control.

As previously mentioned, the slip ring type of motor differs from the squirrel-cage motor, only in respect to the rotor circuit, which is coil wound, the ends being connected to slip rings, and brushes with an auxiliary external resistance in the rotor circuit for starting.

After starting, the rotor windings may be short-circuited by means of a short-circuiting device fixed on the rotor itself, and generally placed at the slip ring end of the shaft. Under these circumstances the brushes may be lifted out of contact and prevent wearing of the brushes and rings. After the motor is started, and running under normal conditions, with its rotor windings short-circuited, its characteristics are similar to those of the squirrel-cage type.

A dim light should be attainable by switch control in the auditorium of theaters and of churches, in hospital wards, and in libraries where specific areas only are in use. A low diffusion of light has to do with office building corridors, in living rooms at times, as also in halls devoted to musical events, and churches.

Considerations of Modern Central Station Loads and Equipment.

(Continued from September Issue.)

BY F. D. NEWBURY.

FROM the standpoint of the station equipment, the instantaneous current demand is of importance only when the size of the instantaneous demand becomes a large proportion of the station capacity. A load resulting in a large instantaneous demand may be objectionable on a given feeder also supplying a lighting load, while it should be entirely satisfactory if supplied from a feeder supplying loads not influenced by fluctuations in voltage.

In considering the questions involving maximum instantaneous demand, it is necessary to determine what really constitutes the load unit. The load unit may be a single motor, and in other cases, it may be a complete mill, including hundreds of motors. This point is illustrated by the action of a certain power company which adopted a general ruling that no cage-wound induction motors larger than 40 horsepower should be connected to its lines. These motors were used in large mills, and in reality the mill, and not a single motor, constituted the load unit. Actual tests on a number of typical mills showed that the current required from the company's lines during starting was less than during the normal operation of the mill. This was, of course, due to the fact that the starting of the different motors was not simultaneous, but extended over a considerable period of time. In this case the power company was not concerned with the starting characteristics of the individual motors, but with the starting and running characteristics of the complete mill.

Loads resulting in wide fluctuations in current demand may be satisfactorily supplied when there is an additional steady load on the same feeders which is not sensitive to voltage fluctuations. A certain power company supplied a large constant direct-current motor load and a small variable elevator load from the same motor-generator set. The con-constant direct-current motor load and a small variable ele-motor load increased until the elevator service became unsatisfactory on account of voltage fluctuations. The service was changed from one eminently satisfactory to one very unsatisfactory simply by changing the proportions of constant and variable load on the same motor-generator set.

Machine.	Torque while Starting Times Full Load Torque.	Starting Current in Line Times Full Load Current.
Single-Phase Induction Motors, with Clutch, Split-Phase-Starter	1 to 1¼	4½ to 6
Single Phase Induction Motors, without Clutch, Split-Phase Starter	2	3½ to 4½
Polyphase Induction Motors, Cage-Wound Type, Auto-Transformer Starter	1 2	3½ to 4 7 to 8
Polyphase Induction Motors, Wound-Rotor Type, Step-by-step Resistance Starter	1 2	1¼ 2½
Synchronous, Motors, Auto-Transformer Starter	3 to 5 7 to 1	1½ to 2½ 4 to 8
Rotary Converters, Auto-Transformer Starter	2 (Sufficient to start itself.)	1½

Another of the common sources of trouble from large momentary currents is due to starting synchronous and induction motors and rotary converters. An idea of the starting performance of these various machines is given in the above table.

In the above table, the smaller torque figures given for synchronous motors cover the requirements of motor-generator sets and air compressors and pumps when the apparatus can be started without load. The larger torque figures refer to motors for driving pumps and fans, which must be started under practically full-load conditions. The wide variation in the starting current comes from differences in construction of the motor, or differences in the proportions of the motor, since, by increasing the size and cost of synchronous motors, the starting performance can be materially improved.

Another kind of load involving wide variations in current demand consists of rolling mill and hoisting machinery. There are not many cases where central stations have been called upon for this class of heavy service, but there are a few cases where the larger water-power plants are furnishing power for such applications. The wide fluctuations in demand from such loads would make it impossible for a central station to consider such service were it not for the load-equalizing possibilities of fly-wheel motor-generator sets. In one case a 2000 kva. station is taking care of such a load involving peaks of 10,000 kva., which illustrates the possibilities of such fly-wheel applications.

The extensions of electric welding in industrial plants has brought the problems of supplying current to welding transformers to a number of central stations. In general, it has been found impossible for this load to be taken care of from central station service, except by the use of motor-generator sets or seperate feeders. The load has unusually low power-factor and usually the load units are of considerable size.

LIGHTING AND HEATING LOADS.

The very marked improvement in the efficiency of arc lamp systems is worthy of comment. The change from the open carbon arc lamp, operated from D. C. constant-current generators driven by induction or synchronous motors, to the A. C. Series enclosed arc lamp operated from one or more large A. C. generators through constant-current regulating transformers, and again to the D. C. series metallic (or magnetite) lamp operated from a large A. C. generator through the constant-current mercury arc rectifier, has been accompanied by a considerable increase in illumination at a considerable decrease in power consumption. The decrease in the latter item is shown by the following table:

System.	Power Consumption per Lamp at the Generator Terminals.		
	Volt-Amperes.	Watts.	P.F.
D. C. Open Arc. Motor-Gen. Set	725	650	90%
A. C. Enclosed Arc-Constant Current Transformer	650	488	75%
D. C. Metallic Arc-Rectifier	450	296	65%

It is apparent that for a plant originally laid out for operating an open arc system, only 62 per cent. (ratio of 450 to 725) of the generating capacity will be required for operating the same number of metallic flame arc lamps with greatly increased illumination, and 38 per cent. of the generating capacity will be available for other applications.

The steam end of the plant (boiler equipment and prime mover) will only be operated at 45 per cent. (ratio of 296 to 650) of full capacity. Considering a new installation, a considerable saving in the first cost of the plant, not to mention decreased expense of maintenance and attendance is effected by the use of the more recently developed arc-lighting apparatus. It should, of course, be borne in mind that the equipment used for arc or series incandescent lighting is only a small part of the total equipment of the station, so that these savings affect the total equipment to a considerably less extent.

The development of Tungsten lamps for series incandescent street lighting has made possible improvement in efficiency comparable with that obtained with the metallic arc. Where central stations have contracts with municipalities to furnish street lighting on the candle-power basis, as is usually the case, the substitution of Tungsten filament lamps for the carbon filament lamps of the same candle-power will permit a reduction in generator capacity of approximately 65 per cent. The reduction in boiler and engine capacity will be about the same as the reduction in generator capacity, since considerations of power-factor do not enter in, as in the case of the arc-lamp apparatus. There seems to be a very decided tendency to standardize on 4-ampere lamps, and this, from the manufacturer's standpoint, is regarded with favor. The 75 and 100 watt lamps seem to best fulfill the average requirements. The comparison between this gain in efficiency, due to new types of arc and incandescent lighting systems, with the possible improvement of a few per cent. in the efficiency of the station generating equipment, is interesting. In general, there are, and probably will be for a good many years, more possibilities in this direction in methods of utilization and in plant management than in the design of the generating equipment.

The advent of the Tungsten lamp in multiple lighting has not given the same additional capacity in the station as it is found that an increased amount of light is used, which results in, if anything, an increased load. There is probably no type of load so satisfactory to the central station as that of the incandescent lamp, especially with its increased use for sign lighting, inasmuch as this is an off-peak load which does not cause any appreciable increase in the cost of operation.

The rapidly increasing load due to electric vehicle battery charging has an effect on the load factor quite similar to that of arc-lighting, since practically all of this charging is done between midnight and the early morning hours. The mercury rectifier battery-charging outfit has an efficiency appreciably higher than that of the motor-generator set formerly used. The use of this outfit also eliminates moving elements and the almost constant attendance essential to the operation of the latter. These mercury-rectifier outfits are also adaptable to arc lamps used for projection purposes, making it possible to use the direct current lamp, with its advantages of greater stability and quietness.

A heating load has the advantage of high power-factor in common with the incandescent lighting load and in addition it has the advantage of being an off-peak load. It is obvious that the period of time that this apparatus is in use is from 6 in the morning to 6 at night and from 9 at night to 12 o'clock at night, conforming to the dining and work periods of the average family. An interesting point in connection with the deservedly rapid development of the heating load is its influence on the importance of distributing transformer copper loss. Obviously with the longer time load is on the transformer, due to the day heating load, the copper loss becomes of greater relative importance.

SIXTY-CYCLE ROTARY CONVERTERS.

Many central stations have a combined lighting and railway load, the lighting and general power being supplied directly from the A. C. 60-cycle generators and the railway load by 60-cycle rotary converters or motor-generator sets. The question whether rotary converters or motor-generator sets should be used cannot be given a definite answer without relation to all the operating conditions, but the following characteristics of the two classes of machines will be of assistance in making a correct decision: First cost, efficiency and floor space will be in favor of the rotary converter, even when the motor-generator set can be wound for line voltage, and still more so when transformers have to be used with the motor-generator set, which is the case whenever the line voltage is above 13,200 volts. D. C. voltage control is in favor of the motor-generator set, but this is of minor importance for railway work. The compound-wound rotary converter, practically in universal use for railway systems, meets the requirements. Power-factor control is in favor of the motor-generator set, since the synchronous motor can be utilized to any extent for power-factor correction. At the same time the beneficial effect on power-factor of adding a large non-inductive load, such as rotary converters, should not be lost sight of.

From the foregoing it is evident that for the great majority of cases the rotary converter can be used to greater advantage than the motor-generator set. In the past, however, the 60-cycle rotary converter has received deserved criticism on account of its sensitiveness in operation and consequent necessity for particularly skillful operators. During the past two years this class of machines has been materially improved in this respect, and the 60-cycle converters now built are thoroughly satisfactory with the same grade of attendance required by any rotating electrical apparatus. This improvement has been secured by using fewer poles, and flashing, and by higher commutator peripheral speed, permitting more communtator bars per pole. The use of fewer poles has, with the constant frequency, resulted in higher revolutions per minute.

THE ADAPTION OF THE STATION EQUIPMENT TO MEET THE REQUIREMENTS OF THE MODERN LOAD.

The capacity of a given generator will vary inversely with the power-factor, that is, the lower the power-factor the larger the generator required. With a given energy load and low power-factor, the kva. capacity of the generator must be greater not only on account of the larger kva. load but on account of the larger field current required to maintain normal voltage for the same armature current.

Should the available exciter voltage be insufficient to force the necessary field current through the generator field winding, the generator terminal voltage will obviously fall, and trouble immediately ensue. It is of prime importance in alternating-current generators to have plenty of margin in excitationn voltage; or, in other words, to always have available some exciter or generator rheostat still in circuit to enable the generator to hold up voltage under unusual load conditions. To insure this requires a proper knowledge of the probable load power-factor under which the generator will operate, since reduction in power-factor requires such a large increase in exciting current.

With the increased use by the general public of electrical appliances, the standard of satisfactory service has been raised, and it has, therefore, become necessary for the central station to take such steps as will enable them to supply constant voltage, resulting in uniform light and general satisfactory service from the customer's standpoint. To accomplish this result, two classes of regulators have been adopted: The generator voltage regulator which is used to hold a constant voltage at the terminals of the generator, and the feeder regulator, either single or polyphase, adapted to hold a constant voltage at the end of the respective feeders that may be supplied by a single generator.

Modern generators, particularly in the larger sizes of turbine units, are designed primarily for use with an atuomatic regulator. This involves a comparatively unsaturated generator, an unsaturated exciter and a comparatively low exciting voltage; at no load, normal voltage, so that changes in magnetic conditions can be made rapidly. All of these conditions can be obtained by suitable design in the generators with the commonly used exciting voltage of 125 volts. With old generator designs not adapted to automatic regulation, the same result can be obtained by increasing the exciter voltage above 125 volts; but this practice should be used only in case of necessity, in order to avoid as much as possible special exciters.

To design modern generators suitable for operation with automatic regulators, and to safely withstand accidental short-circuits, requires proportions antagonistic to a low percentage inherent regulation. The true insurance for successful operation is not a low percentage inherent regulation, but a generator designed with sufficient leeway in exciting voltage to safely hold up voltage under all conditions of load and power-factor that the generator will meet in operation.

With generators operating on fairly steady loads or loads in which the fluctutations occur slowly, which includes practically all generators operating in central stations, there are only three general causes of failure: (1) Insufficient exciting voltage, evidenced by the inability of the generator to hold up voltage. (2) Excessive temperature rises, resulting in damage to the insulation. (3) Weakness of mechanical parts, resulting in heating of bearings, vibration or actual breakage. It is only in special cases, where instantaneous load fluctuations occur, comparable in amount to the generator rating, that inherent regulation will effect commercial operation.

When an A. C. generator is short-circuited, the only factors limiting the instantaneous current are the armature resistance and self induction, and whatever feeder resistance may exist between the short-circuit and the generator. In the case of short-circuits near the generator terminals, only the generator resistance and self-induction limit the instantaneous short circuit current. The armature demagnetization is effective only after the first few alternations; since the armature demagnetization is by far the largest element of the three acting, there will be, obviously, a large difference between the short-circuit current during the first few alternations and the short-circuit current after steady conditions have been reached.

Where modern generators have a steady short-circuit current between one and two times the normal current (when the field is excited for normal voltage at no load), the instantaneous short-circuit current may vary from fifteen to fifty times the normal current. Since the forces acting between conductors vary as the square of the current, it will be seen that the rupturing forces existing in armatures under short-circuit are tremendous compared with the forces under normal operating conditions.

While various schemes, usually involving additional external apparatus, such as auto-transformers or choke coils, have been proposed for protecting large generators from the destructive effects of short-circuits, it would seem logical to adopt such additional safeguards only when it is impossible to so construct the generators that they will, in themselves, stand the service requirements. It has been found by experience that all ordinary generators, if designed with comparatively high armature self-induction and an adequate system of coil bracing, will safely withstand even the enormous shocks of short-circuits. It is only in generators of extreme size, or cases of frequent and severe short-circuit, such as is encountered, for example, in the power stations for grounded A. C. railway systems, that external safeguards have been found necessary.

Government vs. Manufacturers of Incandescent Lamps.

Announcement has recently been made that the United States District Court has decided in favor of the government in the case brought under the Sherman anti-trust law by the United States Attorney General last summer in Cleveland against the General Electric Company and about 35 subsidiary companies controlled by the General Electric Company.

The decree in effect orders the General Electric Company to conduct all its business under its own name and the dissolution of the National Electric Lamp Company and about 35 subsidiary corporations. The petition was dismissed as to the Kentucky Electrical Company. The contention of the Government was that the General Electric Company and its subsidiary corporations had entered into an unlawful combination in restraint of trade.

The National Electric Lamp Company is incorporated under the laws of New Jersey, with headquarters in Cleveland. It was alleged by the Government in a suit filed March 3, 1911, that the National Electric Lamp Company acted as a holding company for the General Electric Company and 35 subsidiary concerns and that a conspiracy existed in restraint of trade. The petition asked that they be enjoined from entering into any agreement fixing prices. Among other allegations made by the Government was that the so-called Electric Trust controlled practically the entire trade of the country in carbon filament electric lamps of which more than 80,000,000 are sold annually.

It may be proper to add that the investigation out of which this suit arose also disclosed eleven other patent pools of a similar nature by which the prices of various electrical devices and supplies were fixed and to which some of these defendants were parties. But since the institution of this suit all these pools have been voluntarily dissolved.

It may further be said that the investigation also disclosed a general trade and patent agreement between the General Electric Company and the Westinghouse Electric and Manufacturing Company, the two largest electrical concerns in the country, covering substantially their whole business; but this agreement, since the institution of the Government's suit, has expired by limitation, and has not been, and it is believed will not be, renewed.

Steam Turbines for Moderate Size Electric Stations.

BY EDWIN D. DREYFUS.

THE national trend toward securing efficient production in our industrie shas long since extended to the modern power station. And here may be found the most carefully planned and executed equipment, achieving not only the economic utilization of materials, but also the efficient application both of manual labor and executive forces. This subject was that of an elaborate paper and discussion by Mr. Dreyfus, presented at the convention of the Mississippi Electrical Association, an abstract of which follows:

It is evident that our present needs demand particularly such qualifications as are intrinsically possessed by the steam turbine. The notable advances in the metropolitan stations in this country have been accomplished almost entirely through the large turbine. Not only has the steam consumption been greatly reduced, but these plants require only from one-quarter t oone-third the engine room operating force which would be necessary for reciprocating machinery. Moreover, and virtually as important is the fact that maintenance expenses have been correspondingly lowered. Therefore, considering also the lower plant investment and fixed charges, the cost of producing power has been substantially reduced. While in the smaller stations the advantages of the turbine may not be present to a great degree, it introduces other economic considerations that should effect an ultimate benefit to the small station comparable with what has been secured in the larger plants.

TYPES OF TURBINES.

The various types of steam turbines are now fairly well known. It may, however, be desirable to discuss them briefly to bring out a few salient facts. Commercial turbines belong either to the so-termed impulse or to the reaction type, or, as in some cases, combine the features of both. It is still found that the fundamental principles of operation thus designated, are too frequently confused. For example, in either design the turbine actually combines the action and reaction features. However, an accurate distinction may be made in the following manner: In the true impulse turbine, all expansion takes place in the stationary nozzles, velocity energy, thus provided, being imparted to the moving blades. In the reaction turbine, the expansion occurs both in the moving and the stationary elements, transferring a small part of the energy by impulse at the entrance and the remaining greater part by reactive thrust on the rotating blade by exit. It may easily be perceived that the steam acting immediately upon the wheel as expansion takes place, will produce the highest economy, and the losses from nozzles to buckets are thus avoided. The best forms of reaction blading, such as the Parsons, really constitute small nozzles in themselves and are, consequently, recognized to be of much higher efficiency than buckets. Nozzle and bucket efficiencies compare approximately as 95-98 per cent to 75-80 per cent.

In connection with the two turbine systems, it is sometimes claimed that the discharge angles in one type may be greater than in another without any difference in efficiency resulting. The error of this statement, while not apparent at first, may be shown vividly by the construction of velocity diagrams, proving that the exit velocity loss occurring in either case will be equally effected by the degree of discharge angle employed. The Parsons turbine is the only design utilizing primarily the expansion of steam in the rotating blades, while the Curtis, Rateau and Zoelly are familiar examples of the impulse type.

Each of the various types cited above have had their advocates, and their predominance in some sections has been due to a great extent, if not entirely, to trade relations, rather than to any real underlying merits of design; and if judged from the former standpoint, this ratio will, of course, tend to distort any estimate of their comparative merits. However, a fair impression may be had of their respective importance when a summation is made of the extent of turbine development, both in this country and abroad. From statistics, we find there exists today approximately 14,612,000 horsepower of Parsons turbines, and about 6,700,000 horsepower of all forms of the purely impulse turbine. This immense quantity of power represented by the Parsons turbine is aided in no small way by marine installations for various types of vessels. In this service the turbine is subject to the most exacting demands, and that the Parsons type has fully complied with the requirements is forcibly shown by its rapid extension in this field, over 6,000,000 horsepower having been installed for marine propulsion. In fact, its advantages have become so marked that a vast amount of energy has recently been expended in adapting it to marine work. And it is almost unnecessary to remark that its success inaugurates a new epoch in marine practice.

What has preceded applied mainly to units of moderate and large powers. The type of machine demanded for capacities less than 300 kilowatts is quite different, as the most elementary form of turbine is essential. In these small sizes, where the economy may be somewhat sacrificed, as the absolute steam quantities are of no appreciable magnitude, the simplest arrangement, using an impulse wheel, has been adopted. The situation bears a very close relation to the change from triple expansion pumping engines in large water works to direct-acting pumps for stations supplying only a small demand. Similarly the fields for the Corliss engine and the small automatic engines, have in general been quite distinct, but naturally turbines do not necessarily have a corresponding line of demarkation.

The small turbine admits a wide departure in construction, and has, therefore, assumed a great variety of designs. Their merits depend for the most part, if not wholly, upon the facility with which they may be adapted to specific requirements and the ease with which substitution of various parts can be made.

A typical installation at the plant of the Mississippi and Gulfport Traction Company, Gulfport, Miss., is shown in Fig. 1. A 1500 kilowatt unit of the same type has been added since this photograph was made. With all the governor gear and valves above the cylinder, the arrangement

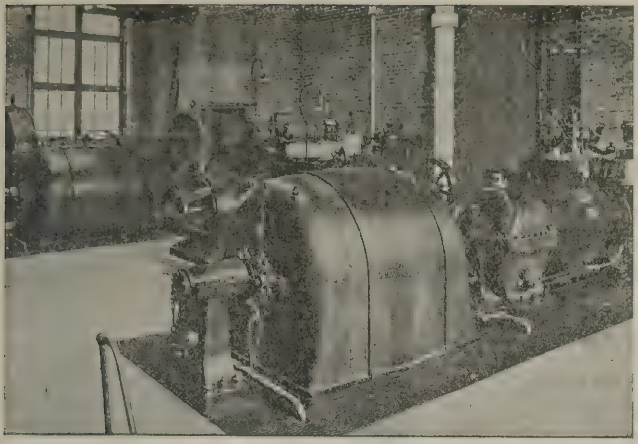


Fig. 1. Turbine Room of Mississippi and Gulfport Traction Company.

adopted for these turbines, their operation is always in plain view.

SMALL IMPULSE TURBINES.

A new development which becomes of especial interest, is a unique type of impulse turbine designed for the generation of small powers. It is mainly in this field that the greatest variations in working pressures are usually found. Steam pressures require a closer consideration in turbine than in reciprocating engine design. Turbines utilize the energy of the steam through dynamic operation; that is, the development of high velocities which are subsequently absorbed during the passage of steam through the rotating wheel. In the engine the expansive force of the steam is exerted directly upon the piston. It is well to keep this distinction in mind when gaging the merits of the small turbine. Through adiabatic expansion of steam between certain limits, there is a given amount of heat energy released. This heat energy is immediately converted into work upon a receding piston in the steam engine, as just mentioned, while in the turbine it is transformed into velocity energy.

In the ideal impulse turbine, the buckets should travel at one-half the steam velocity. In commercial practice, it may be necessary to depart somewhat from the ideal and moreover, in order to simplify stage construction, it is desirable to transform the energy in the high velocity steam into mechanical energy in two or more steps with moderate blade speeds. As an illustration Table 1 has been prepared to present a general idea of the amount of heat energy available per pound of steam between customary working pressures and temperatures.

Table I. B. T. U. available between various initial pressure and 15 lbs. and one lb. absolute.

Initial Conditions		Final Conditions	
Pressure lbs. Abs.	Temp. Deg. F.	15 lbs. Abs. Temp. 213 F.	1-lb. Abs. Temp. 101 F.
		B. T. U. Available.	
105	331	142	294
125	334	155	306
145	356	166	315
165	366	177	325
190	377	186	333

MIXED TYPE OF TURBINES.

A composite impulse and reaction turbine was first designed in this country in 1902, mainly to accommodate large capacities, which innovation resulted in the successful development of the high power double-flow turbine. In the small impulse turbine the economy for condensing work may be materially improved by the addition of a low pressure stage containing Parsons blading. A number of turbines of this type have been built ranging from 100 to 200 kilowatts. For this part an impulse wheel replaces the high pressure reaction blading, and is so designed as to efficiently absorb a large drop in steam pressure, or more correctly, heat energy. Incidentally, this same wheel is appropriated as a balancing dummy for the low pressure reaction end, which brings about unusual compactness. In this design, comparatively low blade speeds and steam velocities may be efficiently employed with the advantages of greatest freedom from the erosion resulting from the high velocity of moist steam jets, the cutting action varying approximately as the square of the relative velocity. Where fuel is costly such a design, although more expensive,

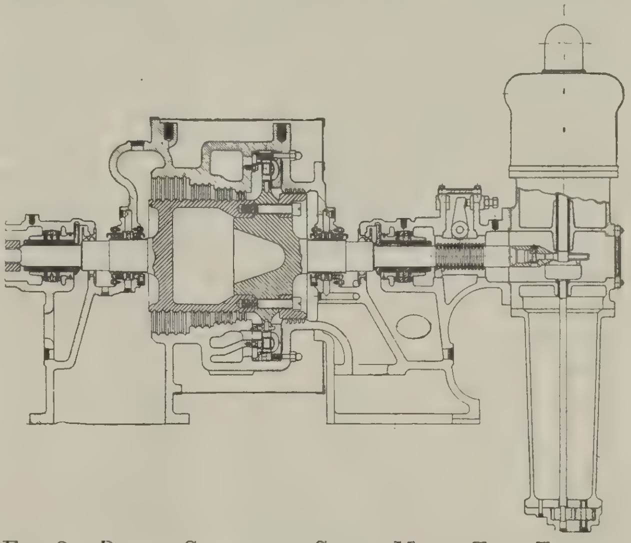


Fig. 3. Detail Section of Small Mixed Type Turbine.

should prove warranted. It further exemplifies the versatility which is possible in turbine designing and is a type which has come into quite general use in Europe, where the fuel item is always the foremost consideration.

LOW PRESSURE TURBINES.

The low pressure turbine will undoubtedly be found to be a benefit to the small reciprocating engine plant. In many of these stations the engines have been operated non-condensing for the reason that the expense connected with a condensing equipment would scarcely be warranted in view of the small return affected. Since the turbine works so efficiently in the low pressure ranges, station operators may safely expect to improve their plant economies from 30 to 100 per cent through installing the low pressure turbine to work on the exhaust of their engines.

Such results are entirely practical and have been obtained, as in a typical case of a 500 kilowatt low pressure unit installed for the city of Regina, Canada, where exhaust steam is obtained from one 22x30 Corliss and one 11 and 20x14 compound automatic engine, governing being accomplished entirely through the latter units as the turbine is tied in electrically through synchronous alternators. The accompanying graphic charts, Figs, 4 and 5, show clearly that the fuel value has been practically doubled at the switchboard. Using the average figure given on the chart, it will be noted that the lo wpressure turbine delivers 0.97 kilowatts per kilowatt of the engines. A fact developed in this station, as in many other low pressure turbine installations, is that no impairment of vacuum occurred due to the pressure in the piping between engine and turbine falling below atmosphere. As noted on the turbine load chart, Fig. 5, the inlet pressure varied from 3 to 15 inches vacuum, an average vacuum of 28.4 inches (30 inch barometer) being maintained at the turbine exhaust. Several advantages, both from the standpoint of efficiency and mechanical operation, accrue from allowing the pressure between engine and turbine to vary with the load.

In a great many cases low pressure turbines warrant the use of cooling towers where an adequate cooling water supply is lacking. Cooling systems may be arranged in various ways, and they generally add but a small percentage to the plant investment. They vary from being made of a pile of brush with suitable distributing troughs at the top, as pursued in some southwestern sections, or wooden lattice construction of open type, or spray nozzles either distributed over a cooling pond, or else, as occasionally done, by appropriating the power house roof as a water shed, to the more expensive enclosed forced or natural draft chimney coolers. These references are simply made to impress the fact that when small stations are unable to obtain a natural supply of condensing water, an effective substitute may thus be devised. In the design of cooling towers, free fall and excessive lift of circulating water must be avoided in order that their operation may be most efficient.

Notwithstanding the high thermal efficiency that may be secured through using the low pressure turbine, its installation is not to be indiscriminately recommended. It simply becomes a matter of economic consideration as to whether or not, at the load factor at which the plant is operated, the saving in fuel expenditure will be sufficiently in excess of the capital charges on the increased plant investment. Generally the construction of the low pressure turbine is similar to that of the complete expansion turbine, excepting that the high and intermediate pressure elements are omitted.

BLEEDER TURBINES.

Frequently central stations find it profitable to supply heating load in addition to its electrical output. Previously in turbine plants, the low pressure steam was taken from the entrance of the intermediate stage and delivered to the heating system through a reducting valve. This method not only entailed considerable loss, but the amount of atmospheric pressure steam that could be bled, was unduly limited. To obviate this shortcoming the standard condensing turbine has been developed, in which the steam that passes from the intermediate to the low pressure stage is controlled by a valve which is, in turn, governed by the pressure in the heating main. All low pressure steam not required for heating, performs work in the low pressure section, and besides, before the steam reaches the pressure

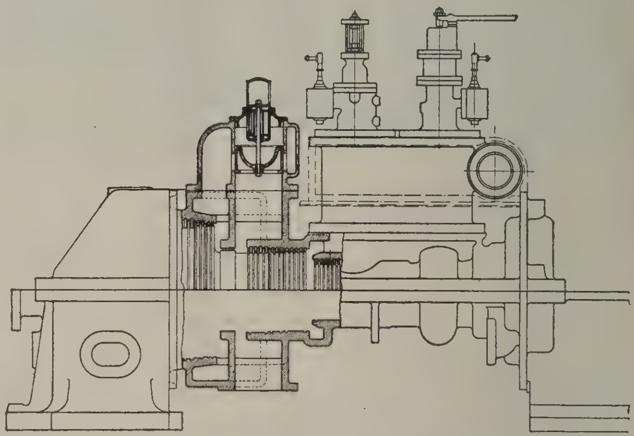


FIG. 6. DETAIL OF AUTOMATIC BLEEDER TURBINE.

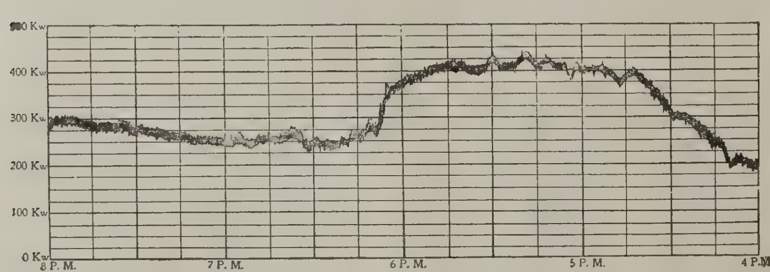


FIG. 4. CHART FOR HIGH PRESSURE ENGINES.

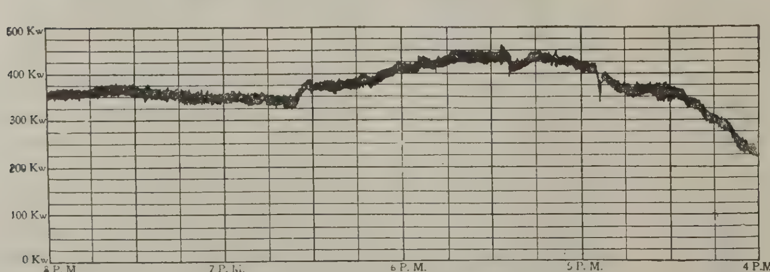


FIG. 5. CHART FOR LOW PRESSURE TURBINE.

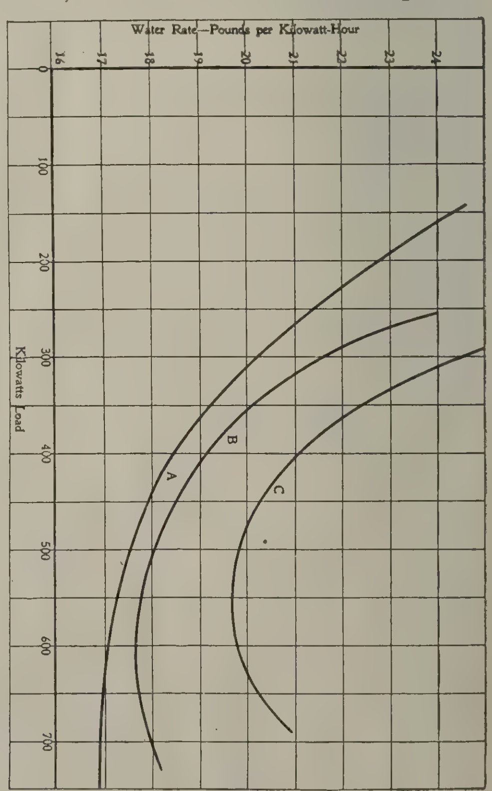


FIG. 7. ECONOMY CURVES OF ENGINE AND TURBINE.

of the heating system, it has been efficiently utilized in the high pressure elements of the turbine. When all of the steam is to be diverted to the heating system, the entire amount may, by special exterior piping, be made to pass through all stages of the turbine, thus obviously improving the economy.

OPERATION AND MAINTENANCE.

Being entirely self-contained, the turbine requires minimum attention, and very frequently is given but little more care than an electric motor. That the turbine is capable of continuous operation over extended periods, has been demonstrated by actual performance. For example, a 500 kilowatt unit at the Quincy Market, cold storage and warehouse recently completed a run of fourteen months without a stop and without any adjustments. While these long runs are of interest in showing the capabilities of the turbine, naturally the wiser policy is to provide for quarterly or semi-annual periods of inspection, as the case may require, unless unusual conditions may obtain.

When the subject of maintenance is considered, the question of local conditions must be given attention. Where there is a good quality of feed water, the turbine has usually been found to retain its original standard in service. But with water possessing any active chemical properties, the cylinders have given evidence of erosion, and where steel blades were used, have required reblading in some cases, and in a few instances reboring and relining of the cylinder. Original bronze blading which had been in service for nearly seven years in a 400 kilowatt turbine at the Johnston Harvester Works, at Batavia, N. Y., did not show signs of impairment.

ECONOMIES.

Several years ago a great deal of discussion was centered about the relative efficiencies of the engine and turbine. Actual tests have fully shown that the turbine excels for condensing service, bearing out the general concensus of opinion. The curves, Fig. 7, may be taken to typify the comparison, where the turbine results were taken from U. S. Government tests and those of the engine as shown in Table II from tests conducted by Prof. D. S. Jacobus at the plant of the American Sugar Refining Company. The much flatter economy curve of the turbine is in evidence. But, in considering economies on the whole, engineers should avoid simply comparing two types of units merely by test results or guarantees. A factor for the decline in efficiency in service should always be introduced. Very little change in turbine economy will take place, especially where moderate steam velocities obtain, and its efficiency may be regarded as a practically constant quantity.

TABLE II—TEST OF CORLISS COMPOUND ENGINE AT AMERICAN SUGAR REFINING CO.'S WORKS, BROOKLYN, N. Y.

Steam Pres. Gauge Dry Steam	Vacuum Ref. to 30 in. Bar	R. P. M.	Ind. Hp.	Mech. Eff. Percent.	Elct. Eff. Percent. Not inc. field loss	Equiv. Kw.	Water Rate Lbs. per Ind. Hp—Hr.	Water Rate Lbs. per Kw.—Hr.	Lbs. per Kw.—Hr.* Corrected to 100 Superht. & 28" Vac.
148	27.48	120.5	1004.0	95.0	93.9	670	12.75	19.16	17.8
149.8	27.98	120.9	853.3	94.3	93.8	562	12.33	18.7	17.6
149.9	27.64	121.2	819.6	93.9	93.8	538	12.55	19.1	17.8
151.3	28.26	121.5	627.4	92.0	93.3	403	12.10	18.9	17.86
150.1	28.33	121.9	491.4	90.0	92.8	311	13.92	22.35	21.15
150.1	28.16	122.6	339.7	85.3	91.8	200	14.58	25.0	23.3

*Correction Factors: Superheat 0.6 per cent. per 10 degrees F. change. Vacuum two per cent. per inch change of Vacuum.

For non-condensing service, the small turbine is an extremely close competitor of the reciprocating engine, and when the inability of most engines to maintain their efficiency is properly regarded, the turbine is fully on a parity, or may even surpass the engine. Partial data on economies are always unsatisfactory, as the working conditions, pressures and capacities should invariably be considered, due to the marked influence they exert upon the results obtained.

Essential as it may be where the fuel supply is costly, the heat efficiency of apparatus is plainly not the only governing factor in the selection of power house equipment. The cost to operate and maintain should also be critically regarded. Total operating cost of small stations is as high as 2.5 cents per kilowatt hour, or more, down to 0.6 cents or slightly less, per kilowatt hour, including fuel, labor, oil, waste, supplies and maintenance. Evidently these figures depend upon size and type of equipment, cost of fuel, loading and other factors, so that comparison may be misleading unless surrounding conditions in the two types of plants are very similar. While such data are usually rare, the following relationship between the turbine and reciprocating engine layout obtained from the operation of stators of about 5,000 kilowatt aggregate capacity in corresponding service, represents fairly well the economic influence of the steam turbine. With the engine costs taken as unity the comparative costs in the turbine station follow:

Fuel	93.0 per cent
Labor and Superintendence	75.5 per cent
Oil, Supplies, Miscellaneous	23.0 per cent
Repairs and Maintenance	56.0 per cent
Total Operation	87.7 per cent

For smaller plants these ratios should increase to some extent, but the overall results with the turbine will remain superior.

Generating Plants in South Africa.

The Victoria Falls & Transvaal Power Co. has at present three generating stations in South Africa, the old one at Brakpan and two new ones at Rosherville and Simmer Pan, while the foundations for the station at Vereeniging are now being proceeded with. The Simmer Pan plant comprises six impulse turbines of 4,500 brake horse power each. The generation is three-phase, 50 cycles at 5,000 volts transformed to 10,000, 20,000, and 40,000 volts, as required. The whole system is managed from the control room, which is in charge of an engineer in telephonic communication with every part of the system.

The actual cost of generation has not transpired, but at the station of the Randfontein Central, where coal costs more in consequence of 25 miles extra haulage, the cost has been brought down to below a farthing (½ cent) per unit at the switchboard and 0.4d (0.8 of 1 cent) into motors all over the property. When the central mill is in full operation and the amount generated increased, with consequent spreading of the standing charges, it is confidently expected that these figures will be improved upon.

Southern N. E. L. A. News.

Report of the Convention of Georgia Section of N. E. L. A.

If the results of a convention of central station men can be adequately expressed in terms of mutual interest, cooperation, a general better understanding and an alliance for betterment of conditions among the companies participating, the first convention of the Georgia section of the National Electric Light Association will be recorded as producing and affecting these conditions and circumstances in the superlative degree. Not only this, the convention further marks the successful establishment of an organization of such scope and of such aims as to be of direct benefit to all affiliated, not only at times of meeting such as it typifies, but at other times when cooperation and mutual assistance may be of benefit.

The conditions necessary for such a successful convention were realized to a full degree at Columbus during September 26 and 27, the weather conditions and the attendance being all that could have been hoped for. The sessions were held at the Masonic Temple and called to order Tuesday morning by President John S. Bleecker, manager of the Columbus Railroad Company, the welcoming address being delivered by Mayor Rhodes Brown. After extending to the visitors a most cordial welcome to the city, the speaker reviewed in fitting terms the resources of Columbus, her natural advantages and the features which have been responsible for the growth and extension not only of the city but the industries which surround it. He further stated that the city should feel honored by the meeting of the first convention of the Georgia Section in Columbus, in as much as it was quite in keeping with the trend of affairs pertaining to electricity in connection with the history of the city. He advised that Columbus was among the first to apply water power through electricity for the propulsion of street cars and also among the first to apply water power through electricity in the industrial part of their community.

The address of welcome was followed by the annual address of President Bleecker. In this address he reviewed briefly the organization of the section, taking up and discussing somewhat at length the object and aims. He stated that while much time and effort had been given to securing members, a considerable amount of time had been spent by the officers and committees in studying questions which will promote common interest. During the first six months of the existence of the Georgia section, a number of interesting and important matters were discussed through the circulating correspondence committee by interchange of letters and it is hoped that at least half of each year will be devoted to this kind of work by the secretary. The time of the secretary and of the members during the second six months was necessarily devoted largely to the preparation of the papers, discussions and arrangements for the convention. President Bleecker advised that this division of the year into two parts along these general lines namely, general correspondence during the first half of the year and preparation for papers during the second half would form a good precedent to follow. He further advised that an executive committee meeting be held each spring for the purpose of reviewing the work during the first six months and preparing for that of the second six months. This arrangement would prove satisfactory until such a time that the section increases, when executive committee meetings would be required oftener.

President Bleecker mentioned a vital point in regard to the greatest good that can be obtained from N. E. L. A. state sections when he stated that the custom of discussing the broader and perhaps more general matters relating to the central station industry through the national association with the state sections confining themselves to local and detail matters can be carried too far. It is not out of place for the state sections to take up some of the broader matters which may have a local or geographical application. The soundness of this statement was plainly evident from a number of the remarks dropped during the convention.

The existence of a public policy committee was taken up and its deliberation during the first year together with the recommendation of the future, briefly stated. President Bleecker explained that the establishment of cordial and beneficial relations with the public is no small item in connection with the proper execution of publicity utility obligations. He quoting from Governor McGovern of Wisconsin and pointing out forcibly the nature of the business in which central station men are engaged to show that the public has a right to direct its servants in their work.

REPORT OF COMMITTEE ON MEMBERSHIP.

From the report submitted by the chairman of the committee on membership, Mr. W. R. Collier of the Georgia Railway & Electric Co., it was learned that at the time the convention convened, there were 14 Class A members, 38 Class B members, no Class C members, 1 Class D member, and 21 Class E members, making a total of 73. At the time the section was formed there were 21 members, thus showing an increase in membership during the year of 240 per cent. It was the opinion of the chairman that while the increase was very satisfactory, it can be equalled in the coming year and with that idea in view he requested all members to consider themselves members of the membership committee.

First Session.

ADVANTAGES OF COOPERATIVE EFFORT BY CENTRAL STATIONS WITH INSURANCE INSPECTORS.

The first paper of the first session under the above heading, was prepared by A. M. Schoen, chief engineer of the Southeastern Underwriters Association of Atlanta, Ga. On account of Mr. Schoen's inability to attend the convention, this paper was read by F. G. Tupper of the same organization. An abstract is as follows:

Many of you can look back to the time when the electric light was looked on with suspicion by a large part of the people and more especially by the women who refused to allow it to displace gas or even the kerosene lamp in their residences because of fear born of ignorance. Those were the days when load peak and load factor had not even been thought of and instead of looking for some way to secure a non-peak load you were trying to overcome these prejudices and obtain any load at all.

In the beginning much bad wiring was installed, due to ignorance on the part of wiremen, the undeveloped state of the art making it impossible to secure suitable materials and the inadequacy of inspections. The result was naturally more or less fires traceable to the wiring installations, and the crediting of many fires not so caused, but of unknown origin, to this same agency. Such occurrences were exploited through the papers with the prejudice already existing against lighting by electricity, these served largely to retard its general introduction into residences for any purpose whatever. The insurance companies were the first to grasp the significance of this threatened danger and to establish at their own expense a system of inspection that should furnish at least some means of protection to the policy holder against the careless, ignorant or vicious workman. Although approaching from different directions and engaged in business essentially different in their natures, the electric company and the insurance company here met on common ground, it being to the interest of both as well as to the customer and policy holder himself to protect the latter against damage by electricity either to life or property.

Naturally the electrical inspectors for the insurance companies devoting their entire time as they do to trying to prevent electrical fires, become specialists in that particular line, they learn of or stumble across fires incipient or serious that never come to the attention of the central station manager. Under these circumstances it would seem that the inspector should form a most acceptable and important cog in the machinery and that hearty co-operation should exist between the central station officials and the inspector.

For a scattered territory, I am of the opinion that the system followed in the Middle States and in the Central West is in theory at least, the best that has thus far come to my attention. There the field has been districted and sufficient inspectors employed to see all work installed; a reasonable fee is charged for each inspection, the sum of which collections added to the amount appropriated by the Underwriters makes possible the employment of the necessary number of men to properly look after this work. Under the circumstances, all work being inspected the insurance companies are enabled to refuse to attach the electric light permit to the policy until the electrician's certificate has been secured by the assured. Whatever the system employed I feel that you gentlemen of the central stations and my department have interests indentical in the results they attempt to achieve and the closer we get together and work together, the better will it be in the end for both of us.

DISCUSSION.

The discussion of the first paper showed how closely the interests of the central station and insurance companies were allied. Those taking part and adding valuable suggestions were: Mr. L. S. Mongomery, manager of National Metal Molding Co., of Atlanta; J. S. Bleecker, manager of the Columbus Railroad Company, Columbus; W. R. Collier, contract agent of the Georgia Railway & Electric Company, Atlanta; E. C. Deal, general manager of the Augusta-Aiken Railway and Electric Company, Augusta; E. C. Roberts, general manager of the Savannah Electric Company, Savannah; G. K. Hutchings, commercial agent of the Columbus Power Company, Columbus; Burdett Lumas, Jr., of the Ware County Light & Power Company, Waycross; S. G. Lumpkin, of the D. F. Wilcox Company, Columbus; T. W. Peters, of the Columbus Railway Co., Columbus, Ga.

Mr. L. S. Montgomery stated that the new electrical inspection passed by the Des Moines City Council, September 13th requires that permits to do electrical work shall be granted only to registered contractors who have filed a bond of $1000. A complete schedule and inspection rates is included in the ordinance and the underwriters code is adopted as official.

Mr. W. R. Collier stated that some years ago, the question was agitated in Atlanta just along the lines of the remarks made by Mr. Montgomery. The proposition as proposed required of the contractor a bond which should be forfeited to the city in case he did poor work. He emphasized the undesirability and general unsatisfactoriness of inspection when any phase of politics had to do with the existence or general policies of the inspectors. He favored the suggestion by Mr. Schoen of charging a small fee, the amount received from the fee being placed in a fund for inspection, insurance companies making up the difference. It was his opinion that if by the payment of this small fee the customer could be guaranteed a good inspection, such customer would have no objection and if worse came to worse most central stations would be willing to stand a proportional part of the fee.

Mr. E. C. Deal referred to the high license for contractors, stating that in his opinion such a condition would enable a combination to be formed of two or three contractors and fix rates so that it would be impossible for many parties to enjoy conveniences of electricity. He stated further that if the contracting concern is to be licensed, such license should not be necessarily high but should be such as to form a protection for the lighting company, interesting the municipality to control features of inspection, so that the lighting company would not have to bear the burden of any defects in workmanship by the contractor. It was his opinion that the inspector is in a position to offer suggestion and assist the lighting company in view of the fact that they are in close touch with what is going on in all sections of the country.

Mr. E. S. Roberts referred briefly to the work of some contractors in Savannah, stating that in his opinion some of the men in the wiring business were able to pass on installations better than the city inspector. He therefore advised that the city inspector be required to pass an examination to qualify for his office.

Mr. G. K. Hutchings reviewed the work of the contractor during his early connection with the central station business stating that the conditions and troubles of the present time are very small in comparison with those of years ago. The great progress made in this direction at the present time is the disposition to cooperate.

Mr. J. S. Bleecker commented upon the similarity of the views of the central stations in a great many instances and further stated that he would put the central station in the same place as the electrical inspector of the municipality. They are both servants of the people and should both endeavor to fill their missions honestly working in harmony and neither be subject to the conditions which each is accused of by the other.

Mr. Burdett Loomis, Jr., took up features of inspection at Waycross which have been controlled by the inspector which, in his opinion, this inspector has no jurisdiction over. He stated that if the recommendations of the inspector were carried out a decided hardship and considerable expenditure of money would be necessary in replacing so-called defective lines and parts. He referred particularly to the installation of wire on secondary circuits and connections to transformers located on poles adjacent to residences.

Mr. E. C. Deal, in referring to the condition of affairs mentioned by Mr. Loomis, stated that it was his opinion that the question of cooperation between the central station and the insurance inspector was at stake. By his experience he had found that the insurance inspectors are glad to make an agreeable arrangement when same will prove satisfactory to all concerned and thus avoid numerous difficulties.

Mr. F. G. Tupper, in reply to the conditions mentioned by Mr. Loomis and Mr. Deal, explained the relations of the inspector to the central station and gave a very good idea of how far the jurisdiction of the inspector extended over the central station pole lines. He made it plain that the interests of the central station as well as the customer, were observed in all cases.

Mr. F. G. Lumpkin stated that cooperation with insurance companies would result in considerable saving to central stations. He referred to a central station which had reduced their rates 10 to 15 per cent by complying with the suggestions of the underwriters association. He advised that all questions of mutual interest be referred to Southeastern Underwriters Association in writing.

At the close of the discussion a very interesting motion was proposed by Mr. E. C. Deal, whereby a committee should be appointed with duties to include the handling of all questions of cooperation between central stations and the underwriters association. The motion reached a final form and was carried as follows: That this meeting of this section recommends to the executive committee the handling of all inspection matters both from an insurance and municipal standpoint and that this committee take care of all correspondence arising from such inspection with the proper authority.

Second Session.

SUPPLY OF ELECTRICAL ENERGY IN TEXTILE MILLS.

The second session was opened on Tuesday afternoon at 2.30 by a paper on "The Supply of Electrical Energy in Textile Mills," by Mr. Geo. K. Hutchings, commercial agent of the Columbus Power Company, Columbus, Ga. This paper is published in nearly complete form elsewhere in this issue.

DISCUSSION.

Mr. Hutchings' paper brought up a number of features of mutual interest to all stations operating in the South, inasmuch as the present day cotton mill is an ever increasing customer. The following members entered into the discussion: F. P. Catchings, general manager of the Georgia Power Co., of Atlanta; and W. N. Southwell, of Central Georgia Power Co., Macon.

Mr. F. P. Catchings presented a very valuable and interesting written discussion on Mr. Hutchings' paper, at the request of the president. He stated that it was his purpose not to attempt the addition of original matter to the fund of statistics presented by Mr. Hutchins, but rather to correlate a few of the more salient facts from information accumulated, both in the published and unpublished data bearing on the subject. He reviewed briefly the difficulty in introducing electrical power in textile mills, stating that it took several years to introduce 10,000 horse power. At the present time, however, of the 300 cotton mills in North Carolina, about 25 per cent are driven electrically. He stated that contrary to the idea existing in the minds of many of the textile owners, the cost of electrical energy is not the first consideration, as it is well established that the cost of power is approximately 5 per cent of the total cost of operation. The cost of heating cotton mills in Georgia may be taken to be 50 cents per horsepower per year. That is in a 20,000 spindle mill, having approximately 1,000 horsepower, it would cost $500 per year for heating. The cost of slashing will amount to $1.40 per h. p. per year, or a total of $11.90 per h. p. per year for heating and slashing. This figure varies with the class of work, but is applicable to the average number of yarns produced in this section. The figure commonly taken in estimating steam power cost is about $4.00 per h. p. per year, which is entirely too high as the heating and slashing cost in this section rarely exceeds 10 per cent of the total power cost. For these reasons it is very difficult to determine any accurate cost of the steam power on the horse power basis.

Assuming the price of electricity to be $25.00 per h. p. per year for 11 hours per day, 306 days per year, and assuming a saving at equal production of 15 per cent in power which is conservative, the cost at which steam power must be generated to equal the price of electricity would be $21.25. From this must be deducted the fixed charges on a difference in first installation cost which we may take at 12 per cent on $46.00, or $5.50 per h. p. per year, leaving $15.75 plus $1.90 which would be required for the heating and slashing operations of the mill or a total of $17.65 is the figure at which steam power must be generated to equal in cost to electric power at $25.00 per horse power.

Mr. Catchings stated that in a converted mill driven by hydro-electric power, one of two results are always brought about. If the original production is maintained, the amount of power necessary is reduced. This should not in all cases be regarded as of paramount importance, the most vital advantage being an increased production from the mill which it has always been found can be obtained through electrical drives. He further stated that mills in which the steam drive is left intact and electric drive installed, the steam drive working as the auxiliary, careful records show that an increase production of 2 per cent to 10 per cent is obtainable. In new mills this figure has been shown somewhat higher.

The importance of production Mr Catchings showed as follows: The value of a new mill's product per annum is about equal to its capital stock. The cost of manufacture with many variations for the class of work may be taken proportionately about as follows: Cotton 60 per cent, power 5 per cent and all other costs 35 per cent. The power cost as a total is about 3 to 7 per cent of the total market value of the products, thus assuming the cost of a 5,000 spindle mill at $100,000, the product in a year will be worth roughly $100,000, and power bills as $5,000. If the output of this mill can be increased ten per cent, the cost value of this increase in products would be $10,000 of which the only cost will be cotton, power and some labor. Allowing for some increase in labor costs, a total cost of this extra production is cotton 60 per cent, power 5 per cent, labor 3 per cent, or a total of 68 per cent, and a net profit of $3,200 per year, or two-thirds of the total cost of power, thus nearly eliminating the power bill.

MEMBERS AND GUESTS AT CONVENTION OF GEORGIA SECTION OF N. E. L. A.

In the course of Mr. Catchings' discussion, he stated that a new mill can be equipped and an old mill converted as a complete installation as far as electric motors and wiring are concerned for about $15.00 per horse power maximum, and has been done as low as $12.00 per horse power. In comparing shaft and belt drive with electric, he stated that it may safely be assumed that the unknown increment of load under load will more than balance the small loss in electric drives which will be due to methods of transmitting from motor to machine. The precentage losses, in an electric drive if it is properly designed, are largely independent of load as the motor itself is more efficient at full load and the wiring system more efficient at light load. This is a point often lost sight of and a condition which is not possible with any mechanical system of drives. The cost of wiring a mill using 2,200 volt motors from 15 h. p. sizes up is approximately $4.00 per h. p. Practically all power is now sold on a basis of 2,300 volts delivered, which is advantageous to both the power company and the customer, as it gives the seller direct supervision over the operation and care of apparatus in the sub-station while the consumer does not have the trouble with the high tension end.

Mr. G. K. Hutchings closed the discussion by stating that the reduction in power demanded by the mill changed over from steam to electric is not as much of an argument as the improved conditions on which the mill will operate. The actual result is that the electrically driven mill has a greater production, therefore, the mill is going to use if anything more power than with steam.

THE DYING OF PINE FORESTS.

The next paper on the program was entitled, "The Dying of the Pine, Cause and Remedy" by E. B. Mason, of the Department of Entomology, Washington, D. C. Inasmuch as central stations of Georgia are directly or indirectly dependent upon the forest for their well being, in one case for fuel and in the other case for water power, it will appear that the subject above given is very closely related to the activity of these central stations. An abstract of the paper follows:

It has been known for more than forty years, that a pine beetle has existed in the Southern states, but it appears, however, that only at long intervals does it increase to such large numbers as to cause widespread depridation such as, for example, the great invasion of 1890-1893, which destroyed a very large percentage of all the pine in the Virginias. The beetles kill a tree and leave it in about thirty days or even more quickly. Three or four broods in the North and four or five, or possibly more in the South develop during the year, in other words, they may be increased four or five times from their original number during a season. They fly in swarms during the night, light on the upper trunk of a pine (they are seldom found in the first eight or ten feet butt cut) and preferably on the largest and best timber. They bore through the bark to the wood but do not bore into the wood. On the surface of the wood they make those winding galleries with which you all are familiar. These galleries, crossing and recrossing one another, girdle the trees many times—thus killing it. The eggs are laid along the galleries, hatch into little grubs which feed on the sticky inner bark for a short time, and then go into the outer bark where they change into beetles with wings. The beetles bore through the bark to the light and fly away in swarms to attack other trees.

In November the beetles go into living trees and their life history is the same as in summer with one exception. They lay their eggs, hatch into little grubs which feed a short time on the inner bark, and then go into the outer bark where they may or may not change into beetles. They do not come out till spring. It is only necessary to cut down the trees in which the beetles are and destroy the bark in which the broods of the beetle are wintering. You do not have to destroy the wood, they only groove it slightly. Furthermore, there are so many beneficial beetles in the tops that feed on this destructive one, that it is really better to leave the tops in the woods.

DISCUSSION.

The discussion on the destruction of pine forest was taken part in by the following members: Charles J. Swift, of Columbus, Ga.; G. K. Hutchings, of Columbus Power Co., Columbus, Ga.; E. C. Deal, of Augusta, Ga.; C. D. Flannigan, Athens Electric Railway Co., Athens, Ga. The discussion took the form of questions put to Mr. Mason, relative to the particular features of the subject not touched on in the paper.

THE LOW PRESSURE TURBINE.

The third and last subject of the second session was a paper entitled, "The Low Pressure Turbine," delivered by E. H. Ginn of the General Electric Company, Atlanta, Ga. An abstract of this paper follows:

Throughout this country, and especially in the Southern territory, there are a great many central stations and industrial power plants now operating large reciprocating engines non-condensing. It has been considered that the fuel saving to be obtained by operating these engines condensing was not sufficient to justify the first cost of condensers and cooling water supply. While this argument was, no doubt a good one when considering only reciprocating engines, with the advent of the turbine this condition has been changed. When the first cost and economy of the reciprocating engine outfit is considered as against the turbine, the latter, practically in all cases of sizes from 500 k. w. up, is by far the better proposition, even when we include in the cost of the turbine outfit the cost of cooling towers as well as condensers. For a new electric plant in sizes of from 500 k. w. up, there are very few cases indeed where the high pressure condensing turbine is not the most economical proposition.

In cases of existing stations, however, equipped with reciprocating engines where it is desired to get increased power of improved economy is found the field for the low pressure turbine. By the use of the low pressure turbine it is now possible to utilize efficiently the energy of steam from approximately atmospheric pressure down to 28 or 29 inch vacuum, which steam is, in many plants, operating non-condensing; entirely lost; or in other plants operating reciprocating engines condensing, only partially used.

The advantage of the low pressure turbine is most obvious in plants which are now operating reciprocating engines non-condensing. There is also a considerable field for low pressure turbines in plants now operating reciprocating engines condensing. Practically any reciprocating condensing engine can be operated at at least full load non-condensing with an increase of from 25 to 30 per cent steam consumption over its steam consumption when operated condensing. If the engine be operated non-condensing and low pressure turbine installed to use the exhaust steam, 80 to 100 per cent more power can be obtained with the fuel consumption increased not more than 40 or 50 per cent, or 30 or 40 per cent additional power can be obtained without increase of steam consumption or fuel cost.

DISCUSSION.

The discussion on this subject was mainly in the form of questions regarding features of operation of turbines. The following members were interested: J. T. Chambers, of the Georgia Railway & Electric Company, Atlanta; E. C. Deal, of the Augusta-Aiken Railway & Electric Co., of Augusta; Mr. W. R. Collier, of the Georgia Railway & Electric Company of Atlanta; Mr. J. S. Bleecker, of the Columbus Railroad Company, and Mr. J. H. Adams of Augusta.

Mr. J. T. Chambers stated that although there was no doubt in his mind as to the advisability in use of the low pressure turbine by the central station, yet he believed that the paper had not considered the steam necessary for operation and the wear on the blades due to the moisture in the steam. In reply to this subject the author of the paper stated that he did not believe that the steam used by auxiliaries would amount to more than 5 or 6 per cent in low pressure turbine installations. He further stated that in the construction of buckets, there was found very little wear due to moisture.

Mr. E. C. Deal asked what would be the result when running at full load and operating both low and high pressure turbines if the vacuum be lost? Second, is it customary to so arrange the steam connection that a low pressure turbine can be operated as a high pressure machine, and if so, what is the method of preventing too much steam taken by the low pressure turbine. Third, if buckets are lost on a high pressude turbine what would be the result in the operation of the low pressure turbine when the steam passes directly from the high pressure to the low pressure?

In reply to these questions the author first stated that if the vacuum is entirely lost all the power of the turbine is lost. He stated that this is the advantage of using a mixed pressure turbine, because if the vacuum is lost the mixed pressure turbine will carry the load. Second, in regard to the use of high pressure steam, he advised that with a mixed pressure turbine the same machine can be used with different nozzles. It is altogether possible to admit high pressure steam into a mixed pressure turbine and no trouble is caused thereby. In regard to the loss of buckets, it was the opinion of the author that it would be no worse in the high pressure than in the low pressure. Mr. J. H. Adams, of Augusta, asked what the velocity of steam and what the wear on the buckets would be. The author of the paper stated that the velocity of the steam in the low pressure turbine could not be any higher than a high pressure turbine working under the same vacuum.

Third Session.

The third and last session open to all members was opened Wednesday morning at 10 o'clock. One of the papers scheduled for this session entitled, "Ice Making as Associated With Central Stations," by Burdett Loomis, Jr., of the Ware County Light & Power Company, Waycross, Ga., was not presented on account of the inability of the author to be present or send the paper. The first paper therefore, to be taken up was entitled, "Electric Heating Utensils," by L. L. Warfield, of the Westinghouse Electric & Mfg. Co., of Atlanta. An abstract of this paper follows:

ELECTRIC HEATING APPARATUS.

The question of properly protecting resistors from oxidizing influence is one which has been given little attention until very recent times. In the case of the sad iron, the protection of the resistor is best effected by the use of a very thin flat resistor element wound on a thin mica form and insulated on both sides by the same material. This form is then clamped while hot between heavy iron plates, one of which provides the ironing surface, under a pressure of many tons.

The same general idea has been applied successfully in the design of water heaters, disc heaters, toasters, and other small stoves. Small water heaters and units for coffee percolators, tea pots, etc., are made in the form of small discs or bent into cylindrical shapes to provide additional radiating surface or to fit the vessels with which they are used. For heating large volumes of water or other liquids, a popular form of heater is constructed along the same lines except that instead of being a disc or cylindrical shape, it is for convenience in handling, made from flattened copper tubing in which the flat resistor elements are assembled under pressure. For heating tanks of water, large hospital sterilizers, glue cookers, coffee urns, etc., or any form of liquid heater, the units are mounted in standard pipe, usually 2 inches, of suitable length and connected at either end with ordinary pipe connections to the main reservoir containing the liquid to be heated. These heaters are arranged for two or three heats as desired by series multiple connection of the resistors and the maximum wattages range from 1500 to 7500. One of the most successful applications of this type of heater is found in the water sterilizer for hospital service.

Other particularly desirable applications of the sealed in and brazed types of heaters are found in the frying pan, chafing dish, glue pots and soldering pots.

Electric cooking in the home, so long looked upon as a form of dissipation only to be indulged in by the very rich, is beginning to be at least not uncommon. The utility toaster stove, the chafing dish, coffe percolator, disc stove, tea kettle, frying pan, small water heaters and many other small devices are being manufactured and sold in constantly increasing quantities.

DISCUSSION.

The discussion of Mr. Warfield's paper revealed a special interest in current consuming devices by all of the members. Valuable suggestions were brought out in connection with the operation of the various devices and the value of each to a particular section given. Mr. W. R. Collier, of the Georgia Railway & Electric Co., Mr. Thomas W. Peters, of the Columbus Railroad Company, Mr. Callender, of the General Electric Co., Mr. Geo. K. Hutchings, of the Columbus Power Company, Mr E. C. Deal, of Augusta-Aiken Railway & Electric Company, took part in this discussion.

Mr. W. R. Collier presented a written discussion in which he took up some vital points in connection with the renewal and maintenance of electric heating devices. He stated that the rapidness and the ease of repair had not been given as much thought as it deserved. There are many types of electric heating apparatus now on the market that have to be sent to the factory for repairs, and this works a very great hardship on the central station and customer. When the customer desires repairs she is equally anxious that the device be returned at once. A wait of a week or so is objectionable. Mr. Collier stated that from his experience and observation he believed that the majority of repairs on heating apparatus were of a minor character, and the percentage of repairs on heating elements comparatively low. The greatest number of repairs seemed to be confined to broken attaching jacks, broken attaching plugs and cords. He expressed the opinion that in the case of the flat iron where the cord is subjected to rough usage, that manufacturers put more thought in the design of the cord and the attaching plugs. The plug of heating apparatus should not be of porcelain, mica or hard rubber would serve better.

Mr. Collier dwelt particularly on flat irons, on account of the fact that more of these devices are sold than any other one heating device. Further, what applies to irons, applies to a certain extent to other household electrical apparatus. He called attention to another question, namely free repairs, and stated that druing the year 1910, the total cost of repairs on flat irons and other heating apparatus done by the Georgia Railway & Electric Company of Atlanta, amounted to only about $100. The question therefore presented itself as to whether or not it would be a good policy for the company to repair free of cost, electrical heating apparatus used by its customers. This could be done not only from an advertising standpoint, but from the standpoint of keeping the apparatus connected.

Mr. Thomas W. Peters stated that the Columbus Power Company had found that the most effective method of placing devices was by personal solicitation. Irons are sold at a price which insured enough profit to carry the account without any loss. Ninety per cent of the heating devices placed on trial remained sold and often provisions are made for a long time payment. It was his opinion that a revenue of $3.00 on an ordinary 6-pound iron will pay considerable money on the investment. The results of experiments with the use of electric irons by washer women were given. The company wired eight houses limited to three openings, furnishing a complete installation of lamps and one 6-pound iron. Service was placed through a 15-cent prepayment meter. The rate was arranged as follows: 10 cents for current, and 5 cents for payment of wiring and iron. This plan did not work as successfully as was expected, due to the high cost of the service. It is believed that if a smaller rate was charged, it would be more successful. Mr. Callender of the General Electric Company, referred to free renewals, stating that he could see no reason why free renewals could not be made, as he had looked into the matter carefully and found that such repairs were very slight with all companies. He mentioned one company, the Athens Railway & Electric Company, that is pursuing this plan successfully.

Mr. L. L. Warfield, of the Westinghouse Electric & Mfg. Company, stated that central stations were pushing the flat iron too hard and should look to other devices. He mentioned the use of the baker's oven, a chafing dish, a coffee percolator, and a toaster stove.

Mr. George K. Hutchings, of Columbus, brought up the difficulty of selling expensive pieces of apparatus of the nature of the different heating devices. He mentioned the use of a fireless cooker and stated that considerable economy could be affected by its use. In reply to Mr. Hutchings on the high cost of heating devices, Mr. Callender stated that central stations should not blame the manufacturers for the cost of heating devices, for the only way to reduce them was to sell them in large quantities.

Mr. E. C. Deal referred to Mr. Callender's remarks on the price of heating apparatus, stating that he had found through experience that in order to introduce apparatus of this nature it was necessary to sell it at approximately cost. In some cases it is necessary to expend money to such an extent that it becomes a losing proposition for a short period. He suggested that manufacturers make a special effort in the way of selling devices at a very close margin, as this would help the central station in starting the devices and in turn help manufacturers in introducing their apparatus. Mr. Deal agreed with Mr. Collier in regard to the question of free renewals, but did not think it would be necessary to determine upon a policy by which all repairs on heating devices should be made. A small charge to cover the cost should be arranged, special attention being given so that the customer would not be troubled while the damaged article is being repaired.

IMPORTANCE OF WAVE FORM TO CENTRAL STATION OPERATION.

This paper was prepared by Mr. Montford Morrison, of Atlanta, and read by Mr. W. R. Collier. An abstract is as follows:

In the beginning, when alternating currents were first treated and experimented with, they were defined as merely positive and negative impulses occurring alternatively, the wave theory not being considered. But as the science progressed it was found that, regarding difference of potential and time, the current occurred in the form of a wave, and from a mathematical calculation, it was decided that this wave followed the law of sines, and hence the wave represented simple harmonic motion and was therefore a sinusoid.

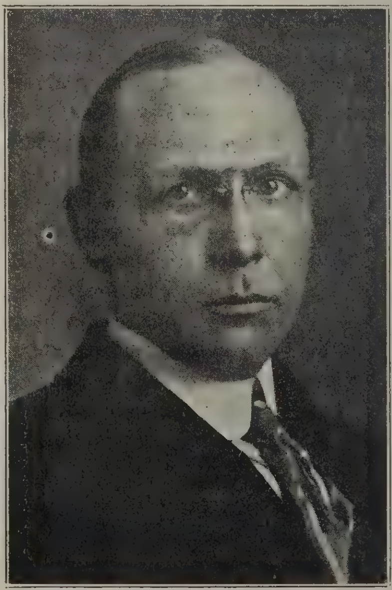
But soon it was found that graphic representation by a simple line curve did not, in many cases, suffice. It was found that two alternating currents of equal so called effective voltage and of the same period may have quite different effects on a system. This phenomenon must therefore be accounted for. It is known now that for the light effect from arc lamps, the peaked curve is greatly inferior to flat, broad form, also it is known that certain wave forms effect the efficiency of motors. More lately it has been found that large amplitudes of the high harmonics cause resonance phenomena, which may become of greater danger in cable lines and the effect of these higher harmonics may be to even change the frequency of the circuit which would lead to unbearable conditions. Integrating watt meters and, as a matter of fact, all instruments and apparatus that depend upon the inductive effect of the current, are influenced by the amplitudes of these higher harmonics. It was from these occurrences that the problem of formulating these waves having harmonics other than the fundamental present, and with this problem solved, we may at once determine the undesirable components and eliminate them. It has now long since been known that the iron loss in a static transformer is dependent upon the form of the wave of electrical pressure which is applied to its primary winding, because the form of this wave, with the constants of the transformer, determine the wave of magnetic flux produced in the core.

Many investigators have spent much time to show the effect of wave form on the life of incandescent lamps. Others have gone more deeply into the effect on arc lamps, and still others have treated with the effect on motors. One of the first steps to improve wave form was taken in the field of direct current engineering, when simple pulsating currents were overlapped to form a straight line. Many thousands of dollars have been spent in trying to improve the shape of the wave in generators. But the generator is not always responsible for the wave shape. Each individual line, every different load, tends to change the wave shape, and since it is in the generator in a desirable form, any change is for the worst. Thus it can be appreciated that it is of vital importance to the efficient operation of the central station to know the wave shapes in their systems, that they may improve, where possible, the undesirable.

In the June issue of the Southern Electrician will be found an article relating to this subject by Prof. F. B. Davenport, under the heading of "Determination of the Emf and Flux by the Harmonic Instrument." Also in the August number of the same Journal you will find an expanded form of the even harmonic discussion by myself, under the heading of, "Mechanical Integration of the Emf When Even Harmonics are Present."

EXECUTIVE SESSION.

After the reading of the above paper, the members went into executive session, at which time the report of the nominating committee was read and the election of officers held. The following are the officers



Mr. Wm. Rawson Collier, President, Georgia Section N. E. L. A.

who will have charge during the coming year: President, W. R. Collier, of the Georgia Railway & Electric Company, Atlanta; Vice-President, E. C. Deal, of the Augusta Railway & Electric Corporation; Executive Committee, R. P. Mayo, O. A. Farrar, and M. L. Sperry. The Secretary and Treasurer is to be appointed by the president. After President Bleecker turned over the duties of the presidency for the next year, Mr. Collier delivered fitting remarks of appreciation for the honor just given him, and complimented in many ways the work of President Bleecker and expressed the hope that the results of his administration would be equally as profitable.

The papers in connection with this report have only been briefly abstracted. They are published in printed form and may be secured by those interested through application to T. W. Peters, Columbus, Ga.

MR. E. C. DEAL, VICE-PRESIDENT OF GEORGIA SECTION N. E. L. A.

SOCIAL FEATURES.

The social features of the convention were well planned and executed. Every one express themselves as royally entertained and left Columbus with a strong feeling of indebtedness to their royal hosts. The social events included an informal reception at the Muskogee Club on Tuesday evening, where a number of local people were invited to meet the guests. On Wednesday afternoon a trip to Goat Rock was the closing social feature and a most successful and appropriate ending for the convention. A special train was furnished and a picnic lunch and other refreshments served on it by the following manufacturing companies: General Electric Company, Western Electric Company, The Westinghouse Electric & Mfg. Company, The Allis-Chalmers Company, and The Electric Storage Battery Company. Upon the arrival of the train at Goat Rock, the party was in the hands of the Hardaway Contracting Company and the Stone & Webster Engineering Company, and shown the details of construction in connection with the large dam now being completed at that point.

As announced in the October issue, a rejuvenation of the Sons of Jove was held at Columbus, and thirteen candidates initiated. The rejuvenation was in charge of Mr. L. S. Montgomery, manager of the National Metal Molding Company and statesman from Georgia. Much cerdit is due Mr. Montgomery for his enthusiastic work at this convention for the results shown in the personnel of candidates indicate that he is a firm supporter of quality in the order rather than numbers. The initiated included a large number of the executives of the various central stations represented at the convention. This is Mr. Montgomery's second rejuvenation during his year as Statesman, and those who have been intimately connected with his work can vouch that his excellent record has been entirely due to his enthusiasm and hard work for the furtherance of the good work to be accomplished by the order.

Illuminating Engineering Society Convention.

The attendance at the fifth annual convention of the Illuminating Engineering Society, held at Chicago, Sept. 25 to 28, was about 275. Of this number over one half were members of the society, the remaining number including guests and ladies. The number is decidedly significant as indicating the general interest in the work of the society, not only by members but by others closely associated with illuminating engineering. Through the report of the committee on progress and the discussion on this report, the advancement during the year in systems of lighting indicated particular progress in the use of systems of general illumination supplemented by local illumination where necessary. Under the old plan in factories and industrial establishments, it has been the practice to use a drop light with an opaque reflector over the special object to be illuminated. The tendency to-day is to get away from the localized system of illumination and modern factories are illuminated in an entirely different way placing greater strength on general illumination, even when greater cost is entailed.

The program was decidedly interesting, all of the papers being thoroughly discussed and many features brought out not covered in them. The order of proceedings at the convention was as follows:

Presidential address by Dr. A. E. Kennelly on "The Relations of Physico-Physiological Research to Illuminating Engineering;" report of committee on nomenclature and standards, Dr. A. C. Humphries, chairman; report of committee on progress, Dr. Louis Bell, chairman; symposium on illuminating glassware, by Messrs. A. J. Marshall, L. W. Young, G. H. McCormick, F. L. Godinez and Bassett Jones, Jr.; "The Manufacture of Glass from the Viewpoint of the Illuminating Engineer," by Mr. E. H. Bostock; "An Analysis of Requirements in Modern Reflector Design," by Mr. F. L. Godinez; "Recent Small Gas-Lighting Units," by Mr. F. H. Gilpin; "Flames Carrying Electric Current," by Mr. C. F. Lorenz; "The Production and Form of Natural Gas from the Illuminating Engineer's Standpoint," by Mr. G. S. Barrows; "Recent Developments in the Manufacture of Incandescent Lamps," by Mr. J. E. Randall; "The New Quartz-Tube Mercury-Arc Lamp," by Mr. George C. Keech; "The Law of Conservation as Applied to Illuminating Calculations," by Dr. A. S. McAllister; "The Photometry of Lighting Units of High Intensity," by Messrs. George H. Stickney and S. L. E. Rose; "Photometry at Low Intensities," by Dr. Louis Bell; "Evaluation of Lamp Life," by Messrs. P. S. Millar and L. J. Lewinson; "Distribution of Luminosity in Nature," by Dr. H. E. Ives; "Light Distribution—Its Influence Upon Illuminating Efficiency and Visual Acuity," by Mr. A. J. Sweet; "Resume of Legislative Enactments on Illumination," by Mr. E. L. Elliott, and "Selling Illumination," by Mr. F. B. Rae.

The entertainment features provided for a two-hour automobile ride on Monday, Sept. 25, for the ladies. On Monday evening a reception and dance was held at the Congress Hotel. On Tuesday afternoon an automobile ride with light refreshments at the South Shore Country Club took place. On Wednesday afternoon the delegates were taken in various places of engineering interest, ending with a theater party, for the visiting ladies.

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.

OPERATING COSTS OF UNITS.

Editor Southern Electrician:

(253.) I would like to obtain reliable data comparing the monthly operating costs of a gas engine, a steam engine and a motor, each operating under average load conditions. Let me put the matter in this form: What are the comparative costs of operating each of the above units at 50% load factor for 260 hours a month, each unit to be rated at 25 horsepower? In the case of the gas engine the fuel is to be purchased per 1,000 cubic feet, and with the motor, electric energy purchased by the k. w. hr. Further, what will be average costs of the unit together with installation charge? With steam engine, the boiler is not included, and with electric motor, wiring to be considered from main cut-in 100 feet. C. E. D.

COMBINED COST OF POWER AND LAMP RENEWALS.

Editor Southern Electrician:

(254.) Kindly publish in the Question and Answer Department of your paper, a formula for obtaining the combined cost of power and lamp renewals per 1,000 hours, for a 40 watt Tungsten lamp. Also explain what this same cost per 100,000 Lumen Hours means. In some lamp catalogues I have seen this cost also given per 1,000 candle-hours. There must be a difference, therefore please explain.

E. J. B.

WHY DID FUSE BLOW?

Editor Southern Electrician:

(255.) A difficulty has come up in our plant which causes me to suggest that some reader of The Southern Electrician familiar with the details of transformer operation together with the troubles often met, should take up this question. A series of "don'ts" and the reasons why in connection with installation and operation of station and line transformers would be of most interest to the station man. My case was this: Our station transformer has a fuse protection of 50 amperes, when the engine is shut down the lights go out as the engine slows down, but the fuse is blown when ready to start again. The transformer voltage is 1,100 to 110. Kindly explain the cause and reason of fuse blowing and give other information suggested above. If there is a book giving electric station operating details, suggest it. L. H.

SINGLE PHASE VS. THREE PHASE MOTORS.

Editor Southern Electrician:

(256.) Kindly advise through the question and answer department as to the advisability of installing a single phase induction motor instead of a three phase induction motor on a system, where both single phase and three phase distribution is available. Also give some information from cases where this has been tried out and definite conclusions arrived at. Kindly furnish information also to show which is the more economical and why. Is there a possible limit of size of single phase motors to use above which three phase should be used? If so, what is it? H.A.B.

LIGHTING LAYOUT FOR A COTTON MILL.

Editor Southern Electrician:

(257.) I would appreciate information on a proper layout for lighting a cotton mill using Tungsten lamps. For an illustration, suppose a weave room be given 160 feet long by 60 feet wide, with ceilings 12 feet high, the room located on second story of a four-story mill and the construction, including windows, etc., being standard mill design. The windows are provided with shades made of unbleached cotton cloth and the ceilings are whitened, also the walls down to about five feet from the floor, where there is a slate color wainscoting. The looms for this room are driven from the room below through belt-holes in the floor. The room below has exactly the same layout and same equipment, doing the same work, but with belt alleys and shafts to obstruct illumination. Cloth 28 to 52 inches is manufactured on both floors.

Kindly furnish a layout of lighting for each of the weave rooms mentioned, giving the watts per square foot of space or the method of rating this kind of illumination. Also mention height above floor that lamps should be hung, also the size of lamps, as well as type of the reflector.

L. L. W.

Free Lamp Renewals, Referring to Mr. Rakestraw's Reply to Question 204.

Editor Southern Electrician:

On looking through some back issues of Southern Electrician I notice that Mr. Rakestraw's opinion on free lamp renewal policy published on page 161 of the April number practically coincides with mine, as expressed on page 40 of the July issue. As regards the latter part of his answer, I am very interested in his suggestion of a touring renewals crew removing all consumer's lamps at regular intervals. I should be glad to hear whether this system has been at all widely adopted, and if so, with what results?

Why are 3.1 watt metallized filament lamps recommended? Doubtless these are superior to the ordinary carbon filament lamp in every respect and are sufficiently robust to stand transport and return on the touring wagon. Further, they do not subject the central station to such a loss of revenue as would be the case if metallic lamps were used, but from the consumer's standpoint, the latter should certainly be supplied. Surely a 3.1 watt metallized lamp cannot be called a high grade lamp of this type? A specific consumption of 2.7 watts per c. p. should be quite obtainable.

Assuming, however, that metallic filament lamps are actually supplied, on the principle that a satisfied customer is a certain earnest of extended demand, these cannot be taken back to the testing room at the end of each year or quarter without a very high percentage of breakages, the filament being very brittle after it has been in use for a time. A considerable compromise thus appears inevitable: either the consumer must pay two or three times as much for current as need be the case, or the station must suffer heavy losses by breakage in return transit; or the otherwise desirable and business-like scheme suggested must be abandoned. Further details of the practical working of free renewals schemes as adopted in America would be very acceptable to the writer and, doubtless, to many other readers of this journal. CECIL TOONE, *England.*

[These comments have been submitted to Mr. Rakestraw in advance of publication, and we are fortunate to have further valuable suggestions from him. These remarks are presented below. In this connection, all central station readers are requested to give this subject careful thought and send SOUTHERN ELECTRICIAN their schemes for handling free renewals. This material will appear in these columns and should prove both interesting and instructive. Let us have not only actual schemes, but suggestions for such.—EDITOR.]

Further Remarks on Question No. 204.

Editor Southern Electrician:

Mr. Toone, of England, has made certain queries and suggestions in regard to my answer to the above question, as published in the April issue of the SOUTHERN ELECTRICIAN. My experience in central station work has not included a large number of companies, and therefore I cannot state what is the practice of companies in general. The Allegheny County Light Company, supplying the city of Pittsburg and surrounding Boroughs with a total population of about 500,000, use the touring wagon for lamp renewals in their centrally located territory, but persons living in the outlying villages have to go to the sub-stations for renewals. The company with which I am now employed use no wagon at all, but require customers to bring the lamps into the office. Of these two plants, I consider the former the more satisfactory, for reasons previously stated.

As to lamps, I believe that the 3.1 watt metallized filament lamp is the most efficient type which can well be used at present for free renewal purposes. Mr. Toone has answered his own question, when he refers to the rugged construction of the metallized filiament, and to the brittleness of the metallic filiament after having been in use. In an article written some time ago for another periodical, I said "free renewals of the metallized lamp cost about one-half to three-quarter cents per K. W. H., and just that much more has to be added to the selling price. If the tungsten lamps were not so fragile and liable to be broken by carelessness, they could be supplied on exactly the same basis, but it would be necessary to add two or three cents per K. W. H. to cover the expense."

It is evident that there would be a good deal more breakage of the metallic filiament lamps than there is at present, if free renewals were given, as customers would not use the same degree of care in handling them and it would be necessary to add possibly four or five cents per K. W. H. to cover the total cost of supplying tungsten lamps. Another important item to be taken into account in considering free renewal of these lamps is that of theft. Everything considered, I believe it much better to allow the customer to supply his own tungsten lamps.

Mr. Toone emphasizes the importance of looking at this question from the consumer's standpoint. It seems to me that the central station can best serve the consumer by furnishing high efficiency lamps at about cost and encourage their use in every way possible If this is done, it will be found that in a short time the majority of the stores and business houses will be glad to put them in, and while the use of these lamps has not as yet extended generally into the residence field of lighting, yet there are indications that it will soon do so. Our company have at present something like 2,000 tungsten lamps in residences, on the flat rate system with the Excess Indicator with very good results.

A. G. RAKESTRAW.

Discussion on Starting Induction Motors, Ans. to Ques. No. 226.

Editor Southern Electrician:

In the answers to Question 226, appearing on pages 119 and 120 of the September issue of Southern Electrician, no mention was made of the primary resistance method nor the star-delta switch method of starting squirrel cage induction motors. Both of these methods have their application and though they are used with small motors, they prevent flickering of lights when on lighting circuits and keep down the starting current.

The first method consists of using a primary resistance starter, which is a simple device and particularly applicable to two and three phase squirrel cage motors of small capacity starting under light load. Non-inductive resistance is arranged in two phases of the primary circuit for either two phase or three phase motors. Sufficient resistance is provided to give the motor from 40 to 50 per cent of the line voltage when the circuit is first closed. At this voltage the motor will develop sufficient torque for the average condition of starting under light loads. The resistance is so proportioned and has sufficient capacity to permit of starting the motor under partial load conditions, requiring from 65 to 75 per cent of the line voltage at the motor terminals to start, and taking from the line a current about 2½ to 3 times the normal full load current of the motor.

While the current taken from the line, when starting with the resistance method, is somewhat greater than that taken with the compensator method, the power factor of the combined resistance-starter and motor is higher than that of the combined compensator and motor. The wattless current is about the same for the two methods, the line disturbance being somewhat greater for the larger sizes. The cost is also lower. Care must be exercised while starting the motor, to prevent cutting the resistance out of circuit too rapidly at first. The torque developed by squirrel cage motors when starting is low at first, but increases as the motor speeds up.

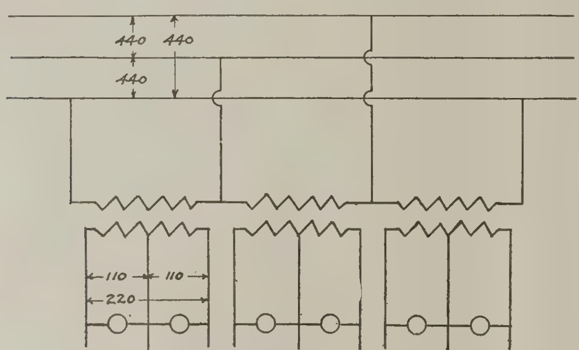
The star-delta method consists in arranging the winding of a 3-phase squirrel cage motor so that it can be connected in star for starting and delta for running. When connected in star, two sections of the primary winding are in series across the full line voltage, while in the delta connection only one section is across the full line voltage. On starting, therefore, the current is considerably lower, due to the higher impedance of the motor circuit, two sections of the windings being in series. After the motor has come up to speed the connections are changed to delta and each section of the winding gets its full rated voltage. This method of starting is essentially applicable to smaller motors and the double throw drum type switch is very simple. In appearance this is similar to an auto-transformer starter as the mechanism is immersed in oil and enclosed in a sheet iron tank. The operating lever is also similar and is so arranged that it is necessary to move to the starting position and pass quickly over the "off" to the running position. Running fuses which are short-circuited on starting are usually provided, mounted on the back of the enclosing tank. GEO. J. KIRCHGASSER.

A. C. Wiring System. Ans. Ques. No. 227.

Editor Southern Electrician:

There seems to be an opportunity, according to the conditions of question 227, for a layout that would be simple, reliable and economical. I would not advise the use of a four-wire system, as I fail to see where it would be of advantage in this case. The feeders should run to pannels in the different parts of the building and the mains to adjacent motors. In some cases where several motors drive machines operating as a unit, it is of advantage to supply all motors from the same feeder pannel.

In regard to lighting, I would advise the use of a 110-220 volt, three-wire system something as follows:



ARRANGEMENT OF TRANSFORMERS AND CIRCUITS.

This gives three, three-wire circuits which can be easily balanced. The three neutrals may also be grounded.

C. L. HAYWARD.

Delta vs. Y Connections for Transformers. Ans Ques. No. 236.

Editor Southern Electrician:

In the above query the inquirer invites entrance into a field of discussion in connection with which so much has been written in the past that it is scarcely possible to do more than act as a mouthpiece in voicing the statements of others. Nevertheless, the importance of the subject is sufficient to warrant repetition. The general custom at present is to employ the delta connection for both the high and low tension windings of transformers operating at moderate potentials, that is up to, say, 22,000 or possibly 33,000 volts. At higher voltages both delta and star high tension connections are in favor, with the low tension windings connected in delta. The star connection for the high tension side possesses an advantage over the delta, in that it puts less strain on the high tension coils, and likewise, by grounding the neutral, limits the potential between primary windings and ground to $1/\sqrt{3}$ times the line voltage.

Star connection for both primary and secondary windings is not considered good practice, although it has been used with more or less success in several important installations. The principal objection to this system is that the potential balance across the phases is very unstable, due to the shifting neutral point. The conditions existing being very much similar to those which obtain in the case of two transformers connected in series, and whose tendency toward unbalancing is well known. This unbalancing may produce enormous rises in potential above those for which the transformer is designed, thus resulting in a breakdown of the insulation. Aside from conditions arising during normal operation, these troubles may be precipitated by various other causes. For example, opening one or more phases in succession between the generating system and a single bank of step-up transformers supplying a transmission line, before opening the high-tension or secondary circuits, and from numerous other causes apt to be met with in practice.

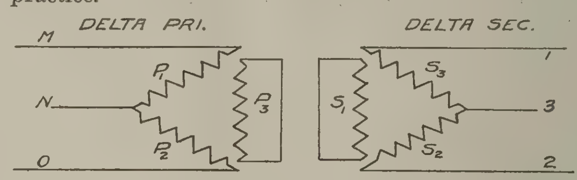


FIG. 1. OPEN DELTA OR V TRANSRORMER CONNECTIONS.

In the case of small transformers for high tension service, particularly of three-phase type, it is customary to employ star connected high-tension and delta connected low-tension windings, on account of constructive advantages and economy in first cost. Aside from the above mentioned features favoring delta connected apparatus there is also the advantage that in case one of a bank of delta connected transformers becomes disabled, due to ground or burn-out it may be entirely disconnected from the circuit, letting the two remaining transformers carry the load. This they will do at normal potential and up to about 60 per cent. of the original bank capacity. In the case of a three-phase transformer thus disabled it is necessary to short-circuit both high and low tension windings upon themselves after their disconnection from the circuit.

The above method of connecting up two single-phase transformers or two phases of a three-phase transformer, constitutes the V connection in Fig. 1. Here again we have the condition of two transformers in series with the attendant possibility of potential unbalance. This feature constitutes the principal objection to the V system of operation. A much preferable method, in case middle taps are available on both the high and the low tension windings of one transformer, is to connect them in T, as per Fig. 2, With equal transformation ratios on the two transformers the potential across two phases of the line will exceed that of the third phase, however, as will be evident from a consideration of the relations. This unbalancing is not enough to be of serious consequence in temporary service.

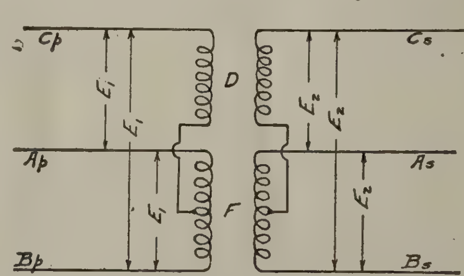


FIG. 2. T CONNECTIONS FOR TRANSFORMERS.

Assuming that the transmission voltage has been fixed, the transformers of a bank of three single-phase units will each carry full line current and $1/\sqrt{3}$ (58 per cent.) times full line potential if connected in star; and full line potential with 58 per cent. of the line current if in delta. On the other hand suppose that the transformer equipment is on hand and the line voltage is to be governed by the system of connecting employed. Then for a given power output, the current in the individual transformer windings will be the same with either star or delta connections, since in the case of the delta connection the line current is 1.75 times the line current with star connection for the same output (the star voltage being 1.73 times that of the delta system). The current per winding of the delta connected transformers is but $1/\sqrt{3}$ times that of the line; hence equal in value to the line current with star connection of the same transformers. C. C. HOKE.

Discussion on Loading Transformers. Ans. Ques. No. 240.

Editor Southern Electrician:

In looking over the answers to question No. 240 by Mr. Hayward and Mr. Broward, I note that they are contradictory and somewhat short, I will therefore endeavor to make the matter clearer. Mr. Hayward states that if the sizes are not the same there will be a difference in the load taken by each while Mr. Broward states that the load will be the same irrespective of size. Mr. Broward further states that at increased load the smaller one takes current from the larger ones because of increased voltage drop and therefore makes the total capacity of the three to be even less than three times the smaller one. A little careful consideration of the theory involved will show that this last statement cannot be true, as I shall presently show.

The division of load depends upon the regulation of the transformers and it might be well to write the manufacturers as Mr. Hayward suggests, but we may very well assume that they have the same characteristics (including regulation) as Mr. Broward's discussion is based upon this assumption and as it agrees fairly well with the probable facts. If the regulation is the same in each case the voltage drop at full load will be the same and is given by the equation $E = IZ$, where E is the voltage drop, assumed equal in all three cases, I the full load current which is proportional to the respective sizes, and Z the combined impedance of the primary and secondary windings which is inversely proportional to the respective sizes since the value of E is the same in each case.

We will assume that the transformers have a full load capacity of 100, 200, and 400 amperes respectively and that the drop at full load is 2 volts. Then $E = 2 = IZ = IaZa = IbZb = IcZc$ where Za is the impedance of the smallest one, Ia is its full load current and the subscripts b and c refer to the other two transformers. From this we find that $Za = .02$; $Zb = .01$ and $Zc = .005$.

Since the ratios are understood to be the same, the secondary voltages are the same at no load. Let the primary voltage be 2000 and the secondary voltage at no load be 100, then the secondary voltage at full load is 100 — drop and must be the same in each case since they are connected in parallel by lines of practically negligible resistance. Therefore if $100 - IaZa = 100 - IbZb = 100 - IcZc$, it is evident that $IaZa = IbZb = IcZc$ and substituting the values for Z, $.02Ia = 01Ib = .005Ic$ which shows that the currents are inversely proportional to the impedances and therefore directly proportional to the capacities.

The total load is $Ia + Ib + Ic$ and from this equation and the one just given we can calculate the currents for any load. At half load of 350 amperes, the loads of the three will be 50, 100 and 200 amperes respectively; which values will agree with both the equations $Ia + Ib + Ic = 350$ and $IaZa = IbZb = IcZc$. If we assume that the current of one transformer could become less than its proper share and the others become more, it is evident that the drop in the lightly loaded one will become less than the others, which is impossible since the terminal voltage (100—drop) is the same in each case. Also if Mr. Broward's second statement were true the terminal voltage of the small one at no load and therefore no drop, would be less than that of the loaded ones since it could not take current from them unless its voltage were lower. It can be easily seen that this is impossible because the terminal voltage rises when the load is reduced, because of the lessened drop. The three will automatically strike a balance when each has its proper share since any increase of load will reduce the terminal voltage because of the increased drop.

It is quite possible, as Mr. Hayward suggests, that the regulation will not be the same and we will therefore assume that the smaller transformer drops three volts instead of two on full load. Our equations will then read $.03Ia = .01Ib = .005Ic$. And $Ia + Ib + Ic = 350$, at half total load, as before. Solving the equations we get, $Ia = 35$ $Ib = 105$ and $Ic = 210$. Thus we see that the load on the smaller one will be less than its share (50) instead of greater as Mr Broward states, since it is to to be expected that the regulation of the smaller ones will not be so good as the larger. There is only one way that a transformer can be made to take current from others in parallel with it and that is by decreasing its terminal voltage at no load, either by changing the ratio of turns or by connecting a boosting transformer between them. Where transformers have been repaired at local repair shops there is a good chance that such change of the ratio will be accidentally made and it is always well to test for same since the cross currents are wasteful of energy.

When the resistance of the connecting bus is not negligible, we may consider the bus as part of the transformer leads and the same theory holds in this case also. However, in this case the distribution of load is affected somewhat by the way the cut-ins are made, there being a tendency for most of the load of a cut-in to be taken by the transformers nearest to it. If a transformer has more than its share of the load either because of superior regulation (low value of Z), or because it is nearest to a large cut-in, there will be a tendency to balance the load, for as the resistance increases with temperature and the temperature increases with current the drop will increase faster than it would if the resistance were absolutely constant, and will thereby lower the terminal voltage. Thus we see that all the phenomena considered are more or less favorable to the operation of transformers in parallel.

Generator Voltage, Ans. Ques. No. 243.

Referring to the latter part of Question No. 243, in the September issue, the voltage of a generator is given by the equation, E = KMN, where M is the field strength, N is the speed, and K is a constant depending on the number of turns, etc. Since the value of M depends on that of E and since there is no equation giving their exact relation, it is not possible to predetermine the voltage at 600 revolutions with any degree of accuracy, but it is certain that the voltage will be something over 220, since it would reach that value if the field were constant.

If it is not convenient to run the machine at 600 revolutions, we can find the answer to the question by connecting the fields (divided in two sections) in parallel and operating the machine at 300 revolutions, when it will give just half the voltage that it would at 600 r. p. m. and normal connections. For instance, if the voltage were 200 it would be 400 when we put the field back in series and increased the speed to 600. The truth of this proposition will be evident when we consider that with the fields in parallel they will receive the same voltage at 300 r. p. m. that they would when in series and with 600 r. p. m., therefore they will reach the same strength and the voltage will become just half what it would at 600 r. p. m.

T. G. Seidell.

Generator Excitation Fails. Ans. Ques. No. 242.

Editor Southern Electrician:

In answer to W. I. N. in question 242, September number, I will say that his troubles are very similar to some which I have had with a Warren 100 K. V. A. alternator, the exciter of which had an overwound drum winding of single cotton covered wire. This machine dropped its load one night shortly after starting, but upon examination nothing could be found that was wrong, and upon starting again it picked up all right and carried its usual load for days before the same thing occurred again.

Satisfied that the trouble was in the exciter, I unsoldered the leads to the segments and tested both commutator and winding. The former was O. K., but a rather faint ring could be obtained between certain coils. On removing the winding, the insulation on about one-third of the bottom coils was found to be slightly burned. This must have occurred gradually, as at no time could any sign of excessive heating be observed. A new winding corrected the fault entirely.

The use of too much compound, especially if it contains paraffin, can easily form an insulating film over the commutator. A few simple tests with a magneto bell and voltmeter will locate the trouble without much time or difficulty.

J. S. Lewis.

Generator Excitation Fails. Ans. Ques. No. 242.

Editor Southern Electrician:

In answer to W. I. N.'s question, No. 242, in the September number of your magazine, I would suggest that he ring out exciter shunt field circuit with a magneto upon one occasion of the failure of the A. C. generator to generate, allowing the generator and exciter to operate at or above normal speed while test is being made, but not allowing A. C. generator to build up. Should exciter shunt field circuit not be opened by this vibration, also try main circuit from exciter brushes to field coils of alternator, through revolving field collector rings for an open circuit. Ring this circuit or portions of it while generator and exciter are operating, but open exciter shunt field circuit during this test. It may be decided whether or not this trouble is in the exciter or alternator by placing a voltmeter across exciter lines at connection board exciter terminals. If a voltmeter is not handy, a 110-volt lamp may be used to tell if exciter holds up voltage at all times. It is more likely, however, to be an open in the shunt field of exciter than elsewhere.

I have often seen D. C. generators of low voltage act in this manner, but there was also a heating of commutator because the brush contact with the commutator was not of great enough area to carry the current at the low voltage generated at the time by the generator. This usually occurs in booster-sets for charging storage batteries or in generators used for electroplating, although I have seen as high as a 52 volt generator fail until pig-tails were used upon carbon brushes. I also prefer not to use commutator compounds, and carbon brushes do not require to be boiled in vaseline if they are carbons of good quality. A pressure of 25 lbs. per square inch of contact surface of carbon brush is a maximum amount of brush pressure required to carry current. The General Electric Co. decidedly specify not to use compounds, and not to use lubrication upon commutators. A little vaseline may be used upon collector rings which are made of cast-iron on these compensated A. C. generators.

Arthur L. Gear.

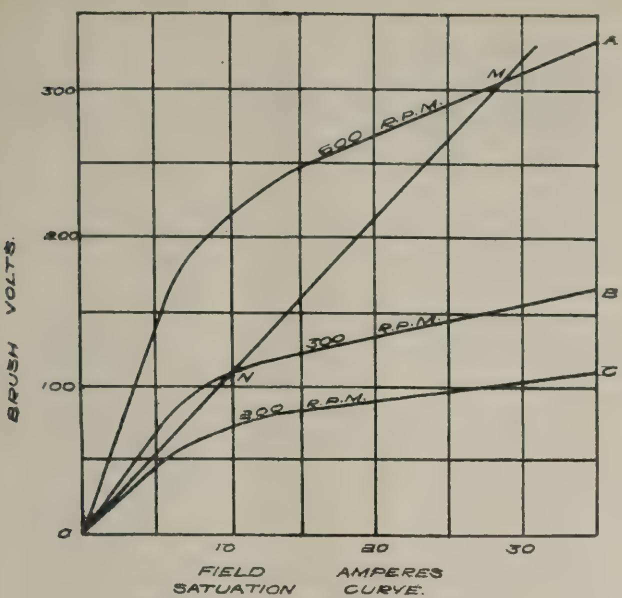
Electrical Units and Generator Performance. Ans. Ques. No. 243.

Editor Southern Electrician:

In reply to the first part of question 243 of the September issue, there are two sets of electrical units. The first is based on the force exerted between two quantities of electricity and the second on the force exerted between a current and a magnetic pole. These definitions are given in electrical handbooks and in many of the regular treatises on electricity. The question asking for the six electrical units probably refers to: 1. The Ampere, or unit of current; 2. The Volt, or unit of electro-motive force; 3. The Ohm, or unit of resistance; 4. The Watt, or unit of power; 5. The Farad, or unit of capacity; 6. The Henry, or unit of induction. The International electrical units include two others: The Coulomb, or unit of quantity, and the Joule, or unit of work.

In order to definitely answer the latter part of this question the "magnetization" or "saturation" curve of the generator must be known. If curve B in the figure be taken as the saturation curve of the generator mentioned for a speed of 300 revolutions per minute, curve A will be the saturation curve for 600 revolutions per minute. These saturation curves show the relations between field current and induced voltage when the machine is running at constant speed and no load.

Thus at 600 revolutions per minute the induced voltage for a certain field current is exactly double that at 300 revolutions per minute. Since the conditions are to be maintained exactly the same at the high speed as at the low speed, the field rheostat is not to be touched but the field current may change. This double voltage then sends twice the current through the field windings and if the field magnetism doubled each time that brush voltage and, field current doubled, the field strength would keep on



SATURATION CURVE FOR GENERATOR.

rising indefinitely. Were it not for the fact that the field cores soon become saturated our voltage would reach an infinite value which would be the case if we could build a practical shunt dynamo with no iron in the magnetic circuit. Such a machine would generate either no voltage or an infinite one.

With a generator having the saturation curves shown in the figure with the operating point at N for 300 revolutions per minute, we can draw a straight line ONM. The intersection of this line with curve A at the point M is the operating point at 600 revolutions per minute, and under the assumed conditions the voltage will then be 310 and the field current 28 amperes, instead of 110 volts and 10 amperes. On the other hand suppose that we reduce the speed to 200 revolutions per minute and draw the saturation curve C. The machine will generate no electromotive force at this speed except the negligible amount due to residual magnetism. The curve ONM is sometimes called the field resistance line, as points on this line show the relation between the potential drop and the current in the fields. Where it intersects the saturation curve is the operating point for any unloaded shunt or compound wound generator at the particular speed for which the saturation curve is plotted.

PROF. H. P. WOOD,
Georgia School of Technology.

Size of Wire for Electric Stoves. Ans. Ques. No. 252.

Editor Southern Electrician:

In reply to question 252 in the October issue I offer the following. The temperature of an electric stove or any other body, depends upon the rate at which heat is supplied and the rapidity at which it can be radiated. A surface will radiate a certain amount of heat for each degree rise in temperature above the surrounding atmosphere. This amount depends on the nature and extent of the radiating surface as well as upon the heat carried off by conduction and convection. It follows then that if we heat a body by electricity or other means that at first there will be no radiation, since the body is at the same temperature as the air and it will begin to rise in temperature at a rate depending upon its size and specific heat, that is upon its heat storage capacity. As it gets warm, it begins to radiate heat, therefore the rise of temperature becomes less rapid until sooner or later a point is reached where the radiation equals the input and the temperature remains constant.

The final temperature depends on the rate at which heat is supplied and radiated, while the quickness of the heating and the time required to reach a steady temperature depends on the size of the body and the material of which it is composed. This length of time may vary from a few minutes in the case of a small stove to several hours in the case of large machinery. In considering electric heat, we have another effect produced by the variation of the resistance with the temperature, termed the temperature co-efficient. We have, therefore, an increase in resistance, a decrease in the current and therefore a decrease in the input as the temperature. This produces a lower finer temperature and an earlier equilibrium.

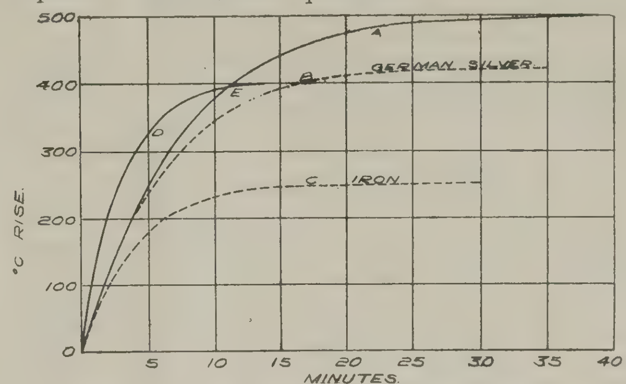


FIG. 1. TIME-TEMPERATURE. RELATIONSHIP.

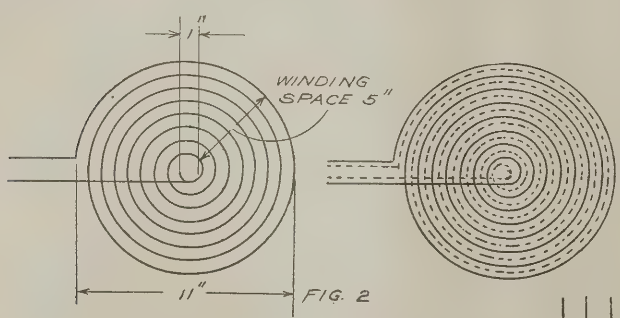
The time—temperature relationship under different conditions is shown in Fig.1. A is a curve for resistance wound with Climax wire or some other having zero temperature co-efficient. B is for the same size article, except wound with German silver wire and C same wound with iron wire, the effect of which is to greatly lower the final temperature. Curve D is for a smaller and lighter body, but with a good capacity for radiation. It gets hot quicker, but does not attain as high a temperature as the larged body. Note that at point E, the temperature is the same after the same time is elapsed. This goes to show that a single reading, such as so many degrees rise after such an interval does not tell the whole story.

In the case of electric stoves, which are designed to heat some utensil, we have a large additional amount of heat abstracted, which keeps the stove at a much lower temperature than would appear from the calculation. It follows, therefore, that a stove which would be injured by allowing it to be heated in the open air, would not be injured in the process of cooking, and we see therefore that we cannot apply theoretical calculations in such cases, but must use arbitrary rules derived from practice. We give below the sizes and wattages employed by one of the leading manufacturers of heating utensils:

Diameter in inches	Watts	Watts per square inch
4½	250	15.6
6	440	15.7
7	600	16
8	735	14.7
10	1100	14
12	1300	11.5
15	1800	10.2
20	2700	8.6

The requirements stated in the question, namely, a temperature of 300 degrees F. after 15 minutes, is far below the ordinary. Four or five watts per square inch would give this, while commercial stoves use ten or fifteen or sometimes as high as thirty watts per square inch of top surface. Since the stove in question is 12 inches in diameter, it has 113 square inches of top surface, and we can, therefore, figure on from 1,300 to 1,800 watts. In computing the proper size of conductor to use, we have two limiting conditions. One is the permissible current density, and the other is the maximum watts per square inch, which can be radiated from the external surface without producing too high a temperature. Where the wire or strip is imbedded in enamel, it may be brought almost to a point of fusion without danger of open circuit. Where the resistance material is not so supported, we must use a lower current density.

We will consider both round wire and metal strip spirally wound as shown in Fig. 2. The left hand figure shows a single winding and the right hand figure a double one, in which one winding is distinguished by dotted lines. The advantage of this is that we may, by using a special plug and socket shown in Fig. 3, first throw the two coils in series, then use one alone, and finally the two in multiple, thus securing three heats. Now assuming that we can wind from within ½ inch of the center to within ½ inch of the edge, we will have 5 inches winding space as shown in Fig. 2. The mean length of turn will then be 18.85 inches or nearly 1.6 feet. The minimum distance between turns depends on the method of winding. If the resistance material is in the form of a strip wound with mica between the turns, this distance would be quite small, .01 or .02 inches. Where the wire is laid in place and imbedded in some material which is poured in around it, it would necessarily be greater



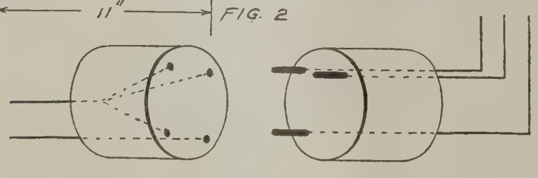


FIG. 3

Figs. 2 and 3. Stove Construction and Connections.

For the purpose of this calculation, we will use a value of .04 inches. The table below gives the details of the calculation for iron, german silver, climax (Driver Harris) wire and german silver strip. The hot resistance is indicated by a star. The other figures being the value when cold. Iron has a high temperature co-efficient, is easily oxidized, is low in specific resistance and is in general not suited for resistance material. German silver is much better in all these particulars, while climax wire has practically no change of resistance in temperature and is very high in specific resistance. The strip winding has the

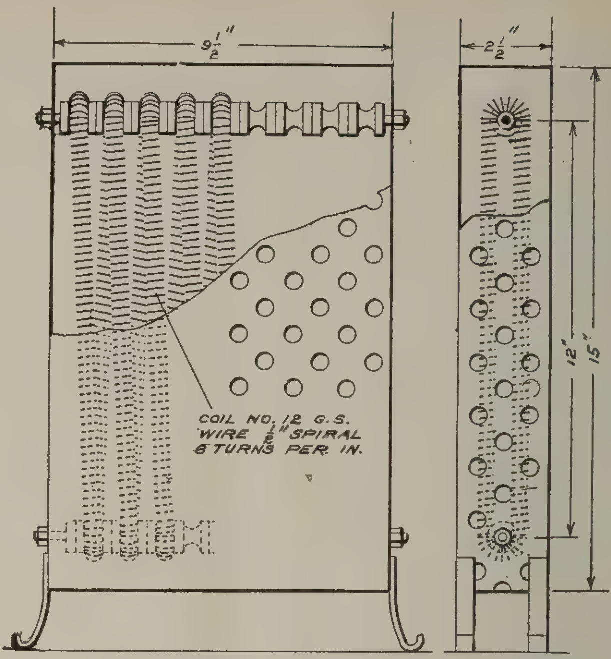


Fig. 4. Construction for Electric Radiator.

advantage in getting a greater weight of metal in the winding space and consequently reducing the current density in the conductor, which lessens the probability of open circuiting. The No. 21 German Silver wire, No. 18 climax, or the No. 36 G. S. strip would probably prove the most satisfactory.

Table I. Details for various wires suitable for electric stove.

Size and kind of wire No.	Diam	Space Reg.	T'ns	Ft.	Ohms per foot	Total Ohms	Amps	Watts	Remarks
18 Iton	.04	.08	62	100	.051	5.10 *12.24	23.5 9.8	2820 1176	
16 G. S.	.05	.09	55	88	.073	6.69 *8.03	17.9 15.	2148 1800	
21 G. S.	.0285	.0685	73	117	.234	27.3 6.32 *80.	4.41 17.64 15.0	5292 2117 1800	Coils in Ser. Coils in Mul. Coils in Mul.
14 Climax	.064	.104	48	77	.128	9.86	12.2	1464	
18 Climax	.04	.08	62	100	.328	32.8	3.66	439	Coils in Mul.
G. S. Strip 30x¼"	.010	.050	100	160	.0582	9.31	12.9	1538	
G. S. Strip 36x3-16"	.005	.045	111	177	.16	27.7	4.33	520	Coils in mul.

*Hot Resistance.

As to the design of a radiator, a consumption of 1,500 watt hours in 30 minutes means a capacity of 3,000 watts, which at 120 volts gives a current value of 25 amps. We select No. 12 G. S. as the proper size of wire. We arrive at this size from a consideration first of the fusing current, which for No. 12 G. S. wire is about 115 amps. in the open air, but would be considerably less in a coil of wire, and further, by the fact that the length of this size, which is required to give the necessary resistance, will just about fill a sheet iron box having a surface of 450 square inches or about 8 watts per square inch, which when we consider the heat carried away by convection, is about as high as should be used. Figuring on a cold resistance of about 4 ohms, we find that 160 feet of wire is required, which if wound in a spiral of ½ inch diameter would require a length of 18 feet. The resistance spiral is wound around porcelain spools as shown in Fig. 4, and only the length is computed which is not touching the spool, since on the turn the layers are short cricuited together. A. G. Rakestraw.

New Apparatus and Appliances.

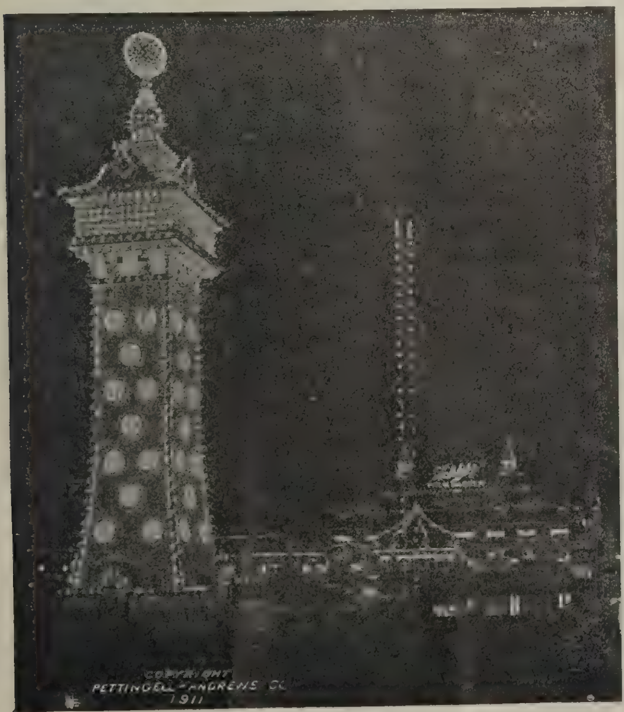
A New Departure in the Decorative Lighting of Amusement Parks.

BY G. A. BARKER.

Progress, in all lines of human endeavor, is achieved by those who have the faith and the courage to handle modern implements while they are still more or less unfamiliar and untried. We shall owe the conquest of the air, and many other "enterprises of great pith and moment," to those progressives, who have already given us the highly perfected transit and electrical service facilities of modern times and who have in not a few instances taken commercial risks before which minds of less keen insight had retreated.

To eliminate, at a *coup de main,* seven thousand carbon filament sign lamps of a standard tested and tired type and to replace them by the recently developed 2½ watt metal filament sign lamps of a standard tested and tried type and park lighting on a large scale, requires the strongest kind of confidence in the quality of the newer lamps. This step was taken last spring by the management of Paragon Park, the well known amusement resort at Nantasket Beach, Mass., and the progressiveness exhibited is none the less noteworthy because experience, now that the summer park season is over, has shown it to have been justified. An equal degree of confidence and initiative was manifested by the Boston electrical concern, Pettingell-Andrews Company, which recommended and engineered this change in decorative lighting equipment, and also by the Warren Electric and Specialty Company, the manufacturers of Peerless lamps, who co-operated with the Boston company on all details involving questions of lamp performance.

A reduction in current consumption from 10 watts to 2½ watts per lamp, with no decrease in initial candle-power and with better maintenance thereof throughout the period that the average lamp is in service, has been effected at Paragon Park, and in addition, the greater brilliancy and whiter color of the high efficiency light have actually made the Park seem more strongly illuminated than it was in previous years, and have sensibly increased its general attractiveness. The effect has also been enhanced by the addition of new electric signs and by extensions of the outline lighting system, which, however, absorb but a fraction of the released load.



View at Paragon Park, Showing Outline Lighting.

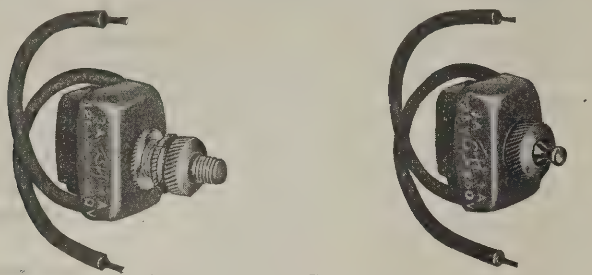
The approximately seven thousand sign lamps used in the ornamentation of this amusement resort are apportioned approximately as follows: To the Park's most prominent landmark, the tower which rises at its center, are allotted some 4,000 lamps; 2,000 more are used in the outlining and decorating of the Palm Garden and Pavilion, 400 in the large "thirst" sign above the Palm Garden, 400 on the Band Stand and 200 in various other parts of the Park. The several structures just mentioned can all be discerned in Fig. 1.

Local low-potential transformers having a 10:1 ratio are used to step down the voltage of the central station mains to that required for the sign lamps, which are designed to consume their rated input, 2½ watts, at a pressure of 11 volts. Current is secured on contract from the Weymouth Electric Light Company. The peak load contributed by the park lighting during the busy season is normally about 275 kilowatts, and this value is maintained for about 4 hours daily, while for 6 hours out of the 24 the park runs at about half of its peak consumption. Thus the sign lighting constitutes but a small portion of the total load, in fact the ceiling of the Palm Garden alone, studded as it is with nearly 1,000 lamps of the 25-watt, 110 volt type, consumes more current than all of the 7,000 sign lamps put together.

The evolution of the sign lamp itself has been rapid and has been marked by great improvements in efficiency. For years the two most common types of lamp for sign lighting were the 2 c. p. and 4 c. p. carbon filament lamps, consuming about 10 watts and 19.6 watts, at efficiencies of 5 and 4.9 watts per candle respectively. The first sign lamp with a tungsten filament consumed 5 watts at 1.33 w. p. c. (old candle) or 1.31 w. p. c. (international candle), while the 2.5 watt Mazda lamp (rated at the same efficiency) is a more recent development. The latest type of construction used in these lamps, employing filaments of drawn wire with clamped joints, gives them improved mechanical strength while the fact that they are more than thrice as efficient as the carbon filament lamps gives them an enconomic advantage over the latter under nearly all conditions in spite of a slightly higher cost.

New Fixture Canopy Switches.

The Cutler-Hammer Manufacturing Company of Milwaukee has brought out a new line of canopy switches made in three styles. The porcelain bodies of the former switches have been replaced by bodies of a tough insulating material which the company has developed. No. 7,155 is of entirely new design and is for installation in the bottom shell of ceiling fixtures. The regular push button is not employed but a threaded stem onto which any standard fixture bottom knob will fit. Where it is desired to cut down wiring expenses this switch can be substituted for a wall switch.

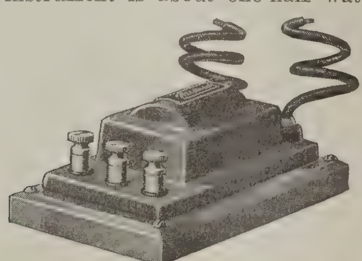


New Fixture Switches.

In the new 12-story Lowry building, at St. Paul, the Minnesota Fixture Company provided the 1,500 keyless socket wall brackets shown in illustration with the new No. 7,151 switches. These canopy switches are very inconspicuous and operate without jar.

The Packard Bell Ringer.

Users of bell ringing transformers should read over rule 30-C of the revised electrical code which requires that air-cooled transformers used inside of building shall be mounted one foot from combustible material or on a slab of non-combustible non-absorptive insulating material. To meet the above requirement, the Packard Electric Company, of Warren, Ohio, has brought out a new bell ringer mounted on a neat enameled slate slab all ready to install. The core loss of this instrument is about one-half watt and it will



The Packard Bell-Ringing Transformer.

stand a continuous short circuit without damage to either the transformer or the bell wiring. Two secondary voltages of 6 and 8 are furnished. Primary leads are of heavily insulated cable and the core and coils are vacuum treated with a water-proof insulating compound. The case is of cast iron neatly furnished in black baked enamel.

A complete descriptive circular will be furnished on request.

Conference of the Sterling Electrical Manufacturing Company.

During the past summer the Sterling Electrical Manufacturing Company of Warren, Ohio, established a procedure that deserves considerable praise from the standpoint of a method taken to establish a closer relation between the company and its members and at the same time persue a work which will result in benefit to all concerned. Reference is made to the six day conference held by the sales and engineering departments of this company at the Riverside farm, three miles up the Mahoning River from Warren, as guests of William E. Coale, treasurer and manager of the company.

The camp was known as Riverside and proved a delightful place for the conference, and a most satisfactory convention was enjoyed by everyone present. A complete Mazda street-lighting system was installed, with lights in every tent. One of the features of the conference was the presentation of a paper by Mr. Coale entitled "Warren Beautiful." This describes in detail the civic movement which culminated recently in the installation of a complete Mazda street-lighting system in Warren, O., a description of the opening of this system and an illustration of it was published in the Sepetember issue of Southern Electrician. Warren is the first city in the United States to exclude every other form of lighting. The paper above mentioned has been prepared for publication in a unique booklet which will be distributed to central station managers, municipalities and officers of business men's organizations interested in street lighting movements. A copy may be secured by applying for it through the company at the address given above.

A Bell Ringing Transformer.

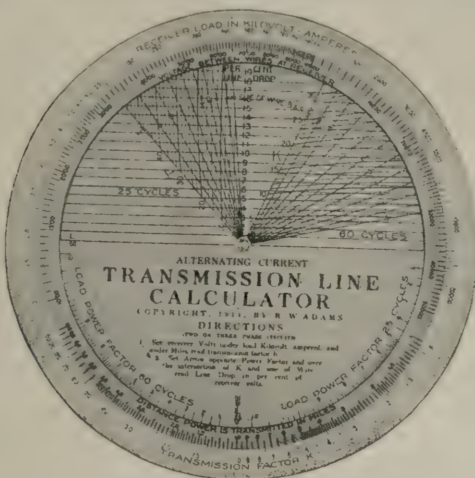
The bell ringing transformer shown below is made by the Victor Electric Company, Jackson Boulevard and Robey street, Chicago. It affords an opportunity for obtaining uninterrupted and inexpensive service, since its function is to change the ordinary 110 volt electric lighting current into 6 volts, thereby making possible its use for operating bells. Besides ringing bells, it will operate annunciators, buzzers, burglar alarms, and small toys. It is of special value in hotels, office buildings, and factories, for operating annunciator systems and elevator bells and signals.

Victor Bell Ringing Transformer.

This device is made in two styles. Both type A and type B transformers being designed for operation on any alternating current of 110 volts. Although type A will operate most bells, buzzers, annunciators, etc., it is sometimes necessary to obtain more than the 6 volts which this size will deliver. In such cases type B should be installed, as three different pressures can be obtained from this size, 6, 10, 16 volts.

Transmission Line Calculator.

An ingenious device designed for the purpose of calculating energy loss and line drop in alternating current circuits, has been placed on the market by Robert W. Adams, 10 Hyde St., Newton Highlands, Mass. The nature of the calculator is shown in the attached cut and consists of a white celluloid disc upon which is mounted a revolving transparent celluloid disc. On these discs are printed the necessary diagrams to perform the calculation mechanically.

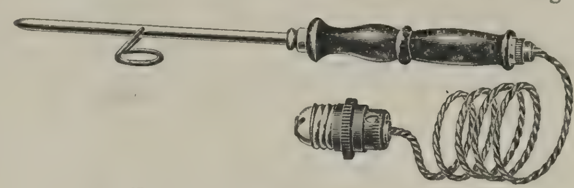


THE TRANSMISSION LINE CALCULATOR.

The transmission line calculator operates in a simple manner and requires only two settings to give the result. Operating directions are printed on the back of the disc, together with an example explaining completely the method of operating. The device is applicable to single-phase and three-phase circuits, and the diagrams are made on a spacing of eighteen inches between wires, but for practical working sufficiently accurate on circuit varying from 6 inches to 36 inches. The largest disc is 4⅛ inches in diameter so that the calculator can be carried in the pocket.

Pelouze Curling Irons.

The illustration herewith is that of a curling iron manufactured by the Pelouze Electric Heater Company, 232 East Ohio street, Chicago, Ill. The design is such that the temperature is so regulated in the construction of the heating element that it will not become hot enough to



THE PELOUZE CURLING IRON.

burn the hair. The handle and frame are made to revolve around the heating element, to which the cord is attached, which saves the cord from wearing out and prevents it from knotting while in use. The shield is also quickly removable should it not be required. The amount of current consumed in this iron is very small.

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.

ANNISTON. It is understood that a Great White Way system will be installed along Second Ave., between 21st and 26th Streets, according to an agitation now being pushed by the Second Ave. Improvement Association. A post manufactured in Anniston will be used for the system.

ASHVILLE. According to reports, the Ashville Cooperage Company is planning to install an electric light plant.

BIRMINGHAM. It is now understood that the Great White Way situation in Birmingham has reached such a point that a style of post has been adopted. It is stated that the Great White Way Committee of the Chamber of Commerce has indorsed the post manufactured by the Union Foundry Company of Anniston, Ala.

DECATUR. A bond issue of $50,000 is being considered for the construction of an electric light plant.

ELBA. It is understood that the Pea River Power Company has arranged to construct a new power plant, to cost about $150,000. Developments will be hydro-electric and energy will be supplied to Troy, Dothan, and other nearby cities. Charles Hutchison, of Troy, Ala., is in charge of the plant.

PIEDMONT. The city has voted on $25,000 in bonds, for the construction of an electric light and water power plant, and the enlargement of the water works.

SCOTTSBORO. The city is contemplating the construction of a water works plant, the engineers in charge being J. B. McCrary & Company, Atlanta, Ga.

TUSCALOOSA. S. G. Blair and H. B. Foster have made application for a franchise to build and operate an electric light plant and street railway system, and also for a natural and artificial gas plant in Tuscaloosa.

FLORIDA.

AUBURNDALE. The city will construct a plant for the manufacture of electric light and power.

BROOKVILLE. The city is soon to vote on granting a franchise to a party at Umatilla, Fla., who proposes to construct an electric light plant and water works system.

JACKSONVILLE. The city is planning to expend $40,000 for the installation of a pumping system and other improvements to its water works system. A bond issue has also been made for improving and enlarging the electric light plant.

JACKSONVILLE. The Postal Telegraph Company is reported to be complying with the city ordinance requiring wires on Bay Street to be placed underground. The cost of the work will be from $25,000 to $30,000.

NICHOLS. The Phosphate Mining Company is to erect a phosphate mining plant to cost $250,000. New buildings will be reinforced concrete construction and fire-proof.

GEORGIA.

AMERICUS. A company has been incorporated, with $50,000 capital stock, by Frank Lanier and Frank Sheffield, to establish an electric light and gas plant. The plant will furnish light, heat and power to Americus, and to the surrounding territory.

ATLANTA. A company known as the Georgia Railway & Power Company, with a capital stock of $27,000,000, has recently been granted a charter by the state. This company is backed by Canadian and English capitalists, and plans to absorb a large number of hydro-electric development projects in the Piedmont section of Georgia. It also plans to take over by a lease arrangement and operate in connection with its other activities, the electric street railway, electric lighting, heating and power companies now consolidated in the Georgia Railway & Electric Company of Atlanta. Under the lease arrangements, the new company guarantees all the obligations of the Georgia Railway & Electric Company, private and public, and agrees to pay 8 per cent dividends on its outstanding stock. Among the water power developments recently consolidated under the Georgia Railway & Power Company, are the power plants at Bull Sluice, Etowah Power Plant, and the Tallulah Falls Power Development now in course of completion. An incorporator of the company has stated that it will not be affiliated with any of the large electrical industries. It is an entirely new company to develop electric power, operate street railways, and furnish light and power to municipalities and private corporations. The company will have as competitors, the Southern Power Company, which is operating in South Carolina close to the Georgia line, the Alabama Interstate Power Company, the Central of Georgia Power Company, with a development near Jackson, Ga., and the Columbus Power Company. The incorporators are J. M. McWinney, of Toronto, Canada; Charles Magee, R. Matheson, and George A. Kingston, of Toronto; Forest Adair, Jack J. Spalding, Alexander C. King, and F. Marvin Underwood, of Atlanta.

BAXLEY. The city has voted on a bond issue, to erect an electric light plant.

CLARKSVILLE. It is understood that John Martin will install an electric light plant at Clarksville.

DOERUN. J. B. McCray & Company, of Atlanta, has been engaged by the city of Doerun, to install an electric light system. The cost will be approximately $7,000.

JACKSON. The improvements to the electric light plant at Jackson are to consist in the changing from steam power to electric, the electrical energy being purchased from the Central Georgia Power Company. A bond issue of $12,000 has recently been voted for these improvements.

JESUP. It is understood that the power equipment for a pumping station at the new water works system will be purchased in the near future.

ROME. It is understood that the Georgia Power Company is planning the erection of a sub-station at this place. D. E. Parsons is said to be the engineer in charge of the work.

KENTUCKY.

BOWLING GREEN. The Isbell-Chapman Electric Company has filed amendments to its charter, changing its name to the William H. Isbell Electric Company.

LEXINGTON. The state inspector has recommended the construction of a plant to supply power, heat and light to the buildings of the Kentucky State University. H. S. Barker is president of the University, and can give other information.

LEXINGTON. The Moore-Young Electric Company has completed the installation of equipment in the Municipal Lighting Plant, at Midway, Kentucky. The cost of the plant was $4,000.

LIVERMORE. It is understood that the Smith Cooperage will construct a power plant.

LOUISVILLE. According to press reports, plans are being developed by W. O. Head, mayor of Louisville, for a power canal, 30 feet wide and 20 feet deep, beginning at the Ohio River and running south five miles to a lake. A turbine is to be placed in the canal, to furnish power for industrial plants. The project is estimated to cost $5,000,000. Investigations and preliminary reports are now under way.

NEWPORT. A contract has been entered into by the city council and the Union Light, Heat & Power Company, for the installation of 300 additional electric arc lamps in the city. This will double the present equipment.

ORANGEBURG. The erection of a small electric light plant is being considered near Maysville. Arrangements are being made to secure connections with some other plant.

PRESTONBURG. The Prestonburg Electric Light Company has filed amended articles of incorporation, increasing its capital stock from $6,000 to $10,000.

LOUISIANA.

HOMER. The city has purchased the electric light plant from E. G. Sawyer.

LAFAYETTE. An issue of bonds to the extent of $60,000 has been made for the improvements to the municipal electric light plant, water works, and other improvements.

NEW ORLEANS. On account of the rates for electric energy, for lighting and power, by the Consumers Electric Company, and the New Orleans Railway, Light & Power Company, the company of Fuerst & Cramer, Ltd., have made it known that they are planning to install a power plant, to operate their works.

SHREVEPORT. The city has recently voted a bond issue of $310,000, for the erection of an electric light plant. The engineer in charge is Anderson Offutt, of New Orleans.

MISSISSIPPI.

GULFPORT. The Gulfport & Mississippi Coast Traction Company has announced that additional shops will be erected at Gulfport. The machinery equipment will cost approximately $5,000.

HATTIESBURG. The Electric Light & Gas Plant and the Hattiesburg Traction Company has been acquired by the H. L. Doherty Co., of 60 Wall Street, New York City. It is understood that $100,000 in improvements are planned for the next two years.

LAUREL. The Gulf States Investment Company, owners of the electric light and power plant at Laurel, is contemplating to construct a street railway system. Application for its franchise is soon to be made. P. H. Sanders, of Laurel, is vice-president of the company, and has announced that the company proposes to build on interurban railway from Laurel to Hattiesburg.

NORTH CAROLINA.

BRYSON. It is understood that C. G. Logan, of Waynesboro, N. C., has been engaged as electrical engineer, to take charge of the installation of a proposed municipal electric light plant for the city. The cost of the installation will be about $9,000.

DURHAM. The Southern Power Company has recently completed its transmission lines from Rocky Creek to Durham, and will be ready to supply electrical energy as soon as the mills are ready for the service. The line is about 175 miles long.

LITTLETON. A second-hand generator and switchboard of a size to light and operate a 40-light plant in a planing mill, is desired by E. E. Wollett.

MARSHALL. The Madison Light & Power Company has been incorporated with a capital stock of $10,000, by J. H. White and others.

NASHVILLE. Prices are desired on electric machinery and fixtures for lighting purposes, by L. L. Davenport. An estimate is also desired on the cost of installing an electric lighting plant in a town of 1,000 population.

NASHVILLE. A company is being promoted by L. L. Davenport, for the purpose of installing and operating an electric light plant.

ORIENTAL. It is understood that the city will install an electric light plant in the near future.

RALEIGH. According to press reports, the board of aldermen has offered to pay for the installation of a White Way system on Martin and Bay Streets, provided that the city will furnish electricity to maintain such a system.

RUTHERFORD. The Carolina Electrical Company, of Raleigh, N. C., has been given a contract for the equipment of the municipal electric light plant at Rutherfordton.

SELMA. It is understood that $20,000 will be expended on the electric light plant and water works, for improvements.

SHELBY. On December 5th, the city will vote on a bond issue of $15,000, for the purchase of an electric light plant.

SHELBY. Prices are desired by C. L. Eskridge, on a second-hand, one horsepower, single phase, 110 volt motor.

SOUTH CAROLINA.

ANDERSON. The Anderson Water, Light & Power Company is installing considerable additional machinery in its plant. J. E. Serine, of Greenville, S. C., is engineer.

COLUMBIA. The Columbia Electric Street Railway, Light & Power Company has applied for a franchise to change and extend its tracks in Columbia.

GREENVILLE. Press reports state that the initial equipment of machinery to test the methods to be used by the Clayton Linen Mills, of Greenville, are now being installed. If the methods prove satisfactory, the company expects to erect buildings for a 7,000-spindle mill, to be operated by electricity. R. L. McDavid is president, and can give other information.

GREENVILLE. The South Carolina Electric Company has been incorporated, with a capital stock of $3,000, by H. G. Cushman and L. Stoddard.

UNION. The Municipal Electric Light Plant and Water Works System has recently made extensive improvements at their plant. A 75 K. W. three phase 60 cycle, 2,300 volt Hawthorn generator, direct connected to a 135 H. P. Harrisburg engine, has been installed, with the necessary switchboard. The interior of the plant has been remodeled and all steam and electric lines have been placed in ducts under the concrete floor. Mr. R. A. Easterling is superintendent of the plant.

TENNESSEE.

ADAMS. The construction of an electric light plant is being considered by D. F. White and J. G. Stoltz.

ALAMO. Plans for an electric light plant, to furnish light and power to the city, are being considered by B. W. Chapman.

CHATTANOOGA. It is understood that the Merchant Association has submitted a proposition to the Board of City Commissioners, for the establishment on an ornamental lighting system. The association has agreed to erect and maintain the lamp standards and wires, provided the city will furnish electricity for same.

CHATTANOOGA. The Tennessee Railroad Power Company is constructing a hydro-electric plant at Hollsbar, 15 miles from Chattanooga, and expects to have it completed in the summer of 1912.

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CONTENTS.

The Central Station, the Contractor and the Manufacturer.

Through the general acceptance of electrical energy as a source of light, heat and power during the past few years, especially in connection with the introduction of more efficient lighting units, successful household appliances for heating and cooking and the small motor, the relation between central station, contractor and manufacturer has been drawing closer and closer. This state of affairs has not necessarily been brought about by any well directed combined effort, the nature of the fields to which these agents cater has made it so.

This relation in as far as it affects the central station and contractor was the subject of an interesting paper and discussion presented at the Niagara convention of the National Electrical Contractors Association in July. At that time a number of valuable suggestions were offered explaining the overlapping of the fields of the electrical contractor and central station. It would seem however that with the present exploitation methods pursued by electrical manufacturers, that one of the important considerations in the problem was omitted. The central station is in business for the specific purpose of generating and distributing electrical energy, the manufacturer of electrical apparatus is in business for the purpose of producing a worthy product and turning it into cash in the shortest possible time. The contractor and supply dealer on the other hand, represents a business which involves the products of both the above. Although there is and has been cases where injuries have been worked to each through the execution of new business methods, these differences are now narrowed down to definite limits. It is becoming plain to each that an exploitation of the field in general simply brings greater possibilities and multiplies opportunities for a more profitable business. The central station, the contractor and the manufacturer each of necessity is endeavoring to realize a profit upon its investment of time and capital. Each of these interests have, of course, their own respective competition, and this competition has grown to such proportions that the main time and energy of the parties interested, are consumed in coping with it. The result is, that the possibilities of the advantages lying in active co-operation between these three interests, has been to quite an extent overlooked.

All application of electrical apparatus is the result of education and experience, and while a review of past efforts shows a phenominal progress made during recent years, a similar survey of the present day equipment of large factories and central stations, justifies the prophecy of a more rapid advance in the immediate future. The tendency at the present time is towards a more diversified or universal application of electrical apparatus; towards a higher efficiency or greater economy of operation and towards the automatic. All this new application and improvement, makes it not only highly desirable but almost imperative for these interests to recognize one anothers welfare.

Of the tnree interests considered, perhaps the average contracting firm labors under the most unsatisfactory circumstances. Less capital is involved and therefore the incentive for the less responsible to enter the business is greater, thus causing a conditon of competition often depriving the competent contractor of the profit and business to which he is entitled. Lack of business training and experience is ruinous to any business and when the contracting field is thrown into a state of confusion through these agencies, conditions are generally bad. The evil effects are keenly felt by the central station through its customers. The contractor and central station are so closely associated in their work that the interests of one cannot be disturbed or improved without effecting for the worse or better the interests of the other. Every sale of apparatus by either means current for the central station and usually calls for additional or new wiring.

Since the province of wiring is now generally turned over to the contractor, the value of intimate association with the central station in the territory becomes evident. Too seldom is this broader view taken of the situation and a feeling of injustice held by the contractor who recognizes his field of activity decidedly separate from that of the public utility organization. This feeling has had a tendency to spring up with the wave of new business campaigns which has recently rolled across the central station field. It is prophesied that with the further and more settled conditions of these departments, this activity will not be considered a detriment but a decided means of co-operation and a method of materially stimulating and building up a contracting business.

What a Technical Education is and What it is Not.

Every now and then there appears in the press, the opinion of an apparently materially successful person, successful in most cases due to the brains and assistance of others, to the effect that a college education is practically useless and a detriment. We will not say that the assistance and brains overlooked by such advisers are those of college men, however, such will bear inspection. The champion of all "knockers" of this class, taking as his subject the technical school and its product, is Mr. R. T. Crane of the Crane Company of Chicago, who, needless to say, is a non-technical man. His outbursts are varied in nature, and his proclamations have been widely heralded by the daily press, not so much, perhaps, as news or information but as a rare sample of the distorted and warped opinions that may originate from those whom everyone has reason to believe wise, careful thinking business men. The last attack issued by Mr. Crane is a pamphlet setting forth his arguments under the title, "The Futility of Technical Schools in Connection with Mechanics and Manufacturing or Electrical and Civil Engineering."

It is not our purpose through these brief remarks to take up particular points brought out by Mr. Crane, these have been refuted time and again to the satisfaction of the most persistent. Perhaps the best information of a carefully weighed and impartial nature on this side of technical and industrial education is that written by Dexter S. Kimball, and published by Cornell University, under the title, "The Need of Industrial Education." A word for Professor Kimball's qualifications to speak, for Mr. Crane would say that he is one of the "Ordinary College Set," immediately, from seeing the "Prof." in connection with his name. Prof. Kimball, according to Mr. Crane's recipe for a trained engineer, served in his youth an old-fashioned apprenticeship. He then devoted himself to science, pure and applied, graduating from a technical school and since served as Professor of Mechanical Engineering and as superintendent of a large manufacturing plant. He, therefore, has a right to take up the subject with authority on the basis of the laborer, the manufacturer, the scientist and the educator.

Professor Kimball frankly states that the old apprenticeship system is dead and that the new systems are very much alive and growing. His analysis of the situation shows that the general characteristics of men to fill successful places in the engineering and industrial fields must include accomplishments, further than inherent ability, general and cultural knowledge, as follows: First, manual skill; second, scientific knowledge; third, manufacturing knowledge. Mr. Crane's recipe for education includes the first and a small part of the third, which is sufficient comment or comparison.

Our friend of the old school has fallen behind the times about 25 years. He fails to realize, because certain young men exhibit an unfavorable attitude toward the manufacturing plumbing shops under his direction, that such a state of affairs should not be taken as a criterion of their value in the business. These statements apply to the other fields which he has invaded. Higher mental development along scientific lines does not necessarily exist with manual skill and shop leadership. The high grade and capable engineer must possess the first, but not necessarily the two last. Prof. Kimball says that it has yet to be shown that the higher techincal schools, with the many faults that they may have, are not fulfilling their purposes fairly well at least. In quoting his words, we are voicing the same sentiments and inviting any others who differ to come forward with the information wherein the industrious, college-educated, technical engineer of today is wanting. This is not for the sake of argument, but for the higher development of the industries and the benefit of those who are spending considerable sums in salaries to technical engineers in the belief that they are getting what they pay for.

It is to be remembered that the technical school does not have for its aim the training of skilled mechanics, tool makers, and foremen; if it were so, manual skill would receive more attention. On the other hand, such a school has for its object the training of young men for the higher levels of the engineering field giving them a thorough training in the fundamentals of engineering science, together with what manual skill and manufacturing knowledge it is possible to impart in time allowed and facilities at hand.

Finally, in regard to higher education, whether it be technical or liberal, we quote again from Prof. Kimball. "It must not be forgotten that the aim and end of all education should be to train a man to think, not only with regard to his occupation in life, which may be very narrow, but also with regard to the broader industrial problems of the day which surround and intimately affect him and which at present he is often blindly seeking td solve. Training for manual skill and in shop methods does not help to make a man an intelligent voter; no more does the study of the higher sciences give the broadened outlook and sympathetic view of his fellow-man, which belongs to the truly cultured man. This broader instruction which makes for better citizenship cannot be well imparted in any shop school or apprenticeship system."

Electrical Equipment of Central Georgia Railroad Shops, Macon, Ga.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

BY A. C. LASHER,

ELECTRICAL ENGINEER FOR CENTRAL GEORGIA RAILROAD CO.

FROM standpoints of economical arrangement, adequate facilities and equipment, the railroad shops of the Central of Georgia located at Macon, Ga., are typical of good engineering and present developments for carrying on work of considerable magnitude connected with all branches of steam railway transportation and maintenance. These shops are without doubt the largest in the South and as to mechanical and electrical equipment one of the finest in the whole country. On this account the electrical features, including the central electric station installed, are of particular interest. In presenting this article considerable material has been based upon that the author recently presented to the student publication of his university, the Iowa State College. In what follows only the electrical details are treated and the illustrations represent the present equipment which is considerably enlarged from the original layout. The present power plant will receive attention first, then the other related power developing appliances which from their variety and scope of their work are rendered especially interesting.

The Central of Georgia Railroad began the construction of the new Macon shops early in the year 1907, for the manufacture of freight cars, and for locomotive and freight car repairs. The financial crisis, beginning the later part of that year, delayed for a time the progress of the work, but when it was finally resumed at a later date, it was with an additional appropriation not only sufficient for present needs, with moderate means for expansion to take care of the future, as was the original intention, but with liberal provision for the present and immediate future, and with ample space for extension which might be called for several years later. The result was a total appropriation of approximately two million dollars, permitting the construction of a magnificent lot of buildings, the furnishing of these buildings throughout with thoroughly up-to-date machinery, making one of the finest equipped railroad shops in the country. It is quite natural in the layout of a shop of this kind, where power for driving machinery is needed in large quantities, that the first, but by no means the least, consideration should be the power plant. In order to bring about the greatest efficiency of production, one of the most important factors of which is reliability of operation, no pains should be spared that would tend to render the prime mover more efficient and reliable in any respect. The equipping of the power plant of the Central of Georgia shops was no exception to this rule.

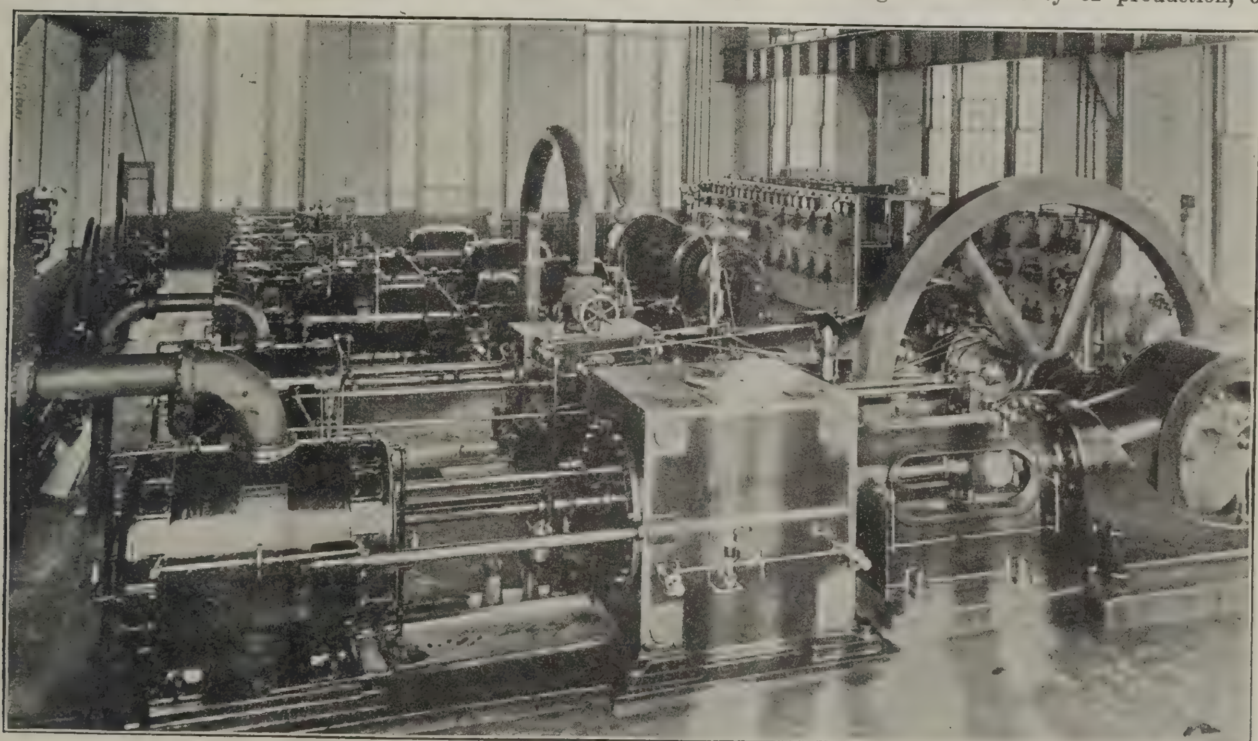


FIG. 1. GENERAL VIEW OF POWER PLANT.

POWER PLANT EQUIPMENT.

The prime movers consist of three Westinghouse Parsons turbo-generator sets of 300, 500 and 625 K. W. capacity respectively, and a Franklin Corliss air compressor, capacity twelve hundred cubic feet of air perminute, delivery pressure 125 pounds. These units receive steam at 175 pounds pressure from five 250 horsepower Sterling water tube boilers. The boilers are hand-fired with a low grade of coal, but are also arranged for automatic firing of shavings and scrap wool from the car shop and planing mill situated at a distance of four-hundred feet from the power house. This fuel is conveyed directly from the wood-working tools to the boiler room by means of exhaust fans, and is admitted to the fires as required by means of a motor-operated drag chain.

The 300 K. W. and 500 K. W. turbines and the air compressor each exhausts into its individual Alberger barometric condenser, and each has its individual equipment of circulating and dry vacuum pumps. The discharge pipes from the circulating pumps are interconnected in such a manner that in case of failure of the pump supplying any unit, that unit may be supplied from either of the pumps without interrupting the service. The 625 K. W. turbine exhausts into a Westinghouse LeBlanc condenser. Live steam from the boiler room is used in considerable quantities in the blacksmith shop for operating steam hammers and forging presses, also in the erecting shop for testing locomotive boliers. This steam is conveyed a distance of about four hundred feet through an underground tunnel. Ordinarily the steam hammers exhaust into atmosphere, but during cold weather they exhaust into the heating system and furnish a lagre part of the heat required by the several shops.

The 300 K. W. and the 500 K. W. turbines are each also arranged to exhaust into the heating system. The vacuum system of heating is employed. A forced circulation of air by means of fan blowers serves to convey the heat from the radiators to all parts of the buildings, each building having its own system or systems of radiators and blowers, which receive steam through the underground tunnel from the low pressure main. The pressure within the main is maintained at from two pounds above to five pounds below atmosphere by means of vacuum pumps located in the returns from the radiators. The load on the turbine which exhausts into the system is adjusted at the governor so as to furnish the necessary amount of steam for heating purposes, the major portion of the load during this time being carried by the other turbines.

The auxiliaries receive steam from a separate system of piping branching from the main steam header and exhaust into a line leading to the feedwater heater. The major portion of the water used for boiler feed is conveyed to the heater from the several cooling coils and jackets on the turbines and air compressor cylinders. If the exhaust from the auxiliaries is not sufficient to raise the temperature of the feedwater to the required degree, live steam under con-

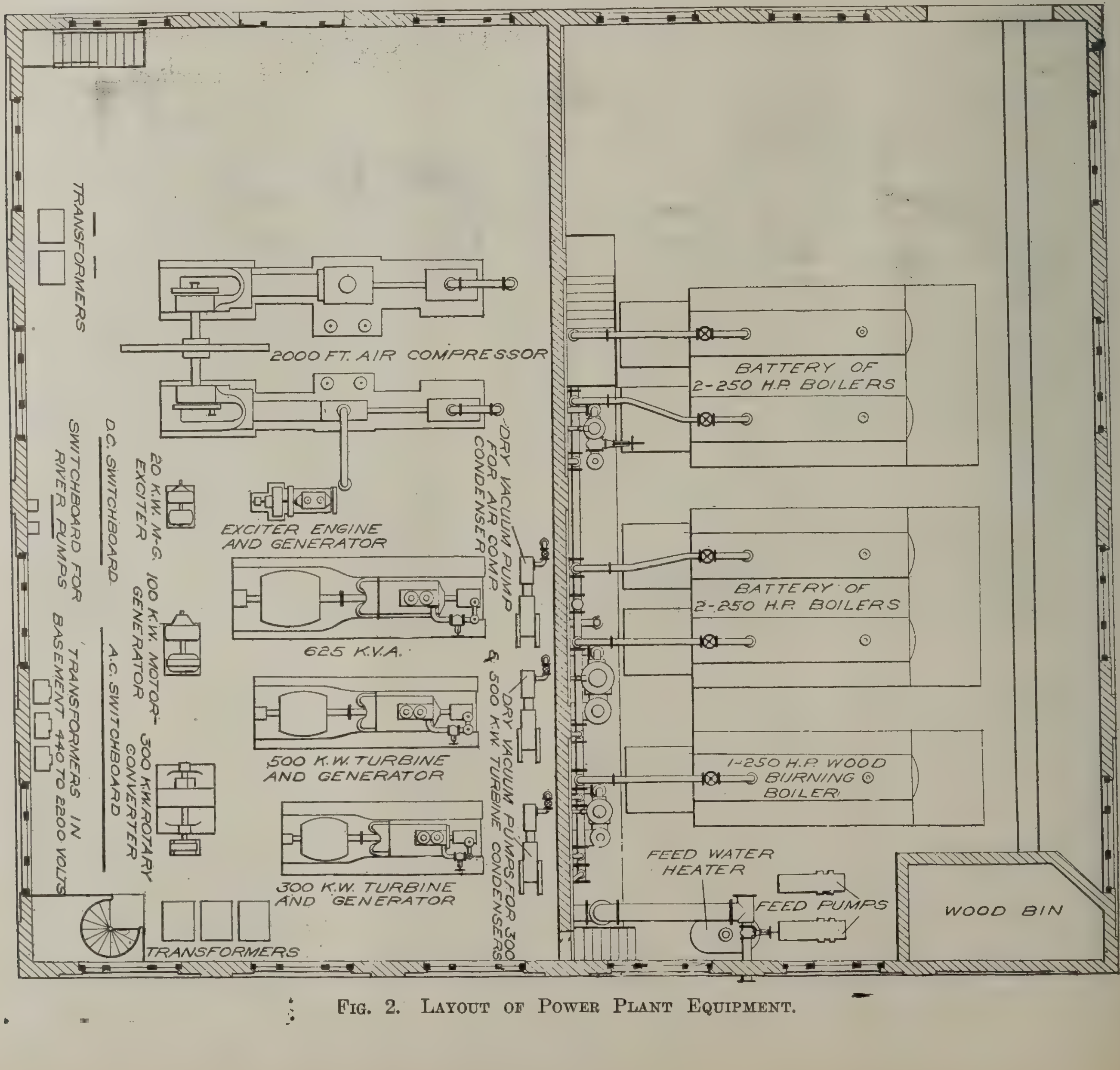
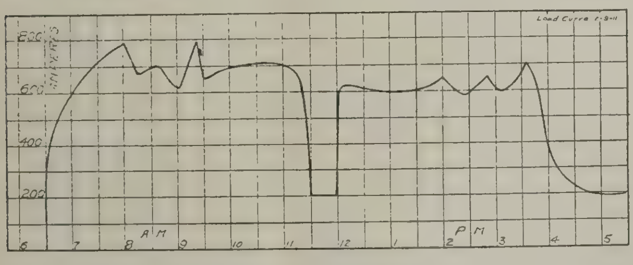


FIG. 2. LAYOUT OF POWER PLANT EQUIPMENT.

trol of a thermostatic regulator can be turned on and the feed water thus held at the desired temperature.

GENERATOR AND EXCITER EQUIPMENT.

The generators deliver 440 volts, 60 cycle three phase to the switchboard, and supply directly to three phase induction motors in the neighborhood of sixty per cent of all the power required, induction motors being used almost exclusively where the machines run at constant speed. A 300 K. W. rotary converter receives alternating current at 147 volts through three 100 K. W. transformers and delivers direct current at 240volts for supplying all adjustable speed motors and all cranes and electric hoists. In addition to the 300 K. W. rotary for supplying direct current motors, there is a 100 K. W. synchronous motor-generating set supplying also 240 volts from the direct current side for operating in parallel with the rotary or singly during periods of light loads. Both the rotary and the 100 K. W. set are arranged as three wire generators for delivering 120 and 240 volts, the former by means of three special small transformers arranged in inter-connected star from the main collector rings on the alternating current side of the machine, the latter by means of balance coils connected to slip rings taken from proper points on the commutator. The purpose of this feature will be understood from the description of the plugging-in circuits in a subsequent paragraph.



LOAD CURVE, TOTAL LOAD IN AMPERES, SUPPLY 3-PHASE, A. C. 440 VOLTS. POWER FACTOR 80-85 %.

The exciter equipment consists of a 20 K. W. direct connected steam-driven set and a 25 K. W. motor-driven set, each delivering 125 volts. A Tirrill regulator operating from either exciter insures uniform generator voltage.

COOLING WATER SYSTEM.

Cooling water for condensing purposes is obtained from the Ocmulgee River at a distance of three-fourths of a mile from the power house, by means of three electrically driven turbine pumps, each capable of delivering one thousand gallons per minute. These pumps are direct connected to 40 horse power three phase 2,200 volt motors which receive their current from step up transformers located at the power house. The motors are started from the switchboard at the power house. The cooling water, after passing the condensers, flows into a reservoir and from this reservoir a portion is drawn off for general use about the shops. The remainder flows back to the river. That portion which is drawn off for shop use is filtered before passing into the supply pipes. In case there is not sufficient water passing the condensers to supply the demand for general use, as may be occasioned by only one of the units running, and that under light load, the receiving reservoir is supplied directly from the main discharge of the river pumps.

The filter plant consists of an 80,000 gallon settling basin, three sand filters of the horizontal pressure type, two motor-driven centrifugal pumps, two duplex steam pumps and the necessary chemical solution tanks and appliances. The combined capacity of the plant varies considerably with the condition of the water, but it is calculated to be around 750 gallons per minute under most severe conditions. Throughout periods of unusually muddy water during spring freshets, the capacity of the plant is restricted by the inability of the mud to settle out while the water is passing through the 80,000 gallon basin. The entire object of the filter plant is to remove mud, as there are no boiler scale forming compounds present.

FIG. 3. GENERAL VIEW OF MACHINE SHOP, SHOWING ELECTRIC DRIVES.

One of the motor-driven pumps just mentioned serves simply to transfer the water from the receiving reservoir to the settling basin after the proper chemical solutions have been added. This pump is driven by a five horse power direct current adjustable speed motor and pumps against a head of about six feet. The other pump, which is of the two-stage turbine type, is also driven by a direct current adjustible speed motor, 40 horse power capacity, and serves to force the water from the settling basin through the filters and into the service pipes, where a pressure of between 50 and 60 pounds is maintained. These units are rendered adjustable in speed by means of shunt field control in order that the flow of water may be suited to the demand.

DISTRIBUTION SYSTEM FOR SHOPS.

Electrical energy is transmitted to the distributing switch panels in the several shops by means of varnished cloth insulated lead covered cables run in underground fibre ducts. In nearly all cases duplicate mains are employed with facilities for easily switching out individual cables in case of alteration or repair. In the more important departments, ring feeders originate at the distributing panels and encircle that department. The feeders are also lead covered with varnished cloth insulation and are laid underground in the same manner as the mains. At convenient distances along the line of feeders, small manholes are built, at which points taps are brought out from the feeders through water-tight fuse boxes. From the fuse boxes to the motors the service wires are of varnished cloth insulation with weather-proof braid run in steel conduit, this conduit being imbedded in the concrete footing of the floor. Each motor is equipped with an automatic overload circuit breaker, the fuses in the manhole serving only to protect the service wires or to enable same to be cut off from the circuit in case of circuit breaker inspection or repair.

At the present time the shop equipment includes two hundred and forty-five electric motors. These range in size from three-fourths to seventy-five horse power, and collectively represent a load of 3,300 horse power. Individual drive is the order throughout, except where several constant speed tools can be advantageously grouped to drive from a single motor.

A convenient and interesting motor classification with reference to starting and operating characteristics is as follows:

	No. of Motors.	Total H. P.
Constant speed alternating current, squirrel cage secondary type	95	1290
Constant speed alternating current, wound secondary	24	565
Constant speed direct current	25	170
Adjustable speed direct current	53	477
Variable speed direct current, Cranes, hoists etc.	48	804

ELECTRIC LIGHTING.

Indoor lighting is obtained principally by means of mercury vapor lamps. Those for the main shops are suspended above the crane runways, and operate from 440 volts alternating current. In the light machine bay direct current lamps are employed, two of the 55 volt lamps being connected in series from one side of the direct current three wire system. In the round house the same system is employed, except that two of the 55 volt tubes are operated in series as one unit, both tubes being mounted together in the same receptacle. These are of the vertical type and are mounted on the outer wall in front of and between the engine pits.

At numerous convenient points in and around the engine pits, plug receptacles are provided for the attachment of cords carrying portable lamps and portable motors. This plugging-in circuit is divided between the two sides of the three wire direct current system and employs standard voltage lamps. A small direct current 100 volt adjustable speed motor mounted on trucks may be connected to any point on this circuit by means of a portable cord and plug similar to those used for lamps and portable motors, and furnishes a very conveninent source ofpower for boring cylinders, turning crank pins, refacing valve seats, etc.

In addition to supplying outdoor lighting for shop grounds and engine terminal yards, the power plant also furnishes general lighting for the freight and passenger depots and switching yards. The outside lighting is obtained by means of seventy-two four ampere direct current series magnetic arc lamps operating from constant current mercury rectifier sets in the power house. The passenger depot and train shed are lighted by means of four and six glower Nernst lamps, as are also the freight car repair

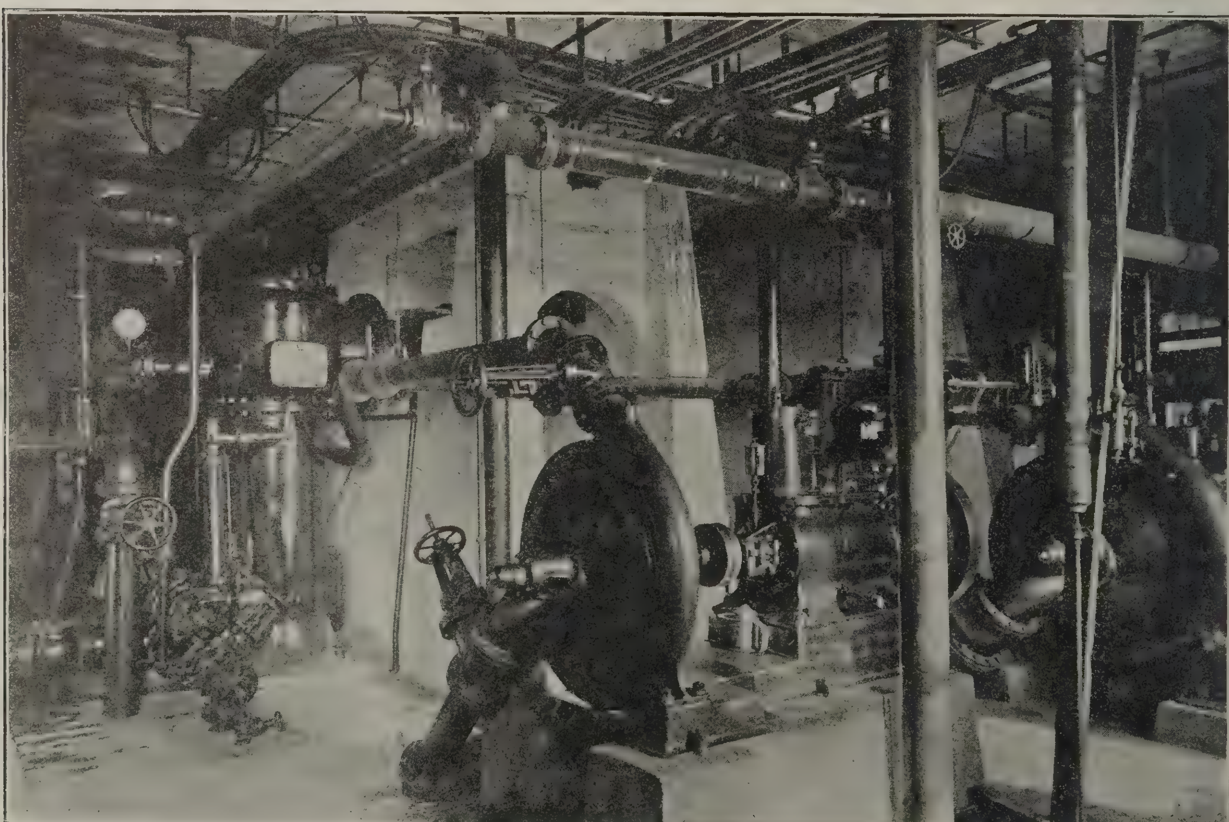


Fig. 4. View Showing Le Blanc Condenser and Pumps for Other Condensers.

shop and the power house engine room and boiler room. Other miscellaneous lighting is obtained by incandescent lamps operating from transformers connected to the 440 volt lighting feeders.

The general layout of the shop ground and the design of the building is the work of the Central of Georgia Railroad's efficient corps of civil engineers. The buildings were erected by contract by outside parties. The design of the power plant, the erection of its machinery and all steam fitting and electrical work was effected by the mechanical department. This department is also responsible for the machine tool layout of the various sections, the installation of the several tools, electrical equipment, wiring, etc., as well as the distribution of steam, compressed air and water for the scores of uses to which these labor-saving agents of civilization are constantly being employed.

Instrument Testing Methods and Equipment for Central Stations.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

BY E. P. PECK.

EVERY central station of average size and above should have a department or division of a department for testing and repairing meters and instruments. In a large system one or more rooms may be used for this purpose alone and several men may give their entire time to the work. The small station also should have an equipment of instruments, with some place set aside and used only for this work, and one man should have the care and use of the instruments. This man may spend a part of his time only on the instrument work, but as he is responsible for the instruments, they will receive better care and better results should be obtained.

The advantages of a local laboratory are many. If accurate standards are kept, the portable instruments may be tested frequently and an accurate calibration maintained. A new meter received from the factory has made a long trip and has had severe treatment before it reaches a Southern central station; and it should, therefore, always be checked before being used as a standard. The writer has on several occasions had to return new meters to the factory or to calibrate them before putting them in service. Further, a portable instrument is liable to change its calibration seriously in several months use and should be checked regularly. Instruments are often used on important tests, when the error of the meter is greater than several per cent. A case came up recently in connection with a medium size central station which illustrates the need of a standard equipment and an instrument repair man in all stations.

An important series of tests was to be made, presumably to settle a dispute as to the performance of some purchased equipment, and an engineer was sent from the manufacturing company. The local man packed his trunk with the meters to be used on the test and carried them to a large well equipped laboratory for test. There were about twelve meters in the trunk and it was the wish of the company to get them checked in about thirty-six hours. An examination showed that about half of the meters were in such bad mechanical condition that it was impossible to check them without preliminary work and only two were in condition to be used with any assurance of accuracy. As the important test could not be postponed, the meters were taken back, only two having been calibrated. From the condition of the meters an error of 10 per cent was easily possible. It is quite often that meters costing less than $200 settle disputes involving amounts of several times that much. In such a case the meters should be known to be correct.

When a meter is returned to the factory for repairs, or for checking, it is gone for several weeks, often several months. Thus it is necessary for a company to have a number of spare meters, in order to always have one available. This extra investment in portable meters could be profitably put in laboratory standards. In addition to the time lost, express charges must be counted in, and there is always the probability of the meters being knocked out of calibration in shipment.

In getting new customers, or in settling the unavoidable disputes with old ones, the statement that the company maintains a laboratory of exact standards, and that the greatest care is used in maintaining the accuracy of the company's meters, cannot fail to have a favorable effect.

[Note.—This article is the first of a series which Mr. Peck is preparing on "Instrument Testing Methods and Equipment for Central Stations. The articles will appear in several issues and develop the following subjects: The Laboratory; Care and Use of Portable Instruments; Checking Watt-hour Meters; Tests of Electrical Apparatus. The article on the Laboratory, presented in this issue, takes up the need of a laboratory, the advantages of a local laboratory, the conditions which justify a laboratory, the arrangement and equipment, including the laboratory instruments, control devices, and sources of electrical supply, considered for both small and and medium size stations.

Under Care and Use of Portable Instruments will be given the instrument equipment necessary for the large number of miscellaneous tests which are called for in central station work, the connections and approved methods of using instruments, and errors to be guarded against in the use of instruments.

Under Checking Watt-hour Meters will be given instructions for the general mechanical and electrical inspection of the meters, the general formula for use in figuring out the checks, with an explanation of the meter constant, the methods and connections for checking watt-hour meters, and convenient forms for entering the records of the checks.

The subject, Tests of Electrical Apparatus, will be divided into four articles as follows: Load Tests on Motors; Tests on Transformers; Tests on Generators; Tests on Rotary Converters.

Each of the above subjects will be treated from the standpoint of the tests a central station engineer will be required to make on apparatus, and will include the instruments and connections, and methods of making the tests. Mr. Peck is decidedly a capable electrical engineer, and from his years of experience in charge of testing as assistant electrical engineer of the Georgia Railway and Electric Co. of Atlanta, Ga., it is certain that his articles will not only be interesting but full of valuable suggestions for others working in the same field or contemplating the establishment of a department similar to that he has charge of.—Editor.]

While the volt and kilowatt hour are intangible units, they are as definite and may be measured as exactly as units of length and weight are measured (except in work of extreme precision) and the customer should know that his kilowatthour is as standard as the central station man's ton of coal.

In the mind of the central station manager it may be known that a proper equipment of meters is convenient, but the final question he has not settled is "Will it pay?" or "Will the cost be justified under our conditions?" This question must be weighed and settled in each individual case, and in addition to the talking points and the convenience of a meter equipment, the question of expenses and income must be considered. The expenses of a system are made up of numberless items, but its income, in the

FIG. 1. SMALL WATT-METER AND AMMETER TESTING BENCH.

case of a central station which meters the energy sold, is based entirely on the meter readings. A reduction in the price of any of the supplies or of labor will make an increase of earnings. But that is a reduction of one item only. Five per cent saved on coal is not nearly five per cent saved on the energy developed. A saving of two per cent of the energy sold is far greater. It is a known fact that nearly all of the changes in watthour meter calibrations are such as to make the meter run slow. An average error of 4 per cent slow for old meters not regularly calibrated is rather less than is usually found. In fact, a meter three or four years old is often found 10 per cent slow.

The question is then, "What investment and maintenance expenses are justified to increase the total income four per cent?" In a new company, the question would be, "What investment and maintenance expenses are justified to save the company a loss of 4 per cent of the total income?" If the cost is greater than the saving, with a profit on cost added, the equipment is not justified; if the saving is greater, the company is losing money by not having the equipment. On this basis it is a very small company indeed, that cannot keep a few standards and give a part of the time of one man to meter calibrations.

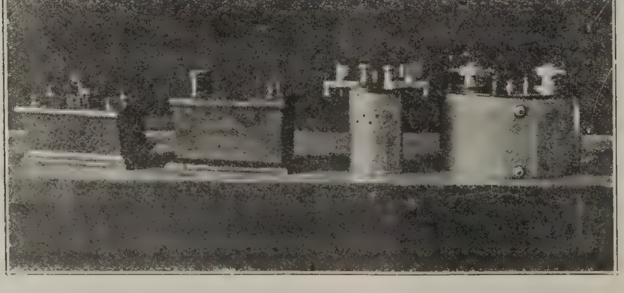
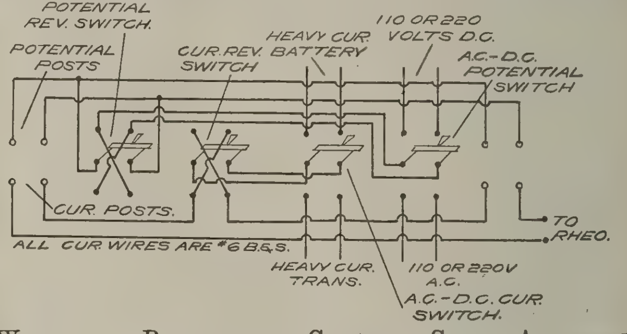


FIG. 2. VOLT BOX AND ONE-TENTH, ONE-HUNDREDTH, ONE-THOUSANDTH OHM STANDARD RESISTANCES.

As above stated, many superintendents and managers realize the need of a proper testing equipment, but do not arrange for it because they think the cost is too great, or because they do not know just the proper equipment to be bought to handle their work to the best advantage. It is the purpose of these articles, therefore, to lay out the equipment of a laboratory, listing the apparatus and giving connections. Also, to show how the apparatus may be used in tests and investigation of the whole system.

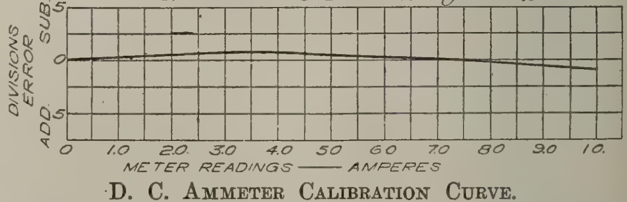
LAYOUT FOR A LABORATORY.

In laying out a scheme for a laboratory it is well to follow a definite plan, and as new apparatus is bought, select it to follow out the main idea. Many times an assortment of meters is purchased in a more or less haphazard



WIRING FOR BENCHES FOR CHECKING SMALL AMMETERS AND WATTMETERS.

manner, with the idea that they may be needed later and it is best to get them while it is possible. It is better to look at the question from a business standpoint and to buy the apparatus most flexible in its uses. In other words, lay out the equipment so that one set of instruments will cover the greatest possible line of work. Follow this idea in both the laboratory and portable instruments and the result will be that much may be saved on the original cost; or more of the essential instruments may be purchased, and a less number of instruments be on hand to be kept in calibration. Laboratory instruments are pretty things and look well if arranged for display, but a large amount of apparatus standing idle with only a small amount in regular use, does not show real engineering judgment. It will be noted that this idea is followed through the whole equipment recommended later.



D. C. AMMETER CALIBRATION CURVE.

If there is any choice of location for the laboratory, a place should be selected as free from vibration as possible, and one which is not subject to stray fields from machines or feeders. It is possible to get good results even if vibrations and stray fields are present, if proper equipment is used and proper precautions taken, but the work is much simplified and accurate results much more easily obtainable if these annoyances are absent. The tables or benches for testing should be made of heavy metals and very solidly braced. It is often convenient to arrange a long bench down the side of the room for holding the primary standards, with shelves, drawers and cupboards underneath.

LABORATORY EQUIPMENT AND RECORDS.

A complete laboratory should contain a set of final reference standards which may be called primary standards, a set of secondary or transfer standards, and a line of portable instruments for general testing. In order to use these instruments to advantage the various voltages and currents must be conveniently arranged and apparatus connected for the exact control of all circuits.

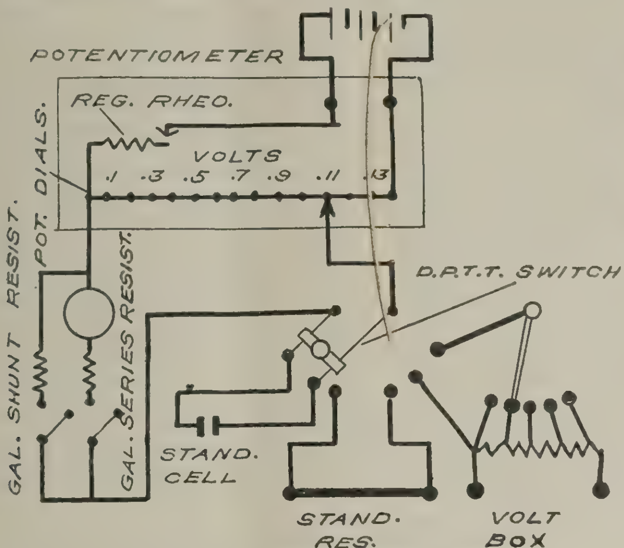


DIAGRAM OF POTENTIOMETER CIRCUITS.

A system of meter records should be kept, which will give all of the data necessary on the work done on meters. A file system may be made which has an envelope for each meter and instrument worked on. The envelope should give, on the outside, the make, number, kind and capacity of the meter. In the envelope should be filed the date of the work done, all details of repairs and calibrations, a record of the calibration, and the name of the man doing the work. By this means a complete history of the meter from the time of its purchase is at hand, and it is only by some such arrangement that a record of the amount and kind of work done may be kept.

PRIMARY STANDARDS.

The fundamental electrical units are the ohm, the ampere, and the volt. Therefore, the primary standards must be standard resistance units of the proper values, and standard cells for obtaining the volt. It is always more convenient and accurate in commercial work to use these two units and obtain the ampere from them, as the standard resistance and standard cell are portable, extremely accurate, and easily used. In order to be able to use these primary standards a potentiometer is necessary, with its galvonometer and multiplier or volt box.

The potentiometer is an instrument made for use in connection with the above mentioned standards, and to measure current and voltage exactly. The construction of different makes of potentiometers varies greatly, each manufacturer adopting a different design. It is well to select one of not too elaborate design, but one which will cover a large range of values and is rugged.

A few years ago it was the practice to purchase laboratory standard indicating instruments to use as primary standards, but it has been found that any instrument depending on the constancy of delicate springs, permanent magnets, and the perfection of jewels and pivots, will not remain constant over several years continual use. While

FIG. 3. POTENTIOMETER AND STANDARDS.

these instruments are excellent as secondary standards, it is necessary that they be checked frequently. One of the largest companies in this country checks such standards every week. In addition to lack of permanency of calibration, it will be found that a complete line of such instruments will cost more than the very accurate and permanent potentiometer outfit.

A suitable potentiometer, with a one-tenth (.1) and a one-thousandth (.001) ohm standard resistance, will measure currents from one-tenth (.1) ampere to five-hundred (500) amperes to an accuracy of one-tenth of one per cent (.1%). With a volt box having 15, 150, and 1,500 volt steps, voltages from one ten-thousandth (.0001) of a volt to 15,000 volts may be measured to the same accuracy. Thus, one instrument with its auxiliaries, will handle an enormous range of both amperes and volts, and if purchased from reliable manufacturers, may be relied on for accuracy and permanence.

A reserve standard resistance, having a resistance of one-hundredth (.01) ohm is advisable. A standard resistance is one of the most permanent standards obtainable, if it is always used properly, but there is always a chance that one of the resistances will be damaged by overload or by careless handling, and in such a case its errors should be determined at once. The resistances may be sent periodically to the makers or to a well equipped laboratory for test; but it is better to have the reserve standard and to make all checks in the local laboratory. If there are only two standard resistances, and one of them has to be sent off for test, the laboratory is badly handicapped during its absence.

For the same reason one or more reserve standard cells should be kept on hand. As the standard cell is the final reference for most of the checks, it is essential that it should not be used after its voltage has changed. Two cells may be purchased at once, one being used as a working standard, and one as a reserve standard. Checks of the working standard are easily made with the potentiometer. The cells should be compared when new, and at later intervals. When a change takes place in one of them, it is well to use the reserve standard as a working standard, and to buy a new reserve standard.

A wheatstone bridge will be needed frequently in connection with both laboratory and outside work. A bridge adjusted to one-tenth of one per cent (.1%) in a portable form is quite satisfactory. The next section of this article will take up other laboratory equipment.

American Switch Gear Structures and Distant Control Apparatus.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

BY STEPHEN Q. HAYES.

IN order to illustrate more clearly the difference in the design of the station made necessary by the use of bottom connected breakers and enclosed busbars for the high tension circuits, Fig. 15 has been prepared for the purpose of comparison. This station shows three different designs of switching equipment for the control of two 15,000 Kva, 66,000 volt, three-phase incoming lines and four 7,500 Kva, three-phase step-down transformers supplying current to two sets of 13,200 volt busbars. Section "A" of Fig. 15, shows the general arrangement of the circuit breakers, busbars, connections, etc., using bottom connected breakers of standard design and arranging to locate the 66,000 volt busbars with their disconnecting switches on the lower floor. With this arrangement, the control desk, the low tension breakers and the high tension breakers are all placed on the upper floor, and in order to provide sufficient head room for lifting the coils and iron out of the transformer case, it is necessary to slide the transformer into the passage way and run it along to the central portion of the building where the floor has been raised under the control desk in such a manner as to provide the necessary head room. With this arrangement it may be noted that the total height of the building required from the floor line to the roof girders is 47 feet, 6 inches. The high tension incoming line breaker and the breakers for the high tension side of the step-down transformers are arranged in two rows in order to provide sufficient space for the breakers.

Section "B" of this figure, shows the arrangement necessary if it is desired to use top connected breakers and still to enclose the busbars. With this arrangement the 66,000 volt busbars, as well as the 13,200 volt circuit breakers with their busbars and the control desk are placed on the upper floor, while the 66,000 volt breakers themselves with their disconnecting switches are located on the main floor near the transformers. With this arrangement a somewhat smaller amount of head room is required, and any transformer can have its coils or iron removed as soon as it is slid out into the passage-way. The building arranged in this manner requires a height of 37 feet, 6 inches from the floor line to the roof girders and requires a second floor the same as shown on section "A."

Section "C" shows the arrangement of this same station with top connected breakers and open busbars and wiring for the 66,000 volt circuits. With this arrangement there is no necessity of any second floor, all of the apparatus is placed on the one level and the height of the building is greatly reduced as the distance from the floor line to the bottom of the roof girders is only 30 feet.

It is needless to say that this section "C" is by far the cheapest with respect to the cost of the building itself. In sections "B" and "C" the design of the circuit breakers is such that there is ample space to place the line breakers and the breaker for the high tension side of the step-down transformers in one continuous row. These three sections of Fig. 15 clearly show how the type of the switch gear and the arrangement of the high tension busbars and wiring materially affect the design of the station.

The preliminary design of the transformer and switching galleries in the Rio Janeiro T. L. & C. Company substation at Rio is shown in Fig. 16. This station is designed to accommodate the necessary switching gear for the control of, four 88,000 volt, three-phase, 50-cycle incoming transmission lines, four banks of step-down transformers, each comprising three 1,700 Kva units stepping down from 88,000 volts to 6,600 volts and two banks each of three 1,700 Kva single-phase transformers stepping down from 88,000 volts to 22,000 volts. The necessary switching gear is also provided for the control of a large number of 6,600 volt and 22,000 volt feeder circuits, as well as various gas engine driven generators, motor generator sets and A. C. and D. C. feeders.

This sectional view is taken through the 22,000 volt circuits and the 88,000 volt circuits, and, it may be noted, that the incoming lines pass through disconnecting switches, oil immersed choke coils, oil immersed series transformers to the 88,000 volt oil circuit breaker. From these breakers the current passes to either or both of two sets of knife type disconnecting switches to the 88,000 volt busbars that are located in masonry compartments 4 feet, 8 inches square near the top of the station. From these busbars the current returns through suitable disconnecting switches to the oil circuit breakers and thence to the high tension side of

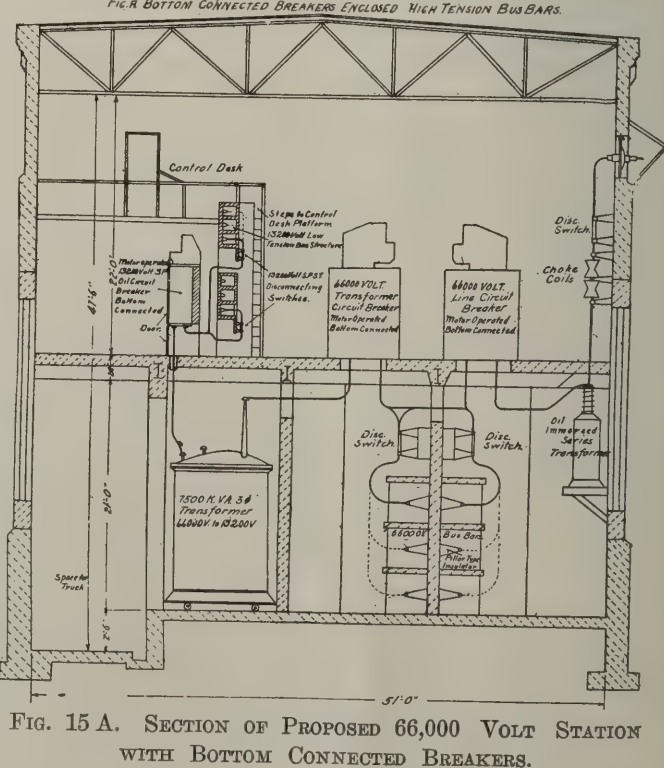
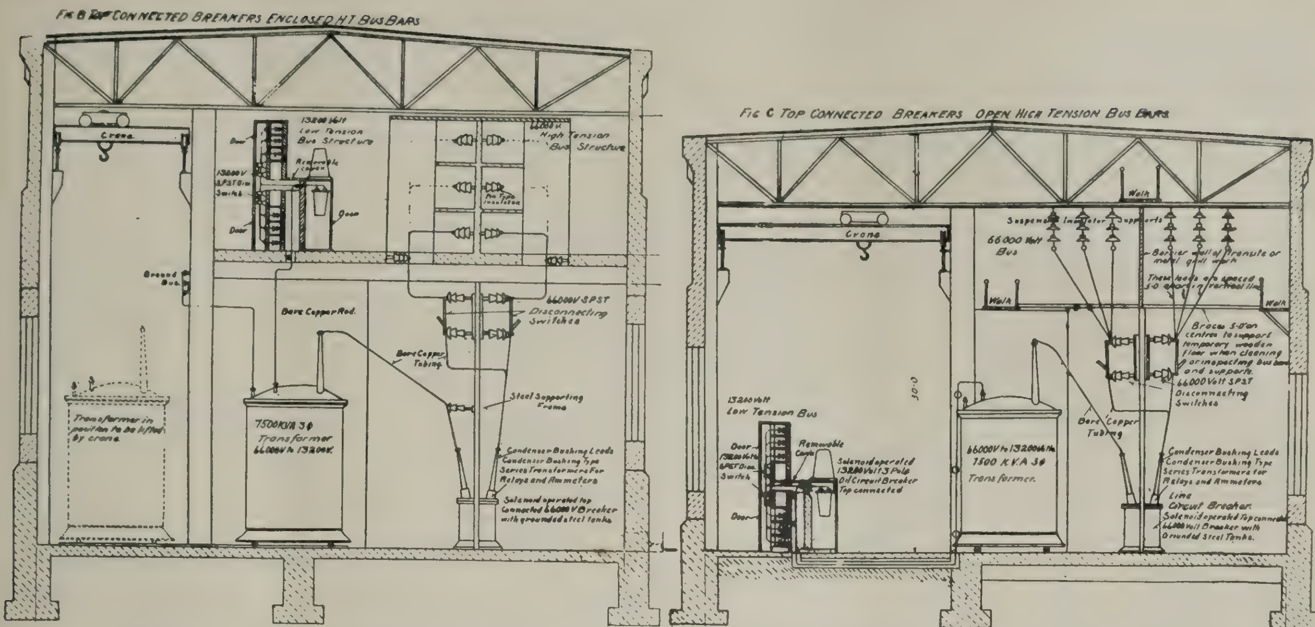


FIG. 15 A. SECTION OF PROPOSED 66,000 VOLT STATION WITH BOTTOM CONNECTED BREAKERS.



FIGS. 15 B. AND C. SECTIONS OF PROPOSED 66,000 VOLT STATION WITH TOP CONNECTED BREAKERS.

the 1700 K. W. step-down transformers. The 22,000 volt circuits from the transformers pass through oil circuit breakers to the buses and from the buses feed out through additional breakers to the 22,000 feeder circuits.

A plain view of the switching galleries in the same station would show the arrangement of the line inlet hoods with their two sets of disconnecting switches and the high tension buses. The high tension line where it enters the building goes to two disconnecting switches per phase, one of which cuts off the current to the lightning arresters, while the other disconnects the circuit through the choke coils to the breakers, etc. The central portion of this cut shows the arrangement of the coil circuit breakers, choke coils, series transformers, main transformers, and indicates clearly the rather elaborate precautions that are taken to keep the various phases in separate masonry compartments. The lower portion shows in a general manner the approximate arrangement of the potential regulators and the low tension oil circuit breakers.

It might be noted that the actual arrangement of this station as installed differs in quite a few respects from the preliminary sketches, but these sketches show clearly the general type of construction for a station of this class where it is desired to have the enclosed system of busbars and wiring. There are a couple of points in connection with this arrangement that are of particular interest. As may be noted from Fig. 16, the disconnecting switches in the high tension circuits are to be pulled from a passage way provided with windows for the purpose. As it is difficult for the attendant in the passage way to determine whether or not the oil circuit breaker, isolated by certain disconnecting switches, is open or not, additional sets of signal lamps are installed in these passage ways and these lamps are operated by means of the signal switches located on the breaker in the same manner as the corresponding signal lamps on the control dask.

This station is so arranged that the four incoming high tension lines may be connected to either of two sets of buses and similarly the circuit breakers for the high tension side of the transformers can be connected to either or two sets of buses; these connections being made by means of the knife switches. In order that the switchboard operator may have a clear idea of the arrangement of the various circuits, a miniature busbar system is placed on the control desk and the usual red and green signal lamps are located near the controllers in such a manner as to show what circuits are open and what circuits are closed. Instead of providing mimic disconnecting switches, telephone lamps

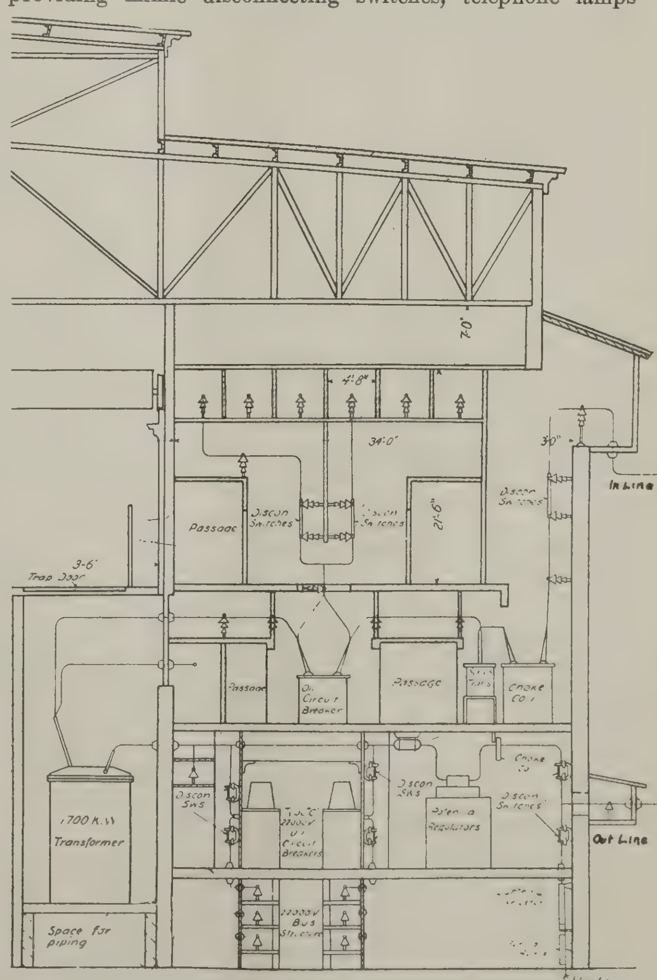


FIG. 16. SECTION OF 88,000 VOLT STATION AT RIO JANEIRO.

are installed on the control desk, these telephone lamps being connected in series with standard incandescent lamps and snap switches. Snap switches and the incandescent lamps are located in the passage ways near the high tension disconnecting switches, and it is the arrangement that the station attendants after opening or closing the disconnecting switches are to turn the snap switch on or off to light up or extinguish the telephone lamps on the desk. By having the additional signal lamp in the passageway and connecting these in series with the telephone lamps on the desk, the station attendants can readily determine whether the signal was properly sent or not. The failure of the lamp due to burning out or some similar cause will indicate the dangerous position, namely—that the disconnecting switches are closed. As the main disconnecting switches in the station are seldom manipulated, it was not considered necessary to adopt any more elaborate signal system, although it would have been possible to have provided signal switches mechanically operated from the disconnecting switches.

A somewhat more elaborate system that has been adopted on more recent plants is to furnish red and green signal lamps of the standard construction instead of telephone lamps for the signal system, and to include the red signal lamps in the miniature bus system in the same manner as the red signal lamps of the circuit breaker controllers are included. Instead of supplying standard knife switches that would simply turn the current on or off on the indicating lamp, single pole double throw knife switches or snap switches are provided so that in one position the red lamp is lighted and in the other position the green lamp is lighted. In a three-phase plant three of these switches would be provided and the station operator would be instructed to throw over a signal switch as soon as he had pulled one of the disconnecting switches in the three-phase circuits and then to operate the second and the third signal switches after pulling the corresponding disconnecting switches. In this manner the station operator would be notified that the disconnecting switches were being manipulated as both the red and the green lamp would be lighted, if some of the signal switches were in one position and the other signal switches were in the other position.

The sectional view through the transformer and circuit breaker house of a proposed 100,000 volt station is shown in Fig. 17. This station was to contain eight 7,500 Kva generators, with provision for eight future generators. Two different transformer propositions were considered, one being to furnish eight 7,500 Kva three-phase transformers, one for each machine and the other to supply three 5,000 Kva single-phase transformers arranged in groups of three each to take care of the output of two 7,500 Kva generators. The transformers whether in three-phase units or in single-phase units were to be used for stepping the voltage up to 100,000 volts and a large number of 100,000 volt feeder circuits were to leave the station. Both the high tension and the low tension circuits were arranged to form complete ring systems, and as the station is practically symmetrical around the vertical center line one-half of the drawing on the right hand side shows the connections for the three-phase transformers, while the corresponding arrangement on the left hand side takes care of the single-phase transformers. The 11,000 volt circuits

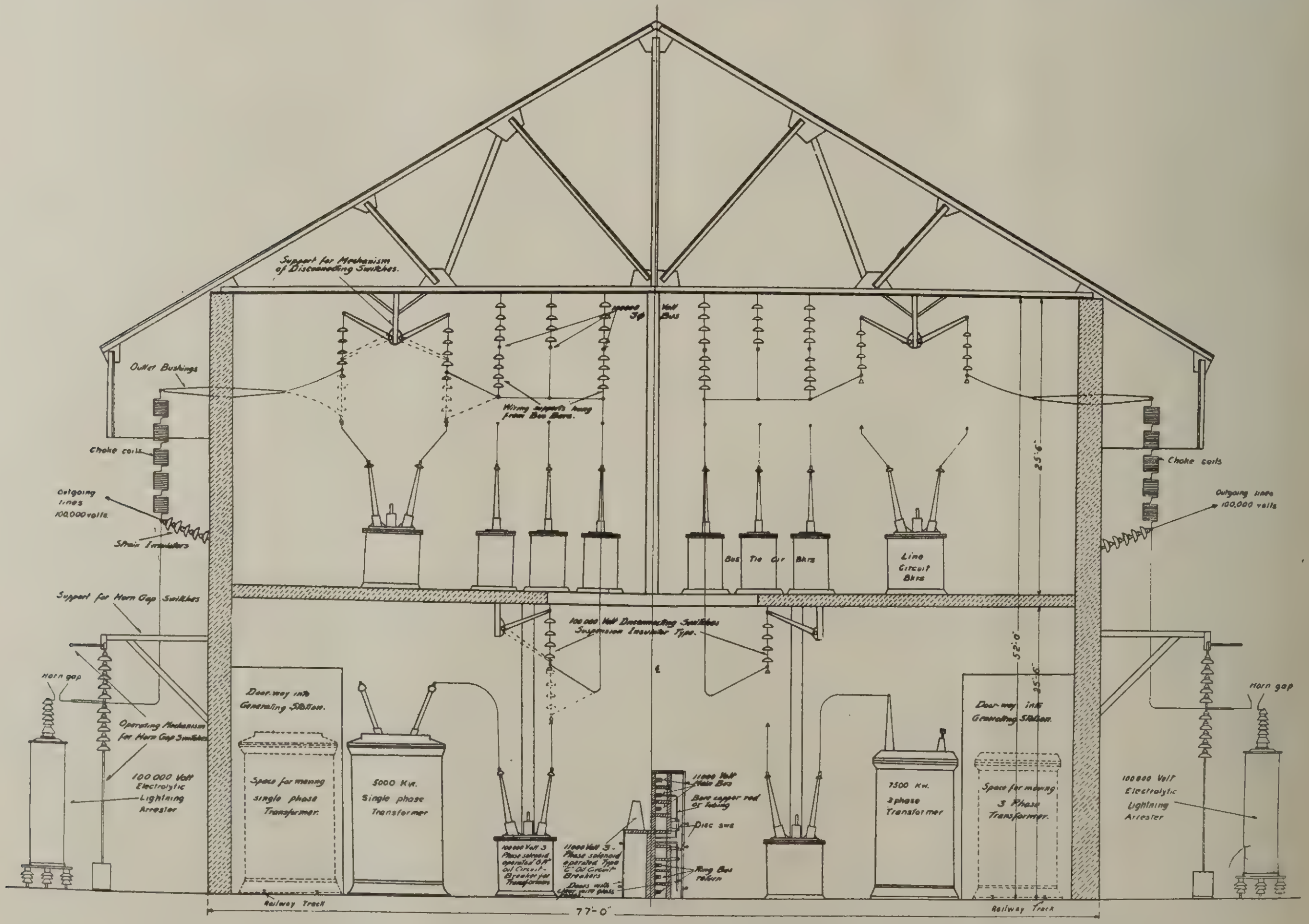


FIG. 17. SECTION OF PROPOSED 100,000 VOLT STATION.

were practically independent of whether three-phase or single-phase transformer units were to be supplied.

One particularly novel feature of this installation was the type of disconnecting switches to be used in the 100,000 volt circuits. As indicated in the drawing the disconnecting switches consisted essentially of contacts hung from suspension insulators, which contacts could be lowered until they made connection with a rod projecting up from a condenser bushing. Flexible leads attached to the moving contacts connected to the station wiring in such a manner that these switches were practically single break switches, and the three poles of a three-pole switch were operated by a single mechanism with a suitable indicating device. This type of disconnecting switches, namely, a combination of suspension insulators and condenser bushings, can be applied to practically any voltage that is apt to be reached in high tension service. The oil circuit breakers in this installation were provided with condenser type series transformers clamped around the condenser bushings, and these series transformers furnish current for the ammeters and relays. Copper tubing was used throughout for the busbars and wiring, the tubing being entirely bare and the busbars being hung from suspension insulators. Where wiring supports were needed, additional suspension insulators ordinarily hung from the busbars or busbar supports were used. The outgoing lines pass through condenser bushings set in the outside wall, and the helical choke coils for the transmission line were suspended from these condenser bushings. The outgoing lines are anchored to the building by means of a series of suspension insulators and the suspension type of switch was made into a horn gap for use with the electrolytic lightning arresters, the lightning arresters, choke coils and horn gaps all being located out of doors. This particular station will probably be somewhat modified for the arrangement shown when it is finally installed.

Principles of Illuminating Engineering.

(*Contributed Exclusively to* Southern Electrician.)

BY A. G. RAKESTRAW.

Discussion of Operating Principles of Arc Lamps and Circuits Used.

THE next group of illuminants to be considered will be those in which the conducting medium instead of being filament is a stream of vapor, commonly termed an electric arc. There are several kinds of arc lamps, but the same principles of operation are common to all. Two conducting bodies, termed electrodes, are first brought in contact, establishing an electric circuit, and then slightly separated. The current density at the point of contact is so great that a portion of the electrode is vaporized. As the terminals are separated, this vapor being a conductor, affords a path for the current which continues to flow and since the resistance of this vapor stream is comparatively high, enough heat is generated to cause further vaporization and thus the arc is maintained by the disintegration of the electrodes.

Arc lamps may be classified either according to the material employed for the electrodes or as regards the admission of air to the arc. We also have distinctions as regards the connections, such as series, multiple and series-multiple, also between A. C. and D. C. lamps. As regards the material employed, we have two general classes, which we may term the luminous and the non-luminous. The latter of these is represented by the ordinary carbon arc, and the former by the various types of flaming arc, including the "luminous arcs" using magnetic electrodes.

There exists a radical difference in behavior between these two groups. The carbon arc follows the law of "black body" radiation, that is, the color of the light and the efficiency bear a definite relation to the temperature. The arc lamp operated at the boiling point of carbon, abounds in short wave lengths producing a brilliant white light, and as far as the total production of light is concerned, is very efficient. However, the greatest production of light comes from the crater of the carbon, and due to their relative position, a good deal of this light is often obscured and part of the rest is absorbed by surrounding vapor and the enclosing globes. There the autual efficiency is considerably below the theoretical value. In the case of the "luminous arcs," we find that due to chemical changes in the material composing the electrodes, that the radiation given forth is different in color and greater in amount, than we would expect from the temperature. This will be taken up more in detail when taking up flaming arcs.

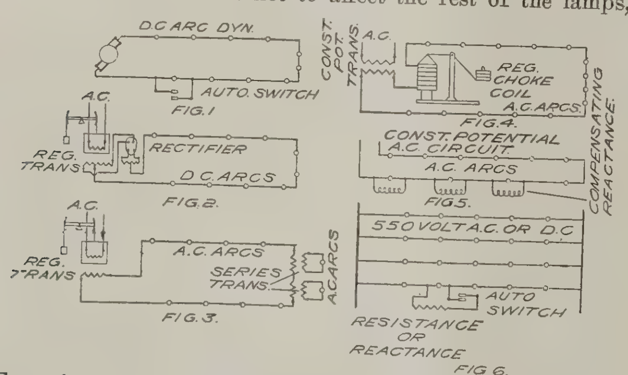
As regards the classification by the admission of air, we have open, enclosed, and semi-enclosed arcs. The first carbon arcs were open to the atmosphere, being only surrounded by an outer globe as a protection against air currents. The efficiency of these lamps are high, since they are operated with a short arc, and a low voltage, but the life is very short, necessitating frequent trimming. The life is about 14 hours with one pair of round carbons, but by the use of a broad flat carbon, as high as 75 hours can be obtained. Sometimes two pairs of carbons are used in connection with a device which cut the second pair into circuit when the first ones are consumed. Besides the short life, another objection to the open arc was the constant shifting of the crater and consequently a great variation in the intensity of the illumination thrown in any given direction from time to time. While this might be tolerated for street lighting, it rendered these lamps unsatisfactory for factory work, and out of the question for reading or any purpose requiring accurate vision. These lamps therefore have been largely superceded by the enclosed arc.

By the use of an air-tight inner globe, around the arc, the rate of oxidation is greatly reduced, and the life of the carbons prolonged. A pair of ½ by 12 inch carbons will last from 125 to 200 hours. Since a long arc is used, the voltage at the arc is about double that of the open arc, and the efficiency is considerably reduced. The question therefore becomes one of balancing the saving in current against the increased cost of trimming of the open arc, but even if these were equal, the enclosed arc would be preferred on account of the better quality of light. The color of the long arc, however, departs from the white, being strongly tinged with violet, and having a hue quite similar to the light from a blue sky.

An attempt to compromise between the open and the enclosed types of lamp, has resulted in the introduction of the semi-enclosed arc lamp. These are made in small units, use a small size of carbon, and give a good volume of light with a medium length of life. Before the introduction of the high efficiency incandescent lamps, they were beginning to find a field for interior lighting, but were not able to compete with the tungsten lamp for this purpose.

Arc lamps may be connected either in series, in multiple or in series-multiple. Due to the unstability of the arc resistance, which varies greatly and somewhat irregularly with changes in length, it is not practicable to put an electric arc directly across the line without some sort of a steadying or ballasting resistance. Furthermore, such resistance is needed to prevent short circuit when striking the arc. A resistance is used for direct current lamps, and a reactance or chokecoil is used for alternating current. This resistance limits the volts in the arc to about 75 to 85 volts on 110 volt circuits, and from 145 to 160 volts on 220 volt circuits. It is evident, therefore, that the watts at the terminals of the lamp and the watts in the arc itself are quite different. In series connections this resistance is not needed, as the circuit is automatically adjusted at the point of supply, either by an automatically regulated arc machine, or by a constant current transformer feeding the line, either directly or through a mercury arc rectifier.

In Figs. 1 to 5, connections are shown for various kinds of series circuits. Fig. 1 shows a D. C. circuit using an arc machine. Each lamp is provided with an automatic cut-out, and in case the carbons are burned out, the lamp is short circuited so as not to affect the rest of the lamps,



Figs. 1 to 6. Connections for Different Series Arc Lamp Circuits.

the generator automatically varying the voltage so as to keep the current constant. Fig. 2 shows the same arrangement, except that it is supplied from a constant current transformer, the current from which is converted to D. C. by a mercury arc rectifier. There are two coils in the constant current transformer, the distance between which is variable. These coils are suspended and balanced by counterweights and automatically adjust themselves to meet the conditions. Fig. 3 shows the same transformer supplying A. C. arcs in series. If it is desired to use lamps adjusted for current values differing from that supplied to the system, it may be easily done by using series transformers as shown. Fig. 4 shows another variation of this system in which constant potential alternating current is supplied, and the regulation effected by means of a choke coil of variable inductance, consisting of a coil free to move up and down on the middle leg of an E-shaped laminated structure, and balanced by weights. As the current tends to increase the magnetic pull draws the coil further down over the laminated pole piece and consequently the inductance and therefore, the choking effect is increased, tending to keep the current constant. Fig. 5 shows another plan that is sometimes used, in which the lamps are fed from a constant potential transformer and each lamp is permanently shunted by an inductance. When the lamp is burning, very little current passes through this inductance, but when the circuit is interrupted, the current has to go through it, and it offers a counter e. m. f. about equal to the arc, thus preserving the equilibrium of the system.

In the case of lamps used on series multiple circuits, such as 2 on 220 volts, or 5 on 550 volts, which are termed power circuits, since there is no automatic voltage regulations, means must be provided for keeping the current steady when a lamp goes out. This is done by means of a cut-out switch which inserts a sufficient amount of resistance or reactance in the circuit to compensate for the lamp. Fig. 6 shows connections for such a circuit.

While series operation of lamps is the most efficient, yet for operation in factories, and for most interior purposes, it is much more convenient to connect them in multiple. In this case, as stated before, it is necessary to have a resistance or reactance in series with the arc. The mechanism used for striking the arc and for regulating the feed of the carbons varies in different kinds of lamps. In some cases the same mechanism that strikes the arc, keeps it adjusted, and in other cases a separate device is used. As regards starting, arc lamps may be either series starting or shunt starting. In the first case the carbons are normally in contact and on closing the circuit, the series current operates a solenoid which draws them apart. Fig. 7 shows the conections of such a lamp, which is the simplest of all arc

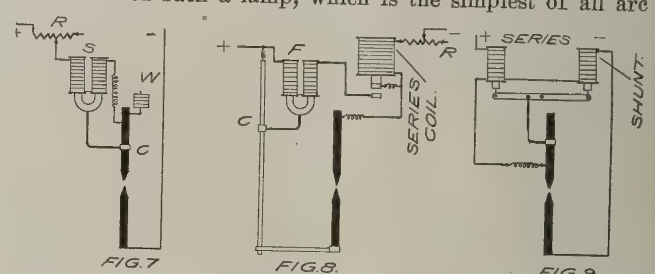


Fig. 7. Diagram for Series Starting Multiple Arc Lamp. Fig. 8. Diagram of Shunt Starting Multiple Arc Lamp. Fig. 9. Arc Lamp for Series or Series Multiple Circuits.

lamps. When the solenoid S, is not energized, the clutch C releases and the upper carbon falls by its own weight until it strikes the lower carbon. When the solenoid is energized it draws the two carbons a definite distance apart. When the arc has burned too long, it goes out, the clutch immediately is released and the arc is struck again. In this case the regulation consists simply in the striking of the arc at frequent intervals.

In the case of the shunt starting lamps, the carbons are normally apart, and the striking is accomplished by an auxiliary shunt coil which momentarily draws the electrodes in contact and releases them. The series current when established, operates a relay which opens the feeding magnets, but when the series current decreases to a certain point, it acts on the relay again, permitting the shunt coil to strike an arc. Fig. 8 shows the connections for such a lamp. In both the above cases the striking and the feeding mechanism are one. Now, in the case of lamps connected in series or in series-multiple, since the current is the same for all lamps in the series, evidently the use of series coils alone cannot give the adjustment necessary for each particular lamp. Therefore, shunt coils are used, connected across the arc. The clutch is connected to a rocker arm, to one end of which the core of the series coils is connected, and to the other the core of the shunt solenoid. The action is as follows: On throwing on the current, the arc is struck by the series coil, as usual. Then the shunt coil exerts a pull opposing the series coil, bringing the rocker-arm to some intermediate position. As the arc lengthens, the voltage across the arc will increase, and finally a point is reached where the shunt coil is stronger than the series, drawing up its end of the arm and releasing the clutch. The carbon then drops part or all of the way and the shunt coil being weakened, allows the series coil to again draw the carbons apart to the proper distance. This is called differential feeding. Fig. 9 shows the connections.

There are two adjustments possible with a multiple lamp. These are the voltage in the arc, and the current strength. The former is accomplished by connecting to various taps on the starting resistance, and the latter by the use of weights on the upper carbon holders. In series circuits, the current regulation is accomplished at the source of supply, but the voltage may be regulated by taps from the shunt coil or resistance inserted in series with it.

In the case of lamps using inclined carbons, the same mechanism which feeds the carbons cannot be used for striking the arc, and that is done by another device, which monentarily brings the electrodes together and then separates them. The feeding itself is ferquently accomplished by clockwork, using an escapement which permits a slow and steady feed, or by allowing the carbons to burn away against a projecting point, or by wedging two carbons of the same polarity together and allowing them to burn away against each other and thus be fed downwards. This method of feeding is termed a sneak feed or a jam feed. This type of mechanism is employed principally for flaming arc lamps, and will be more particularly described when treating that group of lamps. In the next number we shall consider the illuminating features of the arcs, their efficiencies and distribution, and also take up a brief description of some special forms.

Conditions, Practice and Developments in English Central Stations.

(*Contributed Exclusively to* Southern Electrician.)

BY CECIL TOONE, AN ENGLISH ELECTRICAL ENGINEER.

Central Station Fuel, Purchase Basis and Economies in its Use.

By far the greater number of English central stations employ as fuel, coal of one sort or another. Indeed, among some 427 stations, 300 or 91 per cent use coal. Of this number 51 or 12 per cent of the total use anthracite and 339 or 79 per cent of the total use other than anthracite coal, while only 14 use coke; 41 town refuse and 7 oil fuel.

Anthracite is mainly used in stations of less than 600 kw. capacity, being then largely used in the manufacture of producer gas. This fuel is generally too costly for very liberal use under steam boilers, despite its well known advantages for steam raising. Various hard steam coals are widely used, being cheaper than anthracite though more gassy and inferior in calorific value. Coke possesses no special advantage, other than in some cases, ready accessibility of supply. When employed, it is generally used in the form of coke breeze. Oil fuel is too costly in this country to find general favor for steam raising purposes and, unless its price is considerably reduced, it is not likely to be used in other than isolated instances or for such special purposes as helping coal-fired boilers over their peak load. Town refuse is not a satisfactory fuel, and its use is generally taken up on the principle of making a profitable virtue of necessity. Many stations find the operation of refuse destructors, in conjunction with electricity works, very expensive and even unprofitable, though a dozen British stations achieve satisfactory results from the system.

Stations obtaining coal at less than \$2.50 or more than \$5.00 per ton may be regarded as exceptional in this country. The former class includes some 153 stations and the latter some 41 undertakings. The specially cheap coal is almost invariably low grade smudge or slack, and consequently involves difficulties in burning which compensate to some extent for the lower price paid, while the specially expensive fuels are invariably anthracite. It is unusual to obtain the latter at less than \$5.00 to \$6.25 per ton of 2240 lbs. The mean price paid for solid fuel, which is almost entirely coal, in English central stations is: (1) In 245 stations having no traction load \$3.35 per ton; (2) In 144 stations having tramway and general load \$2.40 per ton; (3) In 389 stations (groups (1) and (2) combined) \$3.00 per ton. The mean price of oil fuel in 7 stations, employing it mainly in Diesel oil engines, is \$13.10 per ton, while in several small stations using gas engines supplied from town mains, gas is purchased at from \$0.36 to \$0.50 per 100 cubic feet.

PURCHASE OF COAL ON A CALORIFIC VALUE BASIS.

The purchase of coal on the basis of its true thermal value is gaining rapid favor in this country, and although it has encountered much opposition from colliery owners, numerous large undertakings already employ this system. It is generally conceded that any station burning more than 150 to 200 tons of coal per week, may profitably employ a permanent coal testing staff and agree to pay for its fuel according to its calorific value and ash and moisture percentage.

The Greenwich station of the London County Council has had this system of purchase in operation for some time, with gratifying results to purchaser and colliery owner alike. In this particular case, the standard calorific value is taken as 12,500 B. t. u. per lb.; smalls, that is less than

3-8 inch square, are not to be more than 20 per cent by weight and moisture not more than 10 per cent. For calorific value, ash and moisture tests, samples are taken from each 100 tons of coal in the ordinary way, while for "smalls" a 50 lb. sample is selected indiscriminately from the barges or transporter grabs. If the samples prove to be of less than 10,500 B. t. u. per lb. calorific value or contain over 13 per cent moisture or 25 per cent smalls, the whole cargo is rejected. Otherwise, if the calorific value be greater or less than 23,500 B. t. u. per lb. the price per ton is increased or decreased in the same percentage ratio as the calorific value is high or low. If the moisture content be greater or less than 10 per cent, the weight of coal paid for is decreased or increased in the same percentage ratio as the moisture is high or low. And, if the smalls content be greater or less than 20 per cent, the weight of coal paid for is decreased or increased by one quarter of the percentage by which the smalls content is high or low. This method of purchase is found to be fair to both parties and the uniform quality of fuel thus secured is easy to handle and conduces to maximum boiler efficiency.

TABLE 4. BOILER CAPACITY AND AVERAGE FUEL PRICE OF STATIONS.

Kilowatts Groups L. & M.	DISTRICT NUMBER. (1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
No. of Boilers—L	514	41	16	74	--	136	19	89
—M	58	53	85	92	294	491	86	56
Evap. Cap. of Blrs.—L	2997	475	172	455	----	828	121	826
(1000's lbs. per hr.)—M	657	353	1055	472	2023	3777	420	444
No. Blrs. Per Station—L	20	10	5	15	--	8	5	30
—M	10	11	14	11	18	15	17	7
—L. & M.	18	10	11	13	18	13	12	13
Evap. Cap. per Station—L	176	119	57	114	--	63	30	413
(1000's lbs. per hr.) —M	110	71	176	67	169	140	140	56
—L & M	159	92	136	84	169	115	77	127
Evap. Cap. per Boiler—L	5.85	11.58	10.70	6.15	--	6.10	6.35	9.28
(1000s lbs. per hr.) —M	11.30	6.65	12.40	5.14	6.90	7.69	4.88	7.92
—L. & M.	6.39	8.80	12.10	5.58	6.90	7.35	5.15	8.75
Mean Price of Coal—L	2.62	3.97	2.17	1.56	--	1.97	2.48	1.32
(per 2240 lbs.)	4.36	2.34	1.54	1.79	2.18	1.86	2.51	1.74
—L. & M.	3.20	3.16	1.60	1.71	2.18	1.90	2.50	1.62

NOTE; L indicates lighting and power load only: M indicates stations olsa supplying tramways.

MACHINE STOKING.

Where hand fired furnaces are employed, the periodic opening of the furnace doors, together with the cooling effect of the comparatively large charges of fuel added at each firing, involves a temporary serious diminution of the mean furnace temperature and a corresponding loss by unburned volatile gases and smoke. This, mechanical stoking avoids, by steadily introducing very small charges of cold fuel, meanwhile keeping the furnace doors shut. Again, mechanical stoking enables the best results to be obtained from very inferior fuels, the grate design being chosen with special regard to the class of fuel consumed, so that an even bed of fuel of suitable thickness and uniform porosity is permanently maintained. Forced draught becomes a necessity in most cases, if only by the small percentage air space in the grates, necessary to prevent undue wastage of the small fuel handled. Pinhole grate bars, with air holes about 3-8 inch diameter, are very popular where small coal is burnt, while herring-bone bars, with ¼ inch air spaces, are also much used.

There can be no doubt that mechanical stokers will soon save their cost in any station where low grade fuel is employed and in numerous English central stations their adoption has been the critical factor converting unprofitable to profitable working. It is quite typical of the economies obtainable by this means that in a recent test at the Leicester central station boilers fitted with mechanical stokers showed 10 per cent higher evaporative capacity than had hitherto been the case.

Nevertheless, in spite of their manifold advantages, mechanical stokers are comparatively restricted in their application in English central stations. Of a total of some 330 stations of which particulars are available, 171 or 52 per cent use hand firing and 204 or 62 per cent use mechanical stoking, wholly or in part in both cases; some 46 stations or 14 per cent use both hand and mechanical stoking.

Among some 173 central stations employing mechanical stoking wholly or in part: 50 or 29 per cent use sprinkler stokers; 29 or 17 per cent use coking stokers; 28 or 16 per cent use underfeed stokers; 105 or 60 per cent use chain grate stokers. Although this analysis is not complete, its percentage values are tolerably applicable to the remaining stations of which particulars are not at the moment available.

FUEL ECONOMIES.

So many factors influence fuel economy, indeed, the whole operation of modern boiler house plant has for its

TABLE 5. REDUCTION OF COSTS PER KW. HR. FOR COAL AND OTHER FUEL—YEARS 1905 TO 1910. . .

Station KW. Group.	(1) Classified by 1910 KW. No. of Stations Considered.	Costs in 1910	(2) Costs in same in stations in 1905	Classified by 1905 KW. No. of Stations Considered	Costs in 1905
(a)—L	1	1.60	2.06	2	2.36
(b)—L	8	1.58	1.96	15	1.72
(c)—L	16	1.50	1.72	21	1.54
(d)—L	32	1.14	1.32	18	1.34
—M	3	0.52	0.68	16	1.12
(e)—L	33	1.16	1.30	29	1.30
—M	19	0.78	1.00	24	0.68
(f)—L	11	0.76	1.14	11	1.28
—M	16	0.64	0.74	9	0.86
(g)—L	7	0.86	1.46	4	1.14
—M	6	0.56	0.72	4	0.78
(h)—L	3	0.92	1.08	4	0.96
—M	1	0.38	0.88	2	0.94
(k to n)—L	10	0.56	0.86	7	0.86
—M	4	0.54	0.66	3	0.48
Grand Averages L	121	1.108	1.360	111	1.38
M	50	0.658	0.832	58	0.88
LM	171	0.976	1.204	169	1.22

Note.—The differences between Cols. 1 and 2 and Cols. 1 and 3 are due, in both cases, partly to improved load factor at the later date and largely to working economies. L indicates stations supplying lighting and power load only; M indicates those supplying also tramways and light railways.

creed reduction of the coal bill per kw. hour output, that it is difficult to select items for special treatment under this heading. By far the most notable movement in boiler house practice during recent years has been the utilization of poorer grades of fuel. This has been necessitated by several causes: (a) The price of fuel of a given quality has steadily risen for many years past. (b) All conditions have, of late, made the most strenuous economy absolutely essential to the profitable operation of central station undertakings. (c) The national supply of coal is recognised to be strictly limited in extent and the repeated warnings of scientific observers together with the higher costs due to the enhanced difficulties of mining, have led to the satisfactory utilization of much fuel which would have been considered quite worthless twenty years ago.

An examination of the price of the coal burned in all British central stations in 1902 shows that the price paid per ton, even so recently as nine years ago, was considerably in excess of that now usual, despite the higher present cost of a given grade of fuel. An analysis of the fuel costs per kw. hr. output in 1905 and 1910, as shown in Table 5, leads to similar results. The considerable economy shown by column 1 over column 2, is largely due to the increased output of the stations in 1910, but that a considerable proportion of the economy is due to the use of cheaper fuel and more economical utilization.

Average fuel costs per kw. hr. in English central stations in 1910 were less than the corresponding figures in 1905.

1910 Costs less by:	1910 Costs and Costs in Same Stations in 1905 (Cols. 1 & 2, Table 5.)	1910 Costs and Costs in Stations of same range of kilowatts in 1905 (Cols. 1 & 3, Table 5)
Stations in Group L	18.5%	19.7%
Stations in Group M	21.0%	25.2%
Stations in Group L & M	18.9%	20.0%

Although cheaper qualities of fuel are now used than has hitherto been considered feasible, much greater care is devoted to the grading of coal and this, together with the advantages to be derived from the purchase of fuel on a B. t. u. basis and the full application of mechanical coal handling and stoking apparatus, has enabled a great overall improvement in boiler house economy. It is useless to seek good results from poor fuel unless an adequate draught and sufficiently large grate area can be guaranteed; nor must the influence of the class of load supplied be neglected in choosing the fuel employed. Very small fuel is considerably cheaper per 1000 B. t. u. than larger material, but such fuel has other disadvantages than those already noted: the higher cost of transporting and handling the larger quantities required is appreciable; the calorific value per lb. is low, the moisture content 8 to 10 per cent, and the ash residue 16 to 20 per cent, as against 3 to 5 per cent moisture and 7 to 10 per cent ash in a larger fuel of the same class, and the furnace draught required is from two to three times as great as that needed by nutty coal.

Before fuel economies can be realised, existing sources of inefficiency must be detected and this has been much facilitated by the use of recorders of various kinds, such as draught recorders, combustion recorders, CO_2 recorders, pressure recorders, steam meters and so on. Properly used, these valuable instruments enable the boiler house to be permanently operated under test conditions. Among the main details of upkeep and operation which go to secure the high efficiency of a modern boiler house, may be noted the frequent scaling of the insides of boilers, the application of the steam brush to the outer surface of water tubes, etc., and the thorough lagging of boilers and steam pipes and feed pump cylinders and similar auxiliaries. Oil, waste, water and stores costs and wages costs per kw. hr. output have also been greatly reduced during the past five years. In fact, the mean 1910 costs were lower than those for 1905, as follows:

1910 Costs less by:	1910 Costs and Costs in same stations in 1905	1910 Costs and Costs in stations of same range of kilowatts in 1905
Oil, Waste, Water & Stores		
Stations in Group L	33.5%	34.0%
Stations in Group M	51.5%	51.5%
Station in Group L & M	37.5%	37.5%
Wages (in works)		
Stations in Group L	24.9%	26.0%
Stations in Group M	25.8%	35.0%
Stations in Group L & M	25.3%	26.4%

Nevertheless, no great reduction in the cost per kw. hr. of the above two items can reasonably be looked for in future and it is to the fuel costs that we must look for further economy of operation. The next article will discuss the subject of prime movers, including steam, gas, oil and water types.

Review of Denver Annual Jovian Meeting.

The ninth annual meeting of the Sons of Jove will go down in the history of the order as by far the most spirited and successful annual meeting ever held. The importance which has been placed upon the selection of the next meeting place has increased as the order has grown, but never before was there such direct evidence that various sections of the country are over anxious in their desire to win out in the choice. At this meeting the choice lay between Philadelphia, with Washington Devereux heading the ticket for Jupiter, and Pittsburg, with Robert L. Jaynes as representative for the highest office of the order. The vote went to Pittsburg and the rule of the order as tenth Jupiter has been turned over to Robert L. Jaynes.

There seemed to be considerable confidence early in order of affairs at the Denver meeting on the part of the Pittsburg aggregation; however, the many friends of Washington Devereux had been overlooked, especially those composing the Southern Representation. The decision of the annual election was as close as it was interesting.

Mr. Robert L. Jaynes, tenth Jupiter, was born in Quincy, Ill., and educated in public schools. He has resided in Pittsburg a number of years and acted as selling agent of manufacturers of electrical supplies, including the Hart Manufacturing Co., American Conduit Co., and Bossert Company. Mr. Jaynes has been an active member of the order for the past five years and as Statesman for Pittsburg district, has brought 260 members into the order.

The officers of the Rejuvenated Sons of Jove elected at the Denver convention are: Robert L. Jaynes, Jupiter; Henry E. Hobson, Dallas, Texas, Neptune; Harry C. Biglin, Denver, Pluto; George H. Porter, Chicago, Vulcan; Walter N. Stearns, Atlanta, Ga., Hercules; Herbert H. Cudmore, Cleveland, Mars; William J. Grambs, Seattle, Wash., Appollo; C. McKew Parr, Hartford, Conn., Avrenim; Eli C. Bennett, St. Louis, Mercury.

The Theory of Harmonic Analysis.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)
BY MONTFORD MORRISON.

A Graphical Treatment of Conditions in Alternating Current Circuits.

ALTERNATING current engineering is based upon the simple working theory in which the alternating electromotive forces and currents are assumed to be harmonic. As a matter of fact, the electromotive forces and currents are never exactly harmonic, and therefore, the behavior of the various alternating current machines departs to some extent from the simple working theory. This departure or difference in behavior is due to the non-harmonic character of the electromotive forces and currents, but is sometimes spoken of as the effects of higher harmonics, since the wave may be resolved into harmonic components, the components of the higher order representing the difference between the non-harmonic and harmonic effect. It can be shown by the construction of the generator that the wave produced is in many cases, entirely non-harmonic in its origin.

In almost any case, the performance of an alternating current generator or motor when the electromotive forces and currents in the circuit are non-harmonic may be considered as the same effects that would be brought into existence by the summation of the harmonic components determined by analysis. This brings up an interesting and essential subject, namely, Fourier's series, which will now be discussed.

Physical phenomena are usually constant, transient or periodic. As constant, we would include the terminal voltage of a storage battery and the current in circuit when the resistance of the circuit is constant; the effect of gravity on a stationary mass. Transient phenomena occur during a change in the condition of an object or system, as a change of forces, or disturbance entering an electric circuit from the outside, or originating within it. Among periodic phenomena are the alternating currents and voltages that usually occur in practice; motions of a pendulum, pulsating currents, and such as those of rectified monophase currents; the motion of a piston rod and the valve stem in steam engines, pumps and air compressors when the peripheral speed of the fly wheel is constant. Now, if the fly wheel peripheral motion is constant, the piston rod motion is periodic, and vice versa, but if the piston rod motion is non-periodic, the peripheral motion of the fly wheel is non-constant, and vice versa.

Most periodic functions of engineering are functions of time or of space, for instance, if the constant peripheral motion of a fly wheel of an air compressor be considered as time or space, then motion of the piston could be expressed as a function of the peripheral motion, that is, for each increment of motion in the fly wheel, there would be a corresponding movement of the piston. If the connecting rod were of infinite length, or equivalent to infinite length, the motion of the piston would be pure harmonic motion. However, this is not often the case, like in alternating current circuits, we rarely find a wave that approaches the sinusoid very closely. But all electric current in commercial service is supposed to be periodic. The characteristic of a periodic function (y equals function of x) is, that at constant intervals of the independent variable x, called cycles or periods, the same values of the dependent variable y occur. It will be appreciated, therefore, that it is sometimes important to be able to express a given fraction of a variable x, in terms of the sines or of the cosines of multiples of x. This problem in its general form was first solved by Baron Fourier, a celebrated French mathematician, in his most famous work, published in 1822, (*Theorie Analytique de la Chaleur.*) The solution of this problem plays the most important part in modern physics, where periodic motion is to be considered or motion that may be treated as periodic for analysis. Series involving only sines and cosines of whole multiples of x, that is, series of the form:

$$b_0 + b_1 \cos x + b_2 \cos 2x + \cdots$$
$$+ a_1 \sin x + a_2 \sin 2x + \cdots$$

are generally known as Fourier's series. To fully understand this equation, we first learn what this series really does represent and then determine whether or not it coincides exactly with the law of Fourier, as we understand it. In order to do this we must develop a given function of x in terms of sin x, sin 2x, sin 3x, etc., in such a way that the function and the series shall be equal for all values of x between x equals o and x equal π. Suppose the curve

$$y = f(x)$$

be given and it is desired to form the equation

$$y = a_1 \sin x + a_2 \sin 2x + a_3 \sin 3x + \cdots$$

of a curve which shall coincide with so much of the curve as lies between the points corresponding to x equals o and x equals π.

If the equation

$$y = a_1 \sin x \qquad (1)$$

be plotted, by substituting the proper value for a, it is possible to make this curve pass through any point whose abscissa is more than zero and less than π. Fig. 1 shows equation (1) plotted for a_1 equals $\pi/4$. It will be clearly understood that it was possible to make the curve pass through p by making a_1 large enough, or through q by making it small enough. In practice it is more convenient and generally suffices, when it is desired to have the curve pass through only one point, to make the abscissa $\pi / 2$.

In a like manner the curve

$$y = a_1 \sin x + a_2 \sin 2x \qquad (2)$$

may be made to pass through any two arbitrarily chosen points whose abscissa lie between zero and π, provided that the abscissas are not equal. However, in practice it is customary to make the abscissa of a succeeding point n times that of the first, π being considered as a point, and n representing the order of the points. This may be made clear by the use of Fig. 2, in which the first given point is p having an abscissa of $\pi / 3$, and q being the second of the order, hence n equals q and the abscissa of q is then 2 times $\pi / 3$. This, of course, always divides the base into an equal number of parts, and thus simplifies the work.

Erecting the ordinates p and q, we then obtain their average height by dividing the distance p′q′ by 2, which gives the point a, and drawing lines perpendicular to a, equal to the abscissas of the points p and q, obtain the new points a′ and a″. Now, pa′ equals a″q, and if we give such a value to the coefficient a_1 of equation (1), that will make the curve pass through a′, it will also pass through a″.

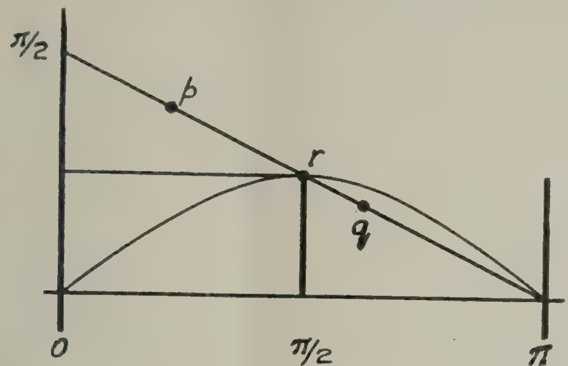


FIG. 1. SINE CURVE COINCIDING WITH ONE ARBITRARY POINT ON GIVEN CURVE.

All that is necessary now to fulfill the requirements, that is, to make the curve pass through p and q instead of a′ and a″, is to add an amount equal to pa′ to a′ and subtract an equal amount from a″. In the plotting of the curve

$$y' = a_2 \sin 2x \qquad (3)$$

it will be observed that between the limits o and $\pi/2$, the curve has plus values, therefore adds, and between the limits $\pi/2$ and π, it has minus values, and hence subtracts. The distance $(\pi/2 - \pi/3)$ equals $(2\pi/3 - \pi/3)$ and since the curve (3) is symetrical, the values for y′ when $\pi/3$ and $2\pi/3$ in substituted x, will be equal and with opposite signs. If a_2 is given, such a value that y′ at $\pi/3$ equals pa′ and curves (1) and (3) be added algebraically (curve (2)), it is obvious that (2) will pass through the points p and q, which fulfill the requirement exactly.

Likewise the curve,

$$y = a_1 \sin x + a_2 \sin 2x + a_3 \sin 3x \qquad (4)$$

can be made to pass through any three points arbitrarily chosen in conditions similar to the foregoing.

In curve (1) we had only one point through which the curve must pass. Now, the condition was, that the point should have an abscissa equal to $\pi/2$. This allows it to have an ordinate of any length between plus infinity and minus infinity. In raising or lowering the height of the curve between these limits, every possible point with an abscissa of $\pi/2$ is passed through. It is plainly evident then that only one adjustment of the curve is necessary for one point. In curve (2) the condition was that the curve should pass through two points, the abscissas of which were $\pi/3$ and $2\pi/3$. In this equation we have two curves, one of which allows mutual adjustment in opposite directions along the ordinates of the points, and the other allowing compound adjustment in the same direction for the first mentioned adjustment. Now, it is obvious that, if we divide

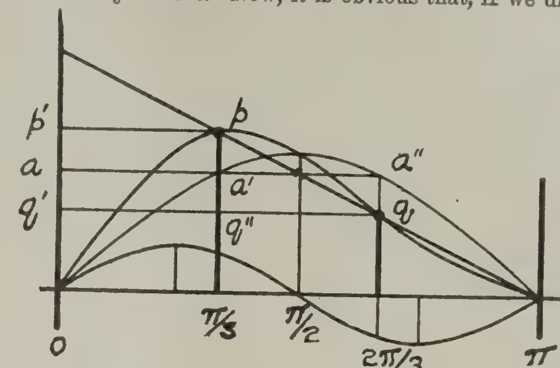


FIG. 2. SINE SERIES COINCIDING WITH TWO ARBITRARY POINTS ON GIVEN CURVE.

the difference in the heights of the two ordinates by the curve intersecting the ordinates at this height, we have only to add half the difference to one ordinate and subtract an equal amount from the other and we arrive at the two given points. Also, if we are to pass the curve through three given points, we must consider the equation:

$$y'' = a_3 \sin 3x \qquad (5)$$

According to the condition that the base length in practice is divided into equal parts, the abscissas of the three points are $\pi/4$, $\pi/2$ and $3\pi/4$. In order to pass the curve through a third given point, it will be found necessary to have not only an adjustment for the new point which lies on the ordinate at $\pi/2$, but an additional adjustment for each of the other two points which must be moved also. Inspection of Fig. 2 will show that that portion of the curve at the left of $\pi/3$ and at the right of $2\pi/3$ must be raised and that between these two points must be lowered. Reference to Fig. 3 shows that curve (5) fulfills the conditions. If the value $\pi/4$ be substituted for x in equations (1) and (5) we obtain,

$$y = a_1 \sin \pi/4 \qquad (1)$$

and

$$y'' = a_3 \sin 3\pi/4 \qquad (5)$$

but the sine of $3\pi/4$ equals the sine of $\pi/4$, hence the ordinate db′ has the same ratio to the maximum ordinate (eb″)

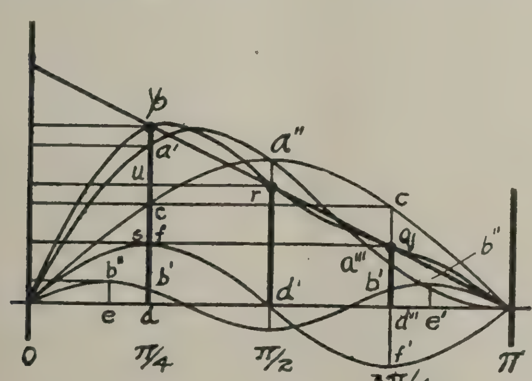


FIG. 3. SINE SERIES COINCIDING WITH THREE ARBITRARY POINTS ON GIVEN CURVE.

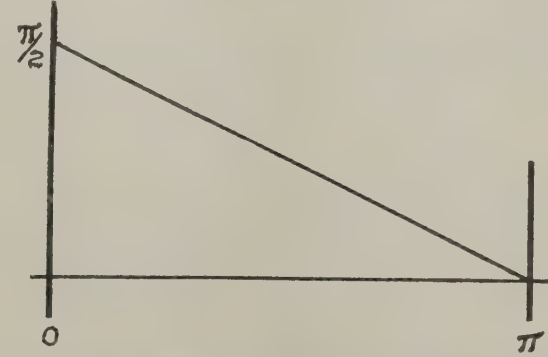


FIG. 4. SINE SERIES COINCIDING WITH AN INFINITE NUMBER OF POINTS ON GIVEN CURVE.

of curve (5) that dc has to the maximum ordinate of (1), (d'a"). That is, db'/eb" = dc/d'a", but let this proportion be represented by P. Then,

$$dp = P\ (d'a'') + df + P\ (eb'')$$
$$d'r = \quad d'a'' \quad - \quad eb''$$
$$d''q = P\ (d'a'') - df + P\ (eb'')$$

And solving for *df*, *d'a"* and *eb"*, we obtain:

(2nd) $df = (dp - d''a)/2.$

(1st) $d'a'' = dp/2P + (dp - d'q)/4 + d'r'/2.$

(3rd) $eb'' = d'q/2P + (dp - d'q)/4 - d'r'/2.$

If proportional dividers are set for the value*P*, the entire work involves only simple plane geometry, since it can be proven by plane geometry that the two ratios db'/eb" and dc/d'a" are equal for any similar symetrical figures with base lengths and positions identical to those in the figure. It will be noted that the second harmonic was solved for first, because it could be used to simplify the work in solving for the others. This second harmonic is equal to the algebraic average height of the first and last points—the last point consider as minus. In the figure (rd—d"q) equals ps and this divided by two, gives the height of the second harmonic (us). Attention is called to the fact that the intersection of the lines as they do in the figure is an accident and would occur only in another similar case.

From a study of what has gone before, it is clear that the equation:

$y = a_1 \sin x + a_2 \sin 2x + a_3 \sin 3x + \ldots$ a sub n sin nx. (6)

may be made to pass through any n arbitrarily chosen points whose abscissas lie between O and π, provided the distances separating the points equal π/n. As a matter of fact, the points may have any abscissas whatever so long as no two are equal, but that will not be taken up here. If n be made very large, y of (6) may be made to coincide with the curve in Fig. 4. Therefore, *"Every periodic motion whatsoever may always be considered as the resultant of the superposition of a definite number of pendular vibratory motions, or is always resolvable into a definite number of commensurate simple harmonic motions."*—Baron Jean Baptiste Joseph Fourier.

EVALUATION OF THE COEFFICIENTS.

Space does not permit of sufficient discussion on this subject, and since this particular topic is to be included in with the "Harmonic Analysis by Means of the Planimeter," this interesting discussion will be excused after a brief survey with a number of references, that the reader may select for reading. We have already solved this problem in drawing figures 2 and 3. And this is a very simple way of doing it. There have been many methods offered for determining the coefficients. Comte Lagrange gave one of the most interesting methods. A great many of these depend upon the integral [2] representing the area of a curve, plotted in rectangular co-ordinates, and in fact, give the algebraic sum of the areas. For instance,

$$a_1 \int_0^{2n\pi} \sin x\, dx = a_1(1 - \cos 2n\pi) = o$$

In this way, by giving the proper values to n, any or all harmonics may be made to vanish, giving new equations from which the values of the coefficients may be determined. Suppose that it is desired to pass a curve through n points. For the sake of simplicity, suppose that the projections of these n points on a line are equidistant. If we do not know the distance between the first and last point, we may either call the distances between the projections of the point 180/n degrees or if calculus[3] is to enter into the discussion we must introduce a new variable,

$$Z = x\pi/c.$$

Then f(x) equals f(cz/π) and this can be developed into a trigonometric series in terms of Z. (For a discussion on this see Byerly's Fourier's Series, page 49, art. 31, mentioned in the foot-notes. The scale of the figure can be reduced to a base length of π and then proceed, if the circular measure for angles must be used.

Let the distance (π/n + 1) between the ordinates be represented by Δx, the abscissas of the points will be Δx, $2\Delta x$, $3\Delta x$, - - - $n\Delta x$, and the ordinates of the points can be measured on the diagrams. Then substituting Δx, $2\Delta x$, etc., in (6) we obtain,

$y_1 = a_1 \sin \Delta x + a_2 \sin 2\Delta x + a_3 \sin 3\Delta x +$. A sub n sin $n\Delta x$.

$y_2 = a_1 \sin 2\Delta x + a_2 \sin 4\Delta x + a_3 \sin 6\Delta x +$. A sub n sin $2n\Delta x$.

$y_3 = a_1 \sin 3\Delta x + a_2 \sin 6\Delta x + a_3 \sin 9\Delta x +$. A sub n sin $3\Delta x$.

and so on to,

y sub $n = a_1 \sin n\Delta x + a_2 \sin 2n\Delta x + a_3 \sin 3n\Delta x + \ldots$. A sub n sin $n^2\Delta x$, (7)

which gives us n equations of the first degree. The equations may be written in the form,

$a_1 1A_1 + a_1 2A_2 + a_1 3A_3 + \ldots\ldots\ldots a_1 n$ A sub $n = y_1$

$a_2 1A_1 + a_2 2A_2 + a_2 3A_3 + \ldots\ldots\ldots a_2 n$ A sub $n = y_2$ (8)

$a_3 1A_1 + a_3 2A_2 + a_3 3A_3 + \ldots\ldots\ldots a_3 n$ A sub $n = y_3$

$a_3 1A_1 + a_3 2A_2 + a_3 3A_3 + \ldots\ldots\ldots$ an A sub n = y

etc., up to n equations, where the A_1, A_2, etc., are substituted for the a_1, a_2, etc., of (7) and a_1, a_2, etc., of (8) represent the known qualities that can be taken directly from the individual equations of (7) by substituting the values of Δ and x. Equations (8) can be expressed as determinants and the co-efficients of (7) thus determined. This discussion will be taken up in a later article as stated before.

CHARACTERISTICS OF FOURIER'S THEOREM.

"Fourier's theorem is not only one of the most beautiful results of modern analysis, but may be said to furnish an indispensable instrument in the treatment of nearly every searching question in modern physics. To mention

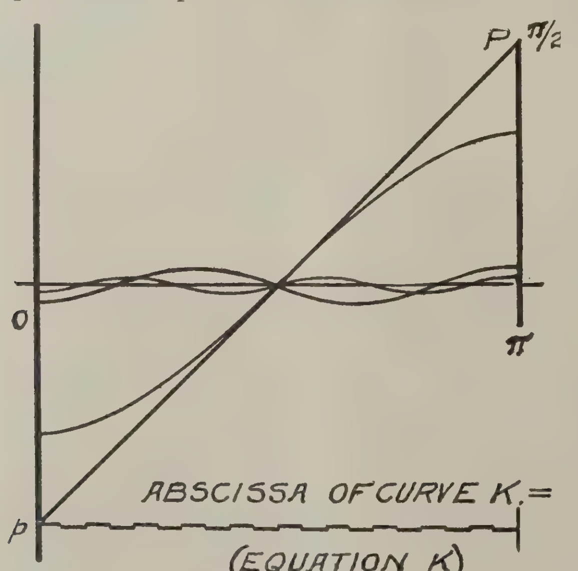


Fig. 5. Cosine Representation of (y = x), Having Only Odd Harmonics Present.

only sonorous vibrations, the propagations of electric signals along a telegraph wire and the conduction of heat by the earth's crust as subjects in their generality not easily handled without it, is to give but a feeble idea of its importance."—THOMPSON & TAIT.

"It is only a mathematical fiction, admirable because it renders calculation easy, but not necessarily corresponding with anything in nature."—VON HELMHOLTZ.

The fact that it can correspond with something in nature makes it a remarkable subject for study. The changes in the order of the harmonics as well as in the algebraic signs also calls for study. In Fig. 3, it will be noted that beginning at o, all of the harmonics have the plus sign, that is they all rise in the same direction. In the figure, the time is supposed to start at o and progress toward π. But if the time were reversed, that is, if we began at π and progressed toward o, it will be observed that the signs of the harmonics alternate in their order. The prime or fundamental harmonic has the plus sign, the second the minus sign, the third the plus, and would thus alternate throughout the series. Therefore, if the line πy, began at o and leaned toward the right, the signs would alternate in the order mentioned above.

The difference between the graphs of the different series is very intersting. It will be seen that if the ordinates dp equalled the ordinate $d''q$ in Fig. 3, the altitude of the second harmonic would reduce to zero, and hence vanish; likewise all the succeding even harmonics. Since p and q would have the same height, there would be no difference of altitude between the corresponding points mentioned from the $\pi/2$ ordinate, the sole purpose of the even harmonic. As to whether the third harmonic would have a plus or minus sign would depend upon whether or not the point r were below or above the altitude of p and q.

We shall inspect some very striking examples of trigonometric series by comparing the sine series with the cosine series. Let us be given the curve,

$$y = x\Big]_{0}^{\pi} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (a)$$

and it is desired to express this in a trigonometric series, It has already been shown graphically that if the line began at zero and leaned toward the right, the signs must alternate, for a sine series. In Fig. 5, curve (a) is plotted and as will be seen, must come under the last mentioned rule. Then we already know the general equation for this curve and it is only necessary to obtain the proper altitudes of the harmonics. Were we to continue the geometrical process that enables us to plot the curve in Fig. 3, we would obtain values for the co-efficients of the sine series to correspond with the curve in Fig. 5, representing simple harmonical progression. Equation, Fig. 4, will be

$$y = \sin x + 1/2 \ \sin \ 2x + 1/3 \ \sin \ 3x \ldots . (b)$$

and therefore for Fig. 5, it would be,

$$y = c[(b)] \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (c)$$

By construction the curve in Fig. 4 has an altitude of $\pi/2$ at o and curve Fig. 5 has an altitude at π of π. Therefore the proportionality factor C of equation (c) must be 2, and the equation for Fig. 5 is,

$$y = 2[\sin x - 1/2 \sin 2x + 1/3 \sin 3x ..] \ (d)$$

It has already been shown that if the altitudes of points p and q of Fig. 3 were equal, the even harmonics would vanish. Such a curve is shown in Fig. 6. By insepction it will be seen that the algebraic signs of the harmonic components must alternate plus and minus at the zero point, to give all plus values a $\pi/2$, thus giving the peak at r, (Using angular values in line (a).) If ordinate r equals $\pi/2$ the area of this curve will be $(\pi/2)^2$ equals $\pi^2/4$. From the calculus[4] we find that,

$$\pi^2/8 = 1/1^2 + 1/3^2 + 1/5^2 + 1/7^2 + \ldots . \quad (e)$$

or

$$\pi^2/4 = 2/1 + 2/9 + 2/25 + 2/49 + \ldots . \quad (f)$$

If any harmonic component be geometrically similar to its fundamental, its area is,

$$2/(n)^2 \ldots\ldots\ldots\ldots\ldots\ldots (g)$$

for the area of the sine is 2, and if the two dimensions of any figure be reduced by n, the result is the original area divided n for one dimension and again divided by n for for the other, which gives (q). The resultant area of the component in Fig. 6 is $T^2/4$, but $\pi^2/4$ equals the right hand number of (f) and therefore the area is,

$$[2/1 + 2/9 + 2/25 + 2/49 \ldots] \qquad (h)$$

from (h) we obtain (e) and dividing (e) through by 1/4 of the base length ($\pi/4$), we obtain the maximum ordinate,

$$\pi/2 = 4/\pi[1/1^2 + 1/3^2 + 1/5^2 + 1/7^2 \ldots]$$
$$= 4/\pi[(\sin \pi/2)/1^2 - (\sin 3\pi/2)/3^2 + (\sin 5\pi/2)/5^2 - (\sin 7\pi/2)/7^2]$$

substituting $\pi/2 = x$, and we have

$$x = 4/\pi[\sin x/1^2 - \sin 3x/3^2 + \sin 5x/5^2 - \sin 7x/7^2] \ (i)$$

x equals f (x) and the equation holds good between the limits substituted for o and $\pi/2$. Transform the co-ordinates by $-\pi/2$.

$$y = 4/\pi[\sin (x - \pi/2)/1^2 - \sin 3(x - \pi/2)/3^2 + \sin 5(x - \pi/2)/5^2 \ldots]$$

expanding by goniometry,

$$y = 4/\pi(-\cos x/1^2 - \cos 3x/3^2 - \cos 5x/5^2 ..] \quad (j)$$

we have the curve shown in Fig. 5. In order to make this equation fulfill the requirements of equation (a), the whole curve must be raised by $\pi/2$. See Fig. 5. Adding $\pi/2$ to (i) and allowing y' to represent y plus $\pi/2$, we have

$$y^1 = \pi/2 - 4/\pi \ [\cos x + \cos 3x/3^2 + \cos 5x/5^2 + \cos 7x/7^2 \ldots\ldots\ldots\ldots (k)$$

this curve is equal to (a) and (d) between the required limits of O and π. See Fig. 5.

Observe that in (a) there are no harmonic components and in (d) there are even harmonics present, but in (k) we have only odd harmonics present. The sine (d) and the cosine (k) series are both periodic functions of x, with a period of 2π. These expansions hold good only for the value worked for, that is both coincide with y equals x from x equals o, to x equals π; also (d) corresponds with y equals x from x equals $-\pi$ to x equals π, and neither coincides with y equal x for any value of x less than $-\pi$ or greater than π. Moreover (d) in addition to the continuous

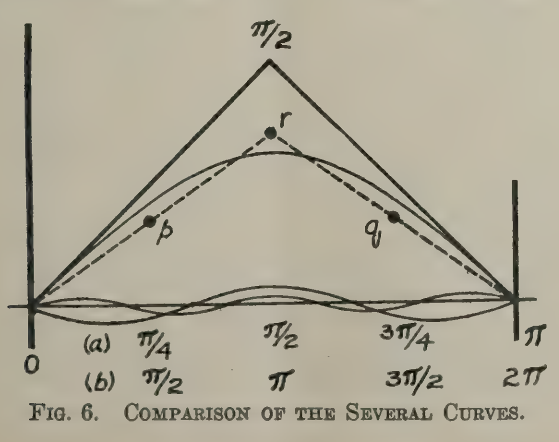


FIG. 6. COMPARISON OF THE SEVERAL CURVES.

portions of the locus represented in the figure gives the isolated points, (π,o) $(2\pi,o)$ $(3\pi,o)$ etc.

Nevertheless, we may attempt to develop a trigometric series that will hold good within any limits for y equals x. It has been observed that if we multiply the angular value of a trigonometric function by n, we divide the period by n, without changing the values of the ordinates. Then, if we also divide the function by n, the scale of the curve is reduced by n. Conversely, if the operation be reversed, multiplying the function by n and dividing the angular values by the same quantity we increase the scale of the curve by n

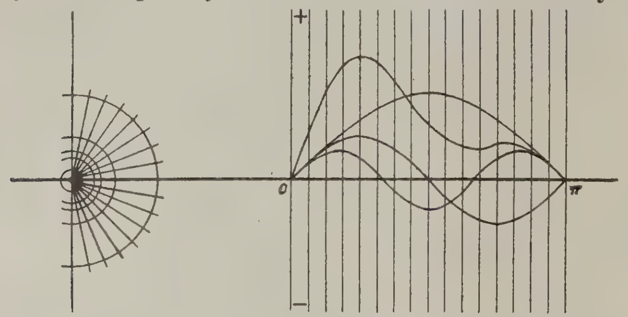


FIG. 7. PROCEDURE IN PLOTTING A SINE OR COSINE SERIES.

Treating (i) thus, we have,

$x = 4/\pi\ [n \sin x - (n/3^2 \sin 3x/n + (n/5^2)x/n$
$\sin 5x/n - \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (l)$

where n equals the desired limit divided by $\pi/2$. Fig. 6 using the angular values on line (b) plots equation (1) where n equals 2. Again treating (d) likewise.

$y = 2[\ \sin x/n - (n/2) \sin 2x/2 + (n/3) \sin 3x/n - \ldots$ (m)

where n equals the desired limit divided by π. These last two equations hold good for minus values as well as plus. Thus have we developed a trigonometric series for any value of y equals x, except when x equals infinity. It will be appreciated that although any function can be expressed both as a sine and as a cosine series and the function and either series will be equal for all values of x between the limits for which it was developed, there is a decided difference in the two series for other values of x.

DIFFERENTIATION AND INTEGRATION OF A TRIGONOMETRIC SERIES GEOMETRICALLY.

Suppose that a set of alternators giving sine waves of different frequencies were operating in synchronism and by mechanical means we obtain the resultant e.m.f. which we are able to plot in the form of a curve. Let this curve be the curve in Fig. 8, having the highest ordinate. This curve we will say is the composite curve of Fig. 3 and since we have analyzed Fig. 3, we know the components of Fig. 7 which are approximately,

$$y = \sin x + 1/2 \sin 2x + 1/3 \sin 3/x$$

Sixteen ordinates are found to be sufficient to obtain accurately the character of the curve. Now divide a semicircle into 16 equal divisions as shown at the left of the curve, describe semi-circles of radii equal to the altitudes of the harmonics, 1, 1/2 and 1/3. Projecting across in the usual manner, the first division to the first ordinate disregarding the one at o, second division to the second ordinate, etc., for the fundamental. And for the second harmonic taking the second division for the first ordinate, the fourth division for the second ordinate, and so on. Of course with the third harmonic, three divisions are skipped for every one ordinate. In this way the component may be rapidly laid out. This method, using a larger number of ordinates is very successful on a small scale up to the seventh harmonic. In a series like the one which we are working but where greater accuracy is desired it is better to substitute in the equation for the values of the ordinates.

Suppose that the complex curve in Fig. 7 is a flux wave in a static transformer and it is desired to find the shape of the e. m. f. that will be produced by this flux wave. The e. m. f. is the rate of change in the flux, therefore the e. m. f will be,

$$dy/dx = \cos x + 2/2 \sin 2x + 3/3 \sin 3x$$

the co-efficients happen to all reduced to one and our new curve is,

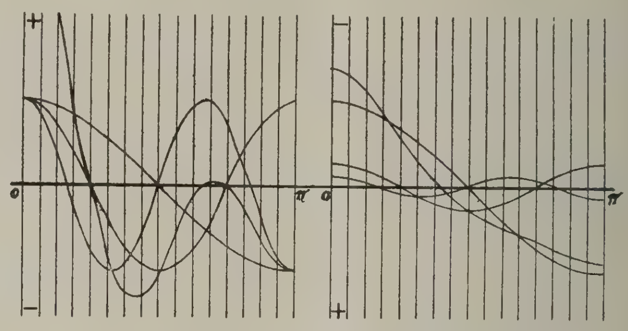


FIG. 8. GRAPHIC METHOD OF DIFFERENTIATING AND INTEGRATING A SINE OR COSINE SERIES.

$$y^1 = \cos x + \sin 2x + \sin 3x \ \ldots\ldots \text{(p)}$$

as all of the components have the same amplitudes, all of the ordinates are projected from the same circle, skipping two divisions for the second harmonic and three for the third, as before. Fig. 8 left hand member shows the individual terms of (p) plotted, also their alegbraic sums (y'). This resultant curve represents what we would expect as the flux plotted out.

Now we wish to find the flux or resultant flux that produced a given e. m. f. wave such as the complex curve in Fig. 8. Integrating the e. m. f. we obtain the flux or resultant which produced it, y equals $f(x)$ and

$$\int f(x) = \int \sin x + 1/2 \int \sin 2x + 1/3 \int \sin 3x.$$

$$= - \left[\cos x + 1/4 \cos 2x + 1/9 \cos 3x \right] \quad \text{(q)}$$

Describing arcs of radii of 1, 1/4, and 1/9 and skipping the proper number of ordinates, plot (8). The right hand member of Fig. 8 is the flux or resultant flux which produces the given e. m. f. in Fig. 7. Algebraic signs of (q) were reversed in the plotting to show more clearly the difference in the composition of the differential and the integral of a sine series. The difference, it will be observed, is that the components have opposite algebraic signs and different amplitudes making a different curve.

[1]Fourier: Theorie Analytique de la Chaleur (1822).
Byerly: Fourier's Series and Spherical Harmonies, Ginn & Co.
Orlich: Aufnahme und Analyse von Wechelstromkurven, F. Vieweg und Sohn, Braunschweig.
Steinmetz: Engineering Mathematics, McGraw-Hill Book Co.
Franklin Electric Waves, Macmillan Co.
Bedell and Pierce: Direct and Alternating Manual, Van Nostrand & Co.
Mellor: Higher Mathematics for Students of Chemistry and Physics, Longmans & Co.

[2]See Nichols: Differential and Integral Calculus, (Heath & Co.) p. 230, art. 157.

[3]See ————: Southern Electrician, vol. 43, No. 3, p. 105, col. 2.

[4]See Byerly: Differential Calculus (Ginn & Co., art. 135.

Alternating Current Engineering.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)
BY WILLIAM R. BOWKER.

A Discussion of the Auxiliary Starting Devices Used With A. C. Motors, Their Design, Action and Application.

IN the November issue, general remarks were presented covering the starting of induction motors. In this article the subject will be taken up in some further detail, explaining the methods used for satisfactory and economical starting, including the action and application of the auto-transformer and other devices.

If a motor is required for the purposes where it is not necessary to start under load, or very light load, the squirrel-cage rotor is preferable; for the dispensing with slip rings and brushes is a practical advantage. This type of motor can be started up under load, but it requires a very heavy and abnormal rush of current, which is disadvantageous, inducing electrical disturbances, and a lower power factor, and a decreased general electrical efficiency throughout the service. The starting characteristics of a motor under load, with a squirrel-cage rotor, are somewhat different than a motor with a coil-wound rotor.

Considering the squirrel cage type of motor; when at rest, and under conditions where it starts under load, the switching in of the stator circuit on the supply service, causes momentarily a maximum flux (magnetic lines of force) to cut the rotor bars, which being of very low resistance, results in an enormous rush of current. The effect is to react upon the stator, opposing the stator magnetic flux passing through the rotor, thus causing the magnetic lines of force to be diverted and pass from pole to pole across the face of the stator iron core. This increases the preipheral magnetic leakage, and the stator current is scarcely reduced, because of the enormous rotor current neutralizing the self-induction effect of the stator windings, resulting in the passing of a large stator current.

The resulting torque (mechanical turning moment) is comparatively small, because this depends upon the amount of magnetic drag between the rotor and stator fields. This in turn is determined by, and is proportional to the magnetic flux interlinked between the stator and rotor iron circuits, and as this magnetic flux is small, owing to the previously mentioned magnetic leakage across the stator polar face, there results a comparatively low starting torque.

The leakage flux also affects the power factor of the motor, and as this leakage is comparatively great, the resulting effect is a low power factor stator current, with its resultant practically disadvantageous disturbance upon the pressure regulation of the electrical supply system.

An auto-transformer, or starting compensator inserted in the stator circuit, does not greatly reduce the starting current taken from the supply mains. While it reduces the starting voltage, the practical effect of employing a compensator is to transform the energy which would otherwise be lost, due to $I^2 \times R$ (current squared times resistance) in a resistance in series with the stator windings; into useful energy, the compensator exerts no other influence and is therefore only useful for moderate starting torque.

It is evident that the employment of the squirrelcage rotor type of motor for starting under load, possesses serious practical disadvantages, and this has lead to special starting devices. A motor of the squirrel-cage rotor type, does not generally exert more than one-tenth of its full load torque when subjected to a full load starting current. At half full load torque, it demands about three and one-half times the full load normal amperes, while if full load torque is required at starting, it takes about four to five times full load amperes.

An auto-transformer does not possess practical advantages unless it is necessary to start the motor at some fractional value of its maximum torque. For any given torque there must be an impressed voltage of such a value as to cause a flow of current through the stator winding of a sufficient magnitude to produce that torque. Most modern induction motors impressed with full line voltage across the terminals, can take about seven times normal full load current when the rotor is at rest, resulting in a starting torque of approximately twice the full load torque. Since any reduction in terminal voltage reduces the starting torque in proportion to the square of the impressed voltage, if the motor terminals have applied to them an impressed voltage of approximately 70 per cent of the normal motor voltage, the current taken from the line will be about five times the normal full load current, and give full load starting torque.

If an ordinary resistance in series with the stator windings were employed to attain this reduction in pressure, with a resulting current five times the normal full load current, there would be considerable loss (dissipated in the form of heat) due to I^2 R taking place in the resistance itself. If this reduction in pressure and current is effected by means of an auto-transformer, it is due to a transformer action, and this prevents an energy loss (in the form of heat) such as occurs when an ordinary ohmic resistance is inserted in the circuit. It is obvious then that the auto-transformer does in no way influence the starting characteristic of the motor, but it does effect a saving in energy at starting.

When a motor has applied to it an impressed voltage of 70 per cent of full normal voltage, and taking about five times normal full load current, it would take from the supply mains (through the intermediary of an auto-transformer) about four times normal full load amperes at full line impressed voltage.

In a test on a 20 horsepower two-phase motor of the squirrel-cage rotor type, when started through an auto-transformer with full load normal current, it gave 32 per cent of its full load torque If started without an auto-transformer, using only an ohmic resistance, so as to limit the current at starting to a full load normal current, the motor at starting would develop under one-tenth of its full load torque. For starting under heavy load, where gradual speeding up is required, the slip ring coil-wound rotor is preferable to the squirrel-cage type, because in starting with a heavy load, the starting current required is not so great. Any starting torque required, within certain practical limits, can be obtained without producing undue electrical strain on the generating plant and generally throughout the service.

The one practical method of overcoming the disadvantages attending a short-circuited low resistance rotor of the squirrel-cage type, is to design and build the rotor with a coil winding, the ends being connected to slip rings on which press brushes They are then connected to the external supply circuit through the intermediary of a non-inductive ohmic resistance, which can be cut out as the motor gradually speeds up, the resistence being so arranged and employed that the rotor current at starting is reduced to less than full load normal amperes, the stator when switched in then takes from the incoming line rather less than full load norman amperes (this being controlled by the mutual inductive action and reaction between the stator and rotor currents) the current being gradually increased as the resistance is cut out, until when full speed is attained the total resistance is completely cut out. After this the short-circuiting device on the rotor shaft may be switched in, thus providing a rotor circuit which includes no external resistance whatever.

In practice the more satisfactory method of speed control is that which employs a variable resistance in the rotor circuit, because the power factor and likewise the electrical efficiency of the system is higher at starting and at reduced speeds, than when the compensator or equivalent device is utilized.

Under general service conditions, induction motors in sizes, up to about 7 horse power, need no auxiliary starting device, being connected directly to the line, and getting full impressed line voltage across the terminals, when the main switch is closed.

It is obvious, as already mentioned, that one method of keeping down the starting current is by employing an auxiliary ohmic resistance placed in the external circuit in series with the stator winding. Since this reduces the torque as the square of the impressed voltage is decreased, this method is in practice, only useful under conditions where the motor starts under very light load. It is then used only as a means of limiting the initial heavy inflow of current when the motor is switched into circuit. Such an arangement is outlined in Fig. 53, which illustrates the

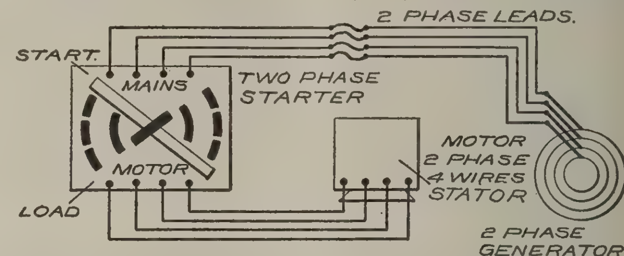


FIG. 53. STARTING DEVICE USING OHMIC RESISTANCE IN EXTERNAL CIRCUIT.

connections of a small two phase motor of three brake horse power, and two hundred volts per phase supplied with two phase current. The rotor is of the squirrel cage short circuited type, in the stator circuit of which there is connected the starting rheostat. When the motor is at rest, the switch handle is always in the off or start position as shown.

To start the motor, gradually move the switch handle from the start to the load position, in which position the starting resistance is entirely cut out of the circuit. To stop the motor, reverse the operation. A main switch may also be used in the circuit, to be closed and opened previous to starting and stopping, after which the starting resistance handle must be returned to its start position.

Direct Current Armature Winding.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

BY J. H. GARRETT.

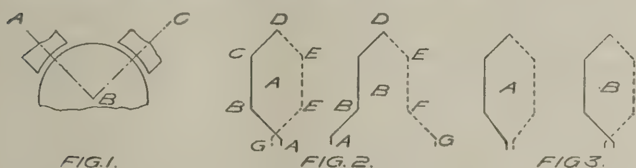
IN view of the progress that is being made in introducing electrically driven machinery into the every day affairs of life, the subject of motor maintenance and armature winding should be of interest to every electrician, mechanic and steam engineer, for it is plain that within a few years anyone employed in these trades who does not possess at least a working knowledge of the electric generator and motor, will not be qualified to meet his duties. The writer has found from his own experience and from superintending the work of others, that the average armature winder does not by any means get at the bottom of the subject. They are inclined to regard the theory of the work as a problem beyond them. It is the purpose of this article therefore, to deal with the problems of winding and testing in a practical, commonsense way, and endeavor to help the man who actually does the work.

Let us consider for the present the commercial types of direct current armatures. In almost all modern D. C. constant potential installations, the drum, closed coil, simplex type is used. These are subdivided into "Lap or Parallel" and "Wave or Series" wound, the difference being in the manner in which the leads from the coils are connected to the commutator and in the distribution of current through the winding. Hereafter the familiar terms "Lap and Wave" will be used.

A coil for this class of machine consists of one or more turns of insulated magnet wire or bar, the ends of which are left open for connecting to the commutator. They are usually wound or shaped upon a former so as to fit as perfectly as possible the periphery of the armature core, keeping the side walls of the coil parallel to the sides of the slots into which they are to fit. The construction of formers will be explained in detail later.

The pitch or spread of a coil is the arc of the armature covered by any one coil, and is equal to approximately the angular pitch of the poles, angle a-b-c Figure 1. The spread of the coil may differ slightly from the angular pole pitch without effecting the action of the machine, but if the difference is large, it is liable to cause sparking at the brushes, due to the fact that E. M. F.s would be generated in one side of the coil at the point of commutation. The coil is shortcircuited during commutation and if both sides should lie exactly in the neutral point that is, the spread equal the angular pole pitch, no E. M. F. would be generated. Without going into armature design, H. A. Foster in his Electrical Engineers' Pocket Book, says: "The proportion of armature circumference spanned by each coil is preferable a trifle less than the pole pitch."

In Fig. 2, single turn coils are shown arranged for a lap and wave winding. The sides a-b-c-d occupying the top of the slots. The diagram suggests a convenient and practical means of determining the nature of the connections. Look at the surface of the finished winding, if as at (a) the lead to the commutator a-b leads toward the center of the coil or in the same direction as c-d, it is a lap wound armature and there are as many paths for the current as there are poles in the machine. Or, if as at (b) the sections a-b and c-d are parallel, it is a wave winding and there are only two paths for the current, regardless of the number of poles in the machine. One should be sure, however, that they have the lead from the top of the coil, as in some cases the bottom leads are brought out on top.



Figs. 1, 2 and 3. Showing Pitch of a Coil and Coils for Lap and Wave Windings.

In a lap winding the coil ends connect to adjoining segments either as in Fig. 3 (a) or (b). In the wave winding they are connected so as to include an arc of the commutator, six pole, one-third, eight pole, one-fourth, etc.

The standard voltage formula for direct current generators is:

$$E = 4 \times N \times f \times \Phi \times 10^{-8}$$

Where E is the voltage generated in the armature, N the number of turns in series between the brushes, f is the number of magnetic cycles per second, and Φ, the magnetic flux (in magalines) included or excluded by each of the N turns in a magnetic cycle. As any direct current constant potential generator can be run as a motor, the above formula holds good for both.

By confining ourselves to the armature winding, the quantity N (number of turns in series between brushes) is the only one over which we have any control. Figs. 4 and 5 show how this may be done in a four pole armature by simply changing the commutator connections. The sheet may be cut out and folded into a round drum so that the lines a-b and c-d coincide. All armature slots and commutator segments are shown, but in order to avoid confusion, only part of the coils are drawn. It is more convenient to assume that they are receiving current from the line.

In Fig. 4, the current enters over the positive line to the brushes 2 and 4 and here divides into two paths from each brush, from brush 2 to left, slots 9-27-8-26-7-25 to commutator segment 15 advancing one segment per coil toward brush (1) back to the negative line. As this brush short-circuits three segments, the path to the right is from segment 20, slots 30-12-31-13 to segment 22 advancing

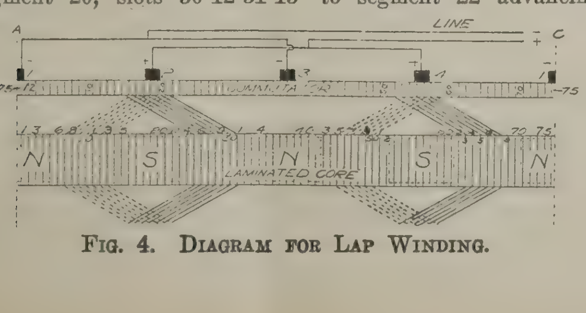


Fig. 4. Diagram for Lap Winding.

to brush 3 to negative line. The same may be traced from brush 4. The width of the brushes being equal to that of two segments, eight coils are short-circuited at all times (75-8)/4 = 17 about, or N (equals number of turns in series) equals 17.

In Fig. 5, the current would enter as before to brushes 2 and 4. From 2, segment 18, slots 28-46, segment 55, slots 65 to 6, to 6 on left of diagram, slot 8, segment 17, slots 27-45 segment 54, slot 64-4-4 slot 7 segment 16 and so on to the negative brushes 1 and 3, the two being connected when the winding is complete directely through one coil, segment 38, slots 48-66, segment 75 as positive brushes 2 and 4 are now connected. The other circuit is from segment 20, slot 11-5-5, slot 68, segment 58, slots 49-31,

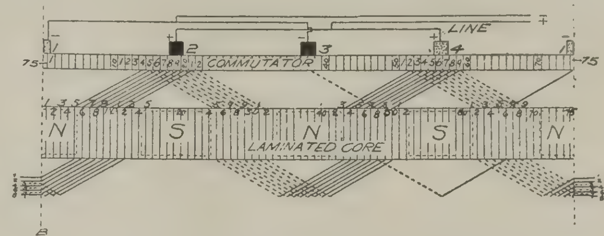


Fig. 5. Diagram for Wave Winding.

segment 21 and on to the right to brushes 3 and 1. There being only two paths for the current, N equals 34 coils in series. If this armature was used in a generator the voltage of the wave connection would be double that of the lap, as the numerator of the voltage formula would be twice as great. It has been stated above that the leads to the commutator in a wave winding include an arc of the commutator equal approximately to that included by adjoining poles of like polarity. By referring to Fig. 5, it will be found that the leads from any coil include 37 segments, or from 1, beginning with any coil, to 38. As there are 75 segments this is one-half segment less than half the circle and in tracing through one complete wave (2 coils in this case) we "drop back" one segment. We might have had a lead of 38 or from 1 to 39. We would then advance or "lap" one segment. There would be no material difference in the action of the armature, only that it would run in the opposite direction, other conditions being the same. The same holds good in the lap winding, that is instead of lapping as they are here shown, they may be connected as in Fig. 2 (a). It will also be noted that we will pass by brush 4 after tracing only one coil, therefore brushes 1 and 4, in fact any positive and negative pair may be dispensed with and the full E. M. F. of the machine will be collected. However, the carrying capacity of the sliding contact is doubled by using the four brushes. Not so with the lap winding, Fig. 5. While the E. M. F. would be as high, current would be taken from only one-half of the armature at the time and the output in watts would be half as much as if the four were used. It can be readily seen that the total output in watts or horsepower of the two armatures running under similar conditions and properly equipped with brushes would be the same. In the lap winding the E. M. F. may be, 110 volts, (all turns of seventeen coils in series) amperes 200 (four paths in parallel) watts equal $110 \times 200 = 22{,}000$. In the wave winding, E. M. F. equals 220, (all turns of thirty-four coils in series) amperes 100 (2 paths in parallel, half the carrying capacity as before) watts equal $220 \times 100 = 22{,}000$. And the following rules are established.

For a lap winding we must have as many brushes as poles and for a wave winding only two brushes are necessary and these may be placed opposite any north and south pole. For example: in a six pole machine the two brushes may be placed 180 degrees apart, although it is customary to place them 60 degrees apart. In order that the E. M. F. generated in the two sides of the coil shall be added, it is necessary that throughout the entire armature the direction must be the same when under poles of like polarity and opposite when under poles of unlike polarity.

PRACTICAL PROBLEMS SOLVED.

The writer received the following order a few months ago: "We are sending you a motor generator set with automatic starter for distant control. Will you put the outfit in first-class condition to operate on an 80 volt D. C. circuit." It was found to be a Holtzer-Cabot machine for wireless set, with Cutler-Hammer automatic starter. The name plate D. C. end read: Type "M", size 3, Rating 5 H. P., Volts 125, Amps 37.5, Speed 1800, Winding Compound 4 pole. The A. C. name plate read: Type "M", Size 3, Rating 2.6 K. W., Volts 110, Amps 23.6, Speed 1800, Separately excited 4 pole. The automatic starter was marked: H. P. 4, Volts 110-125. For starting duty, normal Amps. 32.

The machine and starter were set up and connected to an 80 volt circuit and lamp bank provided for an A. C. load. It was found that the starter would work on 70 volts, there being a sufficient margin to insure satisfactory operation, no changes were necessary in the solenoids. As a matter of experiment the series fields of the motor were reversed and a high, variable resistance inserted in the shunt field circuit. With a steady full load on the A. C. end the machine ran very nicely up to about 1,700 R. P. M. Over this it was unstable and would run away if not closely watched, and as the load under operation conditions would be intermittent, a differential wound motor could hardly be expected to give good service. It became necessary, therefore, to rewind either the armature or shunt field coils, or possibly both. The armature was stripped and the following data found:

Winding	wave
No. of slots in armature	75
No. of segments in commutator	75
No. of coils	75
Turns per coil	2
Size of wire	2 No. 13 B & S in parallel
Spread of coils	1 to 19 or 18 slots
Lead of commutator	1 to 38 or 37 segments

The reader will recognize the winding shown in Fig. 5, with the exception of the fact that we have two turns per coil in this case. The first thing to consider is the size of wire for the new winding. As it was a wave winding the two No. 13 wires in parallel had carried half the current 37.5/2 equal 19 amps. The cross section of wires, 5,178.4 C. M. times 2 equals 10,357 C. M. Then, 10,357 C. M./19 amps equals 545 C. M. per ampere. The input of the machine, which is to remain the same equals 125 x 37.5 equals 4,687.5 watts. Amperes for new winding equals 4,687.5/80 volts equals 58.6 amps. Amperes per path equal 58.6/2 equals 29.3 amperes. Number of C. M.s required equals 29.3 x 545 equals 15,968.5 C. M. Therefore No. 11 B &S wires equals 16,438 C. M. which is the nearest size.

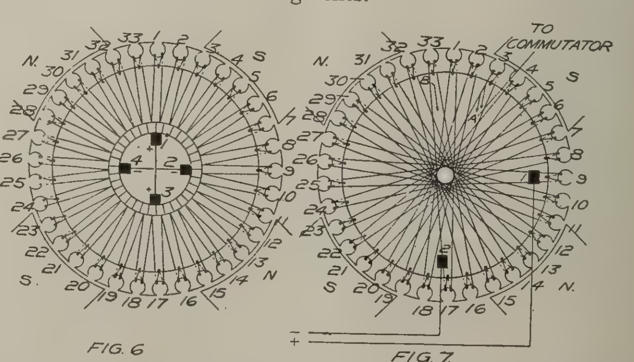
The next and decidedly the most important item to be considered is the speed of the armature with the reduced applied voltage. As nearly all the resistance offered to the applied E. M. F. is in the counter E. M. F. generated, if we are to make the necessary changes in the armature alone, we must change the number of turns in series (the quantity N in the voltage formula) in the same ratio as 80 is to 125. The formula becomes by transposing,

$$N = E/(4 \times f \times \Phi \times 10^2).$$

By direct proportion the speed at 80 volts with the old winding should be as 125 is to 80 as 1,800 is to X equal 1,152 R. P. M., but with the rheostat accompanying the machine in its normal position and a straight compound winding the speed was found to be 1,400 R. P. M.; therefore, 1,800 is to 1,400 as 68 turns is to X turns equals 1,400 x 68/1,800 equals 53 turns required. As we have only 2 turns per coil (68 turns in series equals 34 coils x 2) the only change we can make in the wave winding is to cut out one turn. This would give us 34 turns in series and run the speed up to about 2,400 R. P. M.

Suppose now we connect it lap. As there will be four paths for the same amount of current we can dispense with one of the No. 11 wires. Two turns per coil will give us 17 x 2 equals 34 turns in series (Fig. 4.) As we have plenty of room in the slots, we can put in another turn and now have 17 x 3 equals 51, which will give us with the same strength field and a speed of, 51 is to 53 as 1,800 is to X equals 1,870 R. P. M. The armature was wound in this manner. The machines being already equipped with four brushes, the only change necessary was a readjustment of the series field shunt. The operation under varying loads up to 25 per cent overload was very satisfactory.

Drum type armatures may be double or triple wound. They may be either lap or wave and simply consist of two or three single windings in parallel. The double winding is usually "Double Re-entrant." That is, it would have an even number of segments and in tracing from any one segment we would return to that point by traversing only half the number of coils, every other one. Such a winding should be provided with brushes wide enough to cover at least two commutators segments. It may be made singly re-entrant, all the coils in series by tracing around the armature twice, by using an odd number of segments. The same holds good in the triple winding. There would be three distinct circuits, number of segments to be divisable by three, and the brush should cover three segments for triple re-entrant and may be made singly re-entrant by using an even number of segments.



Figs. 6 and 7. Windings for 4 Pole Ring Armatures.

Very few ring wound armatures are being installed at this time, but as the practical man may at any time be called on to repair this type, it is well to consider them. Figs. 6 and 7 show diagramatically a four pole armature with 33 slots and segments. We will, as in Figs. 4 and 5, assume that the current enters from the line. In Fig. 6, lap connection, there are four paths, two from each of the positive brushes 1 and 3. Brush 1 short circuits coil 1, path to the right is through coils 2-3-4-5-6-7 and 8 to negative brush 2. To the left, coils 33-32-31-30-29-28 and 27 to negative brush 4. Similar circuits may be traced from brush 3. It will be noted that in the circuit to the right from brush 1 we enter the slots over the solid lines or front of the slots, as we are looking at the end of the wire the current is going away from the observer or piercing paper. It should be the reverse, toward the left and tracing this circuit we find that we enter over the broken lines or to the back of the core and the current is coming toward the observer.

The method apopted in Fig. 7, two circuit winding, is a little confusing, but should be less so than if the commutator and its connections were added. These connections would be made from all coils in a manner indicated at (a) or in small armatures one flexible lead may be taped on at the point (b). The brushes 1 and 2 are 90 degrees apart. By using a small straightedge we can easily trace the two paths. From the top of the positive brush through coils 26-10-27-11-28-12-29-13-30-14-31-15-32-16-33 to negative brush 2. All slots are entered over the broken lines or the current is coming toward the observer. As we were under poles of like polarity this is correct. By starting from the bottom of the positive brush the other opposite quarters are traversed and the current is going away from the observer under the south poles.

Indirect Illumination Compared With the Direct System.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

BY B. L. BENSON, ILLUMINATING ENGINEER.

THE question of protection to visual organs is one of too well-known importance for the writer to lay particular stress on it. It is surprising how very much abuse the human eye will stand without any apparent ill effects. The eye may be strained daily for months and even years without the owner being seriously handicapped or the vision be noticeably affected. At the same time, while the results are not especially apparent, they are nevertheless existent and will eventually make themselves felt. Any cause, therefore, of excessive irritation or fatigue to the optic nerve is injurious and should be avoided. It is and always has been an impossibility to do away with eye strain, but people are gradually waking up to the fact that there is no necessity for undue exposure and are taking precautionary measures with a view to so far as possible protecting the eye, and through this all dependant parts of the being.

Until recent years there was little or no attention paid to the artificial lighting arrangement of any interior. Lighting units were placed haphazardly and results were not even calculated. Recently there has been a decided move towards better artificial lighting conditions, owing to the fact that in many instances interiors are entirely dependent on artificial illumination all during the day. This move has led to the opening of a new field in engineering, that of illuminating engineering.

With this agitation of better lighting, has come a great number of lighting systems, many of them possessing great merit, and some of them none that is apparent. In general these systems may be divided into direct and indirect, the latter being the most recent in its developments for successful operation. While the principles of indirect lighting and the throwing of light toward the ceiling rather than directly downward upon the working plane, may appear queer at first; when the actual results are taken into consideration the findings of an investigation point to a distinct field of usefulness for the system. It will be the purpose of this article to draw a few of the important comparisons of the two systems above mentioned and point out, without bias, the actual merits of the indirect and least generally known system.

Comparing features of illumination only, to produce exactly the same average foot candles in intensity, it would take about 15 to 20 per cent more current with indirect illumination than with the most efficient direct lighting. With exactly the same intensity, however, the seeing power of the eye is fully 25 per cent greater with indirect than with direct. The ordinary reason given for this by advocates of the direct lighting is that the aperture of the pupil can be greater where the intensity is uniform and there are no exposed lighting sources, thus increasing the seeing power. While this is perfectly true, the ordinary contention that the long continued keeping of the eye in exactly the same general condition is not only harmful, but does not allow for rest which can be gained by glancing to some dark part of the room, is more or less true, it does not apply to conditions prevalent where the proper design of indirect system is employed.

In the first place, while the intensity of illumination in a room where indirect lighting is employed is almost uniform, at the same time there is sufficient variation to allow the eye some rest. Furthermore, with direct lighting for general seeing, it is necessary that the pupil be constantly active, enlarging and contracting to suit the many different conditions, which of course strains the eye and cuts down its seeing power. With indirect lighting, although there is enough variation in intensity to allow for a slight change in the pupil aperture, thus doing away with any possibility of eye strain when a different intensity is encountered (as when passing into a different room) there is not the wide range in the intensities to encounter as where direct lighting is used, and the pupil changes its size almost instantaneously, the change not being sufficiently abrupt to in any way affect the seeing.

Direct shafts of light when striking the eye are most distressing and injurious. This is true in varying degrees as the light is more or less protected. While, of course, the claim can be made that the eye comes in contact with direct light from the ceiling, the ceiling acting as the lighting source. The ill effects of this are minimized as the light is distirubted over the ceiling plane, making a very considerable area all having a low intrinsic brilliancy. As a matter of fact, the illumination on the ceiling in no way affects the working plane. There is practically no inclination whatever to look upwards in a room where the lighting source is; whereas with bright local spots of light, there is almost an irresitable inclination to occasionally glance at them. They exercise, in fact, a sort of hypnotic power which it is impossible to entirely combat. In fact, after one has become accustomed to the indirect system, there is no more inclination to glance at the ceiling, the only visible lighting source, than there is to glance at the sky when out of doors.

The general results where indirect lighting is employed are practically identical with the light produced by Northern skylight daylight, which is universally recognized as being the best. Another contention which is almost invariably brought out where indirect and direct lighting is used, is that indirect lighting gives a flat appearance to the interior, owing to the fact that as the light comes from the ceiling in every direction, shadows are done away with. Although shadows are softened to an extent where they are not disagreeably noticeable and harsh contrasty appearance is eliminated, the true prospective is in no way interfered with.

An interior lighted by indirect illumination stands out in all its architectural beauty with a much truer representaation of existing conditions than is possible where any other method of lighting is employed. While the foregoing is true and the facts given have been established by actual tests, perhaps the strongest recommendation that can possibly be advanced in favor of indirect illumination is that those working under this system, where it is properly installed, are almost universally satisfied in every respect. It is almost an imposibility to suit every one of a number of people with the same lighting conditions, as one person not only wants, but actually needs, different conditions from another.

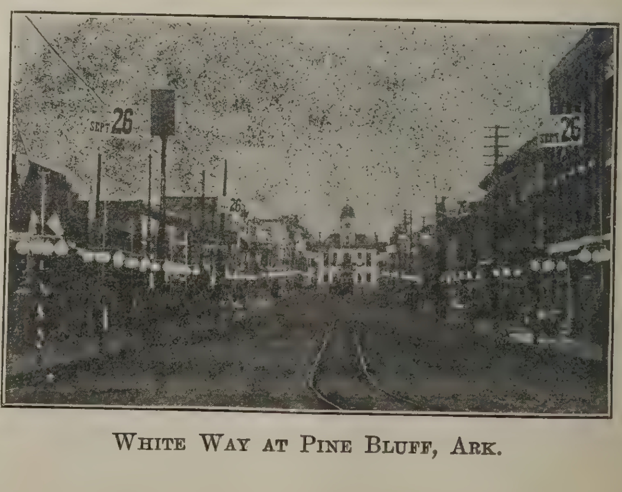
It is perfectly true that the human eye needs exercise to keep it in the best condition. At the same time, it is a very easy matter to overdo in the way of exercise, either of the eye or other physical parts. Such over-exertion is invariably attendant with ill effects, if not serious ones. Where the proper design of indirect illumination is employed, the eye is insured some exercise and yet is fully protected from such exercise being overdone. In figuring indirect lighting a great number of different factors are taken into consideration. In order to cover a certain area with any given number of outlets and in the manner that is best suited for the conditions, it is necessary that a certain height of ceiling shall exist, so that fixtures may hang sufficiently low to insure the expenditure of a maximum amount of illumination on the working plane. Of course, rooms used for different purposes require varying intensities of illumination, as it would not be advisable or even acceptable to use the same inlumination in residences as would be necessary in offices or drafting rooms. At the same time, there is no reason why the quality of the light should not be just as good in one place as in another. This brings out one feature of indirect lighting which makes it especially appropriate for varying conditions, namely, the flexibility. The intensity can be engineered as low as .25 foot candle to 9 or 10 foot candles without in any way affecting the general qualities of the light, or the satisfaction of results. In fact, the fine qualities of the light are perhaps more noticeable where lower intensities are maintained than with the higher degrees.

With a direct lighting, it is almost impossible to keep the average illumination in a room very low with any degree of satisfaction, for no matter how the room is lighted, the direct source will stand out from everything else, and the seeing results are vastly different from what they should be. The eye is attracted to the exposed unit and must be shaded from this before things can be readily distinguished. Taking indirect lighting under the same circumstances, there is no lighting source visible and if the illumination is where desired, that is on the articles in the room, on going into a room where indirect lighting is employed, a very low intensity maintained, there is no cause for getting used to the light, as everything can instantly be seen, without having to overcome the effects used by direct light sources in the range of vision, temporarily blinding the eyes. What is true with a low intensity is equally true with a much higher one, and the protection to the eyes is, of course, much more needed.

White Way at Pine Bluff, Arkansas.

A complete white way system of street lighting has recently been installed at Pine Bluff, Arkansas. The accompanying illustration shows the design of the system, which extends through the three principal business streets of the city, the posts numbering 150, and covering fourteen squares. The posts are of a simple ornamental design, constructed along modest lines that any small city can easily afford. Four sixteen-inch globes are mounted on iron pipe brackets, supported by iron pipe posts. They are firmly set in concrete three feet. The complete specifications of materials used in the posts are as follows: ,

1—3 1-2 x 8-inch Flange on bottom of post,
10—feet 3 1-2-inch Pipe,
1—Reducer 3 1-2 x 2 1-2-inch,
5—feet 2 1-2-inch Pipe,
1—Special Cross with 2 1-2-inch openings and four 2-inch openings,
4—2-inch Arms 18 inches long,
4—2-inch Ells,
4—Cast Iron Globe Holders,
1—2 1-2 x 2-inch Reducer,
5—feet 2-inch Pipe,
1—2 x 3-4 Reducer,



White Way at Pine Bluff, Ark.

1—3-4-inch St. Ell for outlet of loads,
2—Porcelain Insulators,
1—Cutters-Fixed pin (Break arm) where overhead wiring is attached.

Total cost of post set up complete, $24.00.

The plan of installing and operating the "White Way" was worked out in an original manner and consists of a scheme whereby the merchant pays $5.00 per month for one year, at the end of which time the post becomes the property of the merchant. After the first year he pays the company $3.00 per month per pole for the lighting and upkeep of four 60-watt Mazda lamps. The number of hours of burning is from dusk to eleven o'clock week nights, and twelve o'clock Saturday nights, controlled from the power station.

In the campaign, The Pine Bluff Corporation had the support of the local press from two papers, receiving in nine weeks 79 front page write-ups and 110 editorials. The Board of Trade co-operated in the campaign and the grand opening which consisted of eight Aeroplane flights by Brindley & Heth of the American Aviators, Inc., in two Wright biplanes, to the delight of the crowd of 30,000 from all over Southeast Arkansas. At night an Industrial and Floral parade started at 7:30 p. m., when the Mayor threw the switch which lighted the "Great White Way." The parade consisted of 136 decorated floats and autos and lasted two hours and forty-five minutes.

The Pine Bluff Corporation and the Pine City Electric Co., leading electrical contractor, joined in preparing an expensive illuminated float claimed to be the largest of its kind ever built and lighted by storage batteries. The current was taken from sixty Exide batteries which gave a no-load voltage of 130, distributed to 262, 5-W 12-V Madza sign lamps, 8, 250-W 110 V lamps, 16, 100-W 110-V lamps, 10, 60-W 110-V lamps, 24, 40-W 110-V lamps, and about two K. W. in appliances of various kinds. Nine people were on the float demonstrating the uses of electric irons, sewing machines, motors, percolators, chafing dishes, curling iron heaters, fans, toasters, etc. The float was 24 x 11 and ten feet high, made of eight colonial columns and arches with a color scheme of white. The publicity reseived during the campaign has already turned in much new business in the residence and business section, consisting of lighting and power, and has formed an exalted public feeling toward the company. Byron C. Fowler, expresident of the Arkansas Association of Public Utility Operators, is general manager; and Minor Q. Woodard, manager of the New Business Department of the Pine Bluff Corporation.

Atlanta Sales Conference of Western Electric Company.

On Thursday, November 16th, the Western Electric Company's Atlanta house closed a most successful sales conference. Four days were devoted to this meeting and besides the local managers, it was attended by managers and executives of the large electrical supply manufacturers for whom the Western Electric Company acts as Southern jobber and distributor. General business conditions were thoroughly discussed in all electrical fields and arrangements taken up which will make the handling of the fast growing Southern business most satisfactory to the various companies and to the Western Electric Company and its customers

The supply department of the Western Electric Atlanta house was established in 1905 and each year the department has expanded until at the present time it handles a volume of electrical supply business which brings it well up toward first rank among its competitors. The growth of the Atlanta supply department has been influenced to a large extent by the able and efficient house managemnt and particularly by the efforts of Mr. T. A. Burke, supply sales manager, who enjoys a wide and influential acquaintanceship among electrical men of the South. The business of the Western Electric Company for 1911 will be around $66,000,000, the Atlanta house contributing in sales, the largest part of the numerous houses throughout the country. The sales are reported from South Carolina, Georgia, Florida and Alabama.

An important and enjoyable feature of the conference was the quiet social functions. On Tuesday night, members of the conference were tendered a dinner at the Mechanical & Manufacturers's Club by W. R. C. Smith, president of the W. R. C. Smith Publishing Company, publishers of Southern Engineer and Southern Machinery, and C. S. McMahan, secretary and treasurer of the Cotton Publishing Company, publishers of Southern Eelectrician and Cotton. On Wednesday night the contractors of Atlanta were given a smoker at the offices of the company and a lecture on Interphones, enjoyed as delivered by Gregory Brown, of the New York engineering department. On Thursday night the salesmen of the Atlanta office were given a dinner and a most enjoyable time spent. A musical program had been arranged in which the members of the sales force figured, this being the feature of the evening.

Those in attendance at the four days conference other than the Atlanta salesmanagers, were the following: B. H. Scranton, president American Electric Heater Co.; F. V. Burton, sales manager Bryant-Perkins Electric Co.; A. F. C. Keleher, assistant sales maganer Holophone Co.; W. S. Sisson, secretary D. & W. Fuse Co.; J. B. Olsen, secretary Habirshaw Wire Co.; B. M. Downs, vice-president Brookfield Glass Co.; A. B. Wilson, of the Tungstolier Company; W. H. Jones, of General Electric Company; A. N. Bentley, manager Atlanta office of the Electric Storage Battery Co.; H. E. Futch, Southern general manager Pyrene Fire Extinguisher Co.; C. M. Crofoot, Southern sales manager Crouse-Hinds Co.; M. A. Oberlander, assistant supply sales manager of Western Electric Co. at New York City, and Gregory Brown, train dispatching expert of the Western Electric engineering department at New York.

Charlotte, N. C., Meeting of Sons of Jove.

The first initiation of the Sons of Jove in the Carolinas took place at Charlotte, N. C., October 28, when over 50 representatives of the various power companies and electrical companies were taken into the order.

A number of officials well known in the order attended the rejuvenation and assisted in the ritualistic exercises. Among these were the following: Messrs. Oscar C. Turner, past Jupiter, with headquarters in Birmingham, Ala; F. M. Byrne, Statesman-at-large, Atlanta, Ga.; National Organizer, E. D. Strickland of St. Louis, Mo.; L. S. Montgomery, Statesman for Georgia, and C. McKew Parr, of Hartford, Conn., avrenim of the tenth Jovian congress. Following the initiation exercises a banquet was held at the Selwyn hotel. Mr. Oscar C. Turner presided over the affair in the capacity of toastmaster, and pleasure reigned supreme in the large banquet room.

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.

HOW DO TRANSFORMER CORE LOSSES VARY?

Editor Southern Electrician:

(258) Kindly publish information in regard to the variation of transformer core losses when the transformers are used on different frequencies and different voltages. Is there a certain relation between frequency and voltage that should be maintained in order that the core loss may be held the same or at any rate not increased? How, also, is the capacity affected by such changes? B. H. D.

Opertion of Motor-Generator and Turbine.

Editor Southern Electrician:

(259.) I would like to ask the following question in your columns. We have a 300 K. W., motor-generator set running in parallel, over the peak, with a 500 K. W. turbine. This set is driven from a 500 K. W. direct current railway unit. At present we so arrange it that the load on the motor-generator is about 100 K. W. At times heavy railway loads come in, causing the Corliss engine to slacken its speed, before governor can act, when a severe drop in voltage occurs. What would be the result should this happen when the motor-generator is running in parallel with the turbine? The motor-generator could not drop in speed, being tied in with the turbine. Would there be a reversal of current in the armature, with consequently heavy sparking? M. Macdonald.

TRANSFORMER CONNECTIONS AND VOLTAGES.

Editor Southern Electrician:

(260) I would like to receive information as to the possibility of obtaining satsifactory service from the following transformer connections and also as to the secondary voltage that may be expected. I have three single phase transformers, ratio 25 to 1, wound for 11,500 volts primary. Can I successfully use 6,600 volts on primary connected delta and connect secondary star expecting to obtain 460 volts or thereabouts on the secondary. Give computations and explanation. E. W. C.

OPERATION OF ARC LAMPS.

Editor Southern Electrician:

(261) I am interested in the following problem and would appreciate information which you may publish. When alternating current arc lamps are used for street lighting, could a wider spacing of units be used by equipping the lamp with a carefully designed reflector? Also, how does the watt per candle power rating for the average direct and alternating lamp compare in the types used for outside lighting, and what is the rate of carbon consumption for each? I have heard the statement that the ordinary carbon arc lamp is more efficient in watts per candle power than the carbon incandescent; if this is so, what are the reasons? P. A. H.

OPEN Y EMERGENCY CONNECTION.

Editor Southern Electrician:

(262) In the accompanying diagram transformer (a) burnt out, it was disconnected on both primary and secondary sides and the ground used as the third conductor for open Y transmission as shown. These arrangements were maintained until the transformer was replaced. I have been informed that this is not considered good practice, in fact the informer stated before he knew it had been

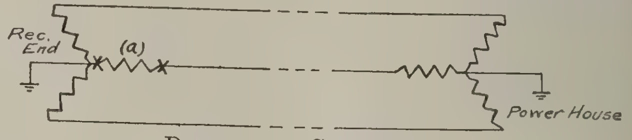


Diagram of Connections.

done that it was impossible with safety. Have your readers used the connection? What would be the actual voltage relation between wires and between wires and ground for a transmission voltage of 66,000. B. C. H.

SPEED CONTROL OF SHUNT MOTOR.

Editor Southern Electrician:

(263) Please advise through your answer columns as to a method of deciding on the most economical method for operating a shunt motor and securing fairly good speed control. The work done by the motor does not require a varying speed at all times; perhaps a week will pass when it will operate at constant speed. Then it may be required to vary the speed on work lasting a day or so. The motor is 2 horse power. Which will be the cheaper, to use a rheostat in the armature circuit or buy a suitable speed regulating device. Kindly state reasons and suggest any other schemes for speed control. H. A. S.

Discussion on Induction Generator. Ques. No. 185.

To Readers of Southern Electrician:

In the May and June issues, interesting and vital facts were discussed relative to the operation of the induction generator. Due to the fact that the characteristics of this machine are not generally understood, and in order that readers may get the greatest value from the discussions as presented, the following statements are given to clear up those points upon which the two writers do not agree. The explanation by Mr. Frank Zuch in the May issue is in most respects correct. In his opening paragraph, however, his statements are incorrect in as far as they state that the induction generator operating on an inductive circuit would tend to adjust itself, that is, the power factor required by the external circuit exactly coincides with the power factor of the induction generator. Aside from this point Mr. Zuch's discussion is correct.

The discussion in the June issue by Mr. Seidell is correct in all its details and very clear. This writer points out Mr. Zuch's mistaken view point in the middle of the paragraph on page 254, beginning with, "Referring, etc.," by the statement, "Mr. Zuch's misconception is undoubtedly due to his failure to consider the part that the synchronous machine plays in the matter." It must be remembered that the induction generator operates under certain conditions and it is the synchronous machine upon the circuit which has to adjust itself until these conditions are met. The accompanying diagram, giving a graphical presentation of the operation of the induction machine as a motor and as a generator may bring out the points mentioned by Mr. Seidell a little more definitely.

The definite and inflexible character of an induction generator is shown by the fact that its operating point must stay on the circle diagram in Fig. 1. In order to stay on this circle, a certain magnetizing current must be supplied to the induction machine (either motor or generator) by some synchronous machine; otherwise the induction machine will not work. It is to be noticed, also, that in changing from motor to generator, the power component of current changes sign, but not the wattless current. The two half-circles, therefore, make a complete one as shown.

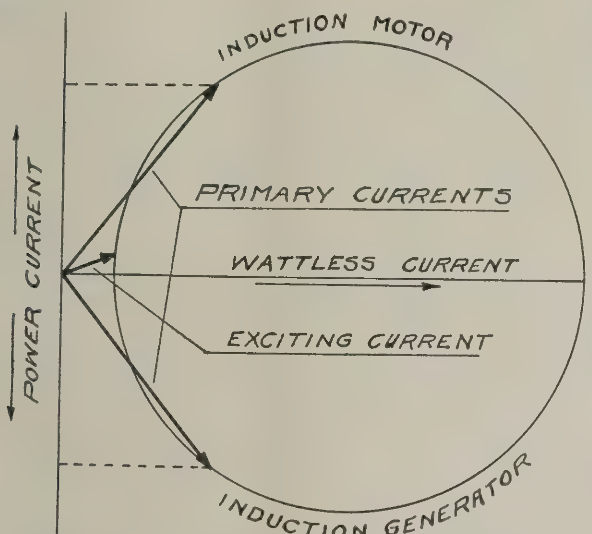


Diagram of Operation of Induction Generator.

In view of the fact that neither of the writers have touched upon uses of the induction generator, a few remarks are presented here. This machine has been little used, due undoubtedly to its inability to supply lagging current and the necessity of using a synchronous machine with it. It has, however, a rugged construction as usually designed, has no commutator, brushes or slip-rings. A smooth wave of electromotive force is produced and the machine tends to damp out rather than to produce harmonics and surges. One of its distinctive good points is that on short circuits the machine gives no voltage.

When the induction generator is operated in parallel with a synchronous machine, the frequency and voltage are determined by the latter machine. The load taken by the former depends upon its speed with reference to the speed of the synchronous machine, that is, upon the slip of the induction generator. This may prove desirable or undesirable. It would be of advantage in a plant where induction generators driven by water power are connected in parallel with a plant of synchronous machines driven by steam power. In this case it would be possible to operate the induction generators through speeding up so that they take a load up to the limit of the water power. This would allow the steam driven synchoronous machines to carry only the excess of the load. The above characteristic is undesirable if the two types of generators are driven at constant speed. As the load increases, the induction generator would not take its share.

In regard to the use of a synchronous machine with an induction generator, one synchronous machine either in the station or in a sub-station, is sufficient for the operation of several induction generators. The synchronous machine may be located at the receiving end of the transmission system, so as to help in improving the regulation, through the leading current supplied to it. Editor.

Discussion on Question No. 241.

Editor Southern Electrician:

The filaments referred to in the above question were probably shattered either by electrostatic attraction between the filaments and surrounding objects, such as the walls of the room, or between the different parts of the filament itself, since the high frequency of lightning discharge might cause the different parts to be at considerable difference of potential. It is also possible that electromagnetic attraction has something to do with it since there is always some electromagnetic attraction between the turns, and while this attraction does no damage at ordinary frequencies (except possibly in the case of the tantulum lamp), it might have an appreciable effect at a higher frequency, one that would coincide with the natural mechanical period of vibration of the filament and hence cause resonance.

If the breakage were caused by the first mentioned phenomena, it might indicate an explanation of the apparent preference shown some lamps. Those nearest to the objects of opposite polarity (the walls, tables, etc.) would naturally be subjected to greater stress than the more distant ones and would therefore be more apt to break. The current could either jump as Mr. Broward suggests in the November issue, or it could act across the gaps inductively. In the latter case we should consider the switches as a condenser in series with another one, of which the filaments, constitute one plate and the walls the other.

Discussion on Question No. 242.

The trouble in this case is very probably due to a swinging open circuit in the rotating field of the generator, or to a break somewhere in the exciter circuit. Such breaks are difficult to locate since they occur only at certain intervals. The trouble can be located by a careful search and the following method is recommended: Place a half dozen small pilot lamps at different points in the exciter circuit, one at the exciter generator itself, one just beyond the series rheostat (if there be one), one at the brushes that bear on the large generator rings, one connected to the terminals of the revolving field and then watch these lamps carefully the next time the trouble happens. If the trouble is in the exciter, all the lamps will go out, but if the break is in the revolving field, all of them will continue to burn except the one at the field terminals and that one will also continue to burn if the trouble is beyond it also, that is, somewhere in the field itself.

An ammeter should be inserted in the exciter circuit to indicate whether the exciter current fails or not, since if all the lamps should keep burning, there would be no other way to be sure that the field circuit was open. If the current stops and the lamps up to the last one still burn, it showns conclusively that the trouble is in the revolving field and we have still to find which coil it is. A convenient way to do this is to shunt each coil with a lamp, the lamps being of different colors, or fastened at different distances from the center of the field, since it is necessary to be able to determine which is burning while the machine is running. Since the normal voltage of each coil is much less than that of the lamps, they will not burn up to candle power until the break occurs, but when that happens, all of them will go out except the one shunting the faulty coil, which will light up to full candlepower.

It is, of course, possible, though not likely, that the trouble is in the large generator armature, or the outside lines, but in the former case there would probably be some fireworks to indicate its whereabouts.

It is not at all likely that any condition of overload, or power factor, has anything to do with it? T. G. Seidell.

Electrical Units, Ans. Ques. No. 243.

Editor Southern Electrician:

In answer to question 243 appearing in the September issue of Southern Electrician, I beg to submit the following in compliance with the request of Mr. S. V. E.: There are two distinct systems of electrical units, one called electromagnetic units, and the other electrostatic units. The electromagnetic units are moreover subdivided into what are called absolute or C. G. S. units and practical units, the latter being some power of 10 times the C. G. S. units. The six units requested by Mr. S. V. E. undoubtedly are the practical units, which have been named in honor of distinguished men of science. The units are: the volt, ampere, ohm, coulomb, watt and joule.

The volt is the unit of electromotive force, or difference of potential, and means the same thing in speaking of electric current that a pound pressure does in speaking of a current of water; in other words, it is the electrical pressure, and is the force required to cause a current of electricity to flow against a resistance. The volt is sometimes defined as the electrical pressure required to force one ampere through a resistance of one ohm. The value of the volt is equal to 10^8 C G. S. units, from the volt is derived the kilovolt, equals 1,000 volts, millivolt equals 1/1,000 of a volt, and the microvolt equals 1/1,000,000 of a volt.

The ampere is the unit of current strength, or is the rate of flow of a certain quantity of electricity in unit of time. The value of the ampere is equal to 1/10 C. G. S. units.

The coulomb is the unit of quantity of an electric current, and is the amount of electricity that follows per second past any point in a circuit, when the current strength is one ampere, for example: If one ampere flows for 30 seconds, then the total quantity of electricity is 30 ampere seconds, or 30 coulombs. The value of the coulomb is equal to 1/10 C. G. S. units.

The ohm is the unit of resistance, and is the opposition offered by any substance to the passage of an electric current within that substance. The value of the ohm is equal to 10^9 C. G. S. units.

The watt is the unit of electrical power and is the unit of work performed in unit of time, or

$$\text{Watts} = \frac{\text{work}}{\text{time}} = \frac{\text{joules}}{\text{seconds}} = \frac{\text{(volts x amperes x seconds}}{\text{seconds}}$$

= volts x amperes or E x I. The kilowatt equals 1,000 watts.

The joule is the unit of electrical work and is the amount of work performed by a current of one ampere flowing for one second under a pressure of one volt. Joules equal volts x amperes x seconds, or J equals V x I x T.

The standard values of the above units are as follows: The standard ohm is the resistance of a column of pure mercury 106.3 cm. long of uniform cross-section and weighing 14.4521 grams at 0° C, or roughly it is the resistance of a 1000 feet of copper wire 1/10 inch in diameter (No. 10 B & S Gauge). The standard ampere is the rate of flow of a steady current which deposits .001118 grams of silver per second from a standard solution of silver nitrate. The standard volt is 1/1.0183 of the voltage of a standard Western cell. E. J. Mora.

Electrical Units, Ans. Ques. No. 243.

Editor Southern Electrician:

Referring to question 243 appearing in the September issue, I will name and define the following six electrical units requested by S. V. E. (1) The ampere is the unit of electric current and is the expression referring to a current of electricity flowing continuously similar to the gallon per second in the flow of water. The ampere is then the rate of flow of the electric current. (2) The volt is the unit of electrical pressure or electromotive force. It is often defined as that emf that will maintain a current of one ampere in a circuit whose resistance is one ohm. The volt means the same thing in speaking of a current of electricity that a pound pressure does in speaking of a current of water. And also just as a higher pressure is required to force the same current of water through a small pipe as a large one, so a higher electrical pressure is required to force the same current of electricity through a small wire as through a large wire. The ampere represents the current flowing and the volt represents the pressure causing it to flow. . (3) The ohm is the unit of resistance in an electric circuit and is equal to the resistance offered to an electric current by a column of pure mercury 106.3 centimeters long and one square millimeter in section at a temperature of 32 degrees F. There is no general unit of resistance for the flow of water, however the ohm corresponds to the resistance offered by the pipe to the flow of water in it. (4) The coulomb is the unit of quantity of electricity. It refers to quantity of electricity in the same way that the gallon does to a quantity of water. In units it is the quantity of electricity that flows in one second through a circuit, the strength of the current being one ampere. (5) The joule is the unit of electrical work and represents the amount of work done when one coulomb of electricity flows under a pressure of one volt. One joule equal .7373 foot pounds. (6) The watt is the unit of power and is the power due to a current of one empere flowing in a circuit under a pressure of one volt. One watt equals 1/746 horsepower.

In reference to the second part of this question I advise S. V. E. to reason the question thus: If a coil cuts 100,000 lines of force in one second a certain electromotive force is the result at that speed. Then if the speed of the coil is doubled it would be equivalent to causing the same coil to cut 200,000 lines of force in the same length of time. Therefore since the electromotive force depends on the rate of cutting, then it is evident that the electromotive force in the latter case would be twice what it was in the former one. That is if a generator is now running at a voltage of 110 and a speed of 300 r.p.m., at a speed of 600 r.p.m. the machine would generate 220 volts, all other conditions remaining unchanged.

LE ROY SCOTT.

Generator Voltage, Ans. Ques. No. 243.

Editor Southern Electrician:

In reference to the last part of Question 243, I would say that if the speed of the generator is doubled that the effect will be to double the voltage, provided the field strength remains constant, such as would be the case if it were separately excited. If, however, it is a shunt or compound wound machine this relation would not hold good. If, however, the field of the machine is well saturated, in which case a large change of field current will produce a comparatively small change in the field strength, the voltage generated would vary pretty nearly proportional to the speed.

Grounding Lightning Arrestors and Switchboard, Ans. Ques. No. 247.

As I understand Question No. 247, if all connections are well made and a permanent ground secured, there should be very little danger of shock. It goes without saying that the system of water piping and the frames of the machinery should be made a part of this ground system.

Inductance of Choke Coils, Ans. Ques. No. 248.

The inductance of this set of choke coils is practically negligible with current at 60 cycles, but offers considerable impedance to the high frequency surges of lightning discharges. The power factor of the system would not be effected by putting in these coils. 24,000 volts is considered good practice for this spacing. A. G. RAKESTRAW.

Loud Speaking Telephone, Ans. Ques. No. 245.

Editor Southern Electrician:

I have noticed in your September issue that C. C. D. wants information covering a device for amplifying the sound in the receiver of a telephone in order that it will be more sensitive or better adapted to use in central station power plants where there is constantly more or less noise to interfere with conversation. This is a feature which has received some thought by the writer and a few experiments have been made. If the inquirer will refer to my article in the May issue of the Southern Electrician he will find a discussion relative to the properties which go to make up a receiver of the highest efficiency, however, the matter of a very sensitive one is not taken up.

There are several things to be taken into consideration if this condition is to be improved, as the modern receiver is ordinarily as sensitive as one could desire, except as the inquirer suggests, in a power plant or other noisy place. The place to begin, in devising a circuit or change in condition is evidently at the receiving station, as otherwise every other telephone in the exchange would have to be fitted to suit the case; this being out of the question, we will have to next consider the type of instrument, whether local or common battery; if of the former type the battery supply can be regulated at will; if of the latter, other means will have to be introduced. The intermittent condition in which the inquirer found that some people could be heard louder than others, especially one with a very heavy voice, can be accounted for by the fact that evidently such persons speak at the proper distance and in front of the transmitter instead of otherwise; then too, if notice will be given to the article in which the inquirer read concerning the receiver, you will find that I stated, "As only a small percentage of the energy of the sound waves reaches the diaphragm, the value both as regards energy and wave form is still further reduced. Therefore, not more than one per cent of the energy generated at the sending end of the line is received as sound at the receiving end." This goes to prove that if more energy reaches the diaphragm the same will transmit more energy to the line; the person with a strong voice will naturally create a wider vibration of the diaphragm than one with a weak voice or if not speaking directly in front of the transmitter.

The methods which I would recommend the inquirer to try out would be to rewind the receiver magnet coils to a higher resistance so they will be more sensitive to the weak currents which reach it. However, the resistance should not be too materially increased as to seriously affect the voltage impressed in the receiver circuit. A special induction coil may be tried in connection with such a receiver; one which will give a greater step-up proportion from the primary to the secondary. This proportion should not be too wide and some experimenting will have to be done with several coils before the best results will be obtained. Chapter on induction coils in Volume V. of Abbotts "Telephony" will give the experiments which will be valuable.

If the induction coil is improved or the receiver is made more sensitive, it will be as readily perceptable to the sounds made about the telephone upon which it is placed as those from the other end. In the case of a power plant or noisy place, this would be objectionable both from this reason and that the party at the other end of the line will get the noises from the machinery. In order to obviate this, it will be necessary to reduce the efficiency of the transmitter to such an extent that the outside noises will not affect seriously its talking qualities; in a local battery instrument, this may be accomplished by reducing the battery supply, or in both this and the common battery instruments by inserting sufficient resistance in the transmitter circuit only. Still another plan would be to arrange a spring wire of good conductivity in a way to be in position near the transmitter terminals, so same may be short circuited when listening to conversation from the other party and releasing it when talking.

The writer has experimented with a thin mica sheet diaphragm with a portion of an ordinary receiver diaphragm cemented to it in the center and over the pole-pieces, the edge being supported by thin cardboard washers at sufficient distance from the pole-pieces. This was not as successful as anticipated, although might be made satisfactory by further experiment; some improvement was noted in the amplitude of the sounds but the quality was not improved. This is the extent of the writer's knowledge covering the subject of methods of devising a more sensitive receiver, and I trust it will be the means of helping the inquirer in producing the result sought. L. O. SURLES.

A Correction.

On page 214 of the November issue, the third sentence from the end of Mr. Arthur L. Gear's article reads as follows: "A pressure of 25 poudns per square inch of contact surface of carbon brush is a maximum amount of brush pressure required to carry current." The figures given as 25 pounds should read 2.5 pounds.—ED.

Meters For Tests, Ans. Ques. No. 246.

Editor Southern Electrician:

Referring to question 246 of the September issue, the questioner would require for the A. C. end of his system during the test, a potential transformer with a ratio of 10 to 1, and a low reading voltmeter which has been calibrated with the transformer. This, I think, would give him range enough for all potential readings. For current readings a series transformer and a milli-voltmeter, which has been calibrated with it, will be all that is necessary.

For the power factor indications there is a very good portable power factor indicator on the market. If he wishes to go a little farther and get a little more equipment he might add one or two portable wattmeters. Perhaps it would be best to have them, as the readings obtained would give the true power factor.

A list of capacities of instruments might help as follows:

Potential transformer ratio, 10 to 1.

Portable voltmeter, 0 to 220 volts.

Milli-voltmeter, 0 to 500 milli-volts.

Wattmeters—current, 50 amperes; potential, 220 volts.

The wattmeter should be calibrated with the transformers.

For the direct current end a voltmeter with a range of 0 to 300 volts and an ammeter with suitable capacity for the largest motor on the circuit is required. If motors are very large the ammeter could be provided with a shunt of different capacities. G. I. MORGAN.

Inductance of Choke Coils, Ans. Ques. No. 248.

Editor Southern Electrician:

In answer to question 248 in the October issue, the following is submitted: The inductance of a coil with no iron in the magnetic circuit is given by the formula,

$$L = (395\ r^2T^2)/10^{10}l.$$

The values given for the coils in the question are turns $T = 154$; length $l = 72$ inches; $r =$ radius $= 1/2$ diameter $= 16/2 = 8$ inches. Substituting these in the formula we find the inductance of each coil to be,

$$L = 395 \times 8^2 \times 154^2/10^{10} \times 72 = .000835 \text{ henry.}$$

For the two coils, then, the total inductance will be $.000835 \times 2 = .001667$ henry. To understand how this addition of inductance to the given circuit would affect its power factor, it is first necessary to have some idea of how inductance affects the electric circuit in general. Inductance is a property of an electric circuit by virtue of which a certain resistance called reactance is set up opposing the flow of the eletric current. It is due to the magnetic field set up by the current around itself; and, like a plain resistance, absorbs energy from the current. Resistance, however, converts this absorbed energy into heat; reactance does not, but stores it in some mysterious way in the surrounding magnetic field, and when the current is interrupted, returns it as an addition to the current. Hence, the "induction effect" so well known to the working electrician.

In direct currents the effects of induction are virtually absent and there is no energy consumed in overcoming it; so that the total available energy of such a circuit is that given by the rule, volts $\times$ amperes = energy in watts. In alternating current circuits, however, on account of the peculiar character of the current, inductance is a thing to be reckoned with; and where present in a circuit, the foregoing rule for calculating the available energy of a direct current circuit does not hold entirely true, but the result obtained by it, must, to obtain the real energy, be reduced by an amount required to overcome the reaction.

It is this peculiarity which gives rise to the use of what is known as the power factor in connection with an alternating system. The power factor, as it is termed, is merely the fraction which shows what proportion of the energy obtained by the product of the voltage and the amperage of the system is real energy. The balance is merely phantom energy, as it were, of use only for overcoming that other phantom, the reactance.

The reactance of an alternating circuit is equal to $2\pi nL$, where $\pi = 3.1416$; n is the frequency; and L, the inductance in henrys. It is measured in ohms, the same as resistance; so if CR is the E. M. F. required to overcome the resistance in a circuit carrying C amperes, $2\pi nLC$ will be the E. M. F. necessary to overcome the reactance of the same circuit. The E. M. F. overcoming the resistance is in phase with the current, but the E. M. F. overcoming the reactance is 90 degrees ahead of the current. Consequently, these two E. M. F.'s cannot be added numerically to find the total E. M. F., but must be combined geometrically, for this purpose.

To show the method geographically, OP, Fig. 1, is laid off horizontally to some scale to represent CR, or E_1, called the power component of the E. M. F., and PM at right angles to this to represent $2\pi nLC$, or E_2, called the wattless component of the E. M. F. The total E. M. F., E_1 is the resultant of E_1 and E_2; that is, the diagonal line OM, which represents the total, or impressed, E. M. F. to the same scale as was employed to lay out the lines OP and PM. The angle Φ is the angular displacement between the impressed E. M. F. and the current, and is called the angle of lag of the current.

The apparent energy is equal to the current C multipled by the total E. M. F., E or $C \times E$. The actual energy is equal to the current multiplied by that part E_1 of the E. M. F. in phase with the current, equals $C \times E_1$. Since OPM is a right angle, OP, by trigonometrical definition, is the cosine of the angle of lag Φ. By the same authority, OP is to OM as cos Φ is to 1. From which $OP/OM = \cos \Phi$, or $OP = OM \times \cos \Phi$, and $E_1 = E \cos \Phi$. Obviously, then, $CE_1 = CE \cos \Phi$, and therefore, the real energy = apparent energy $\times$ cosine angle of lag. However, it has been previously defined that the real energy of an alternating current circuit is equal to the apparent energy multipled by the power factor. The cosine of the angle of lag must therefore be equal to the power factor.

Now, let us consider the effect upon this cosine, or power factor, of an increase in the inductance of a circuit. Take, for example, a system of which the power factor is .82. As given in the question, the power factor is the cosine of the angle of lag, as was previously stated; so from a table of trigonometrical functions, we find that .82 is the cosine of $34°55'$. This, then is the angle of lag of the current. Figure 1 has not been laid out to scale; nevertheless we will utilize this figure for further explanation.

Suppose, now, we increase the given inductance by an am ount l, with no appreciable increase of the resistance R, as would likely be the case by connecting in the circuit, the choke coils as suggested in the question. The new inductance of the circuit will then be $L+l$, and the reactance will be increased to $2\pi n(L+l)$. The E. M. F. required to overcome it will be $2\pi n(L+l)$ C. Extending PM to N to represent this increased E. M. F., it will be observed; first, that the angle Φ is increased; second, that ON must be greater than OM. Hence, the impressed E. M. F. will have to be increased an amount equivalent to the distance MN to compensate for the increased reactance.

The power factor will now be the cosine of the new angle of lag; that is OP/ON; and, since ON is greater than OM, the value of OP/ON is less than the value of OP/OM. OP/OM, however, is the value of the old power factor, so the power factor, with the changed conditions, is less than the original. In many cases it may not be feasible to increase the impressed E. M. F. to compensate for any additional E. M. F. In that event, the current will be cut down. For, the inductance must absorb energy somewhere, and if it is not permitted to take it out of the E. M. F., the current must suffer the loss.

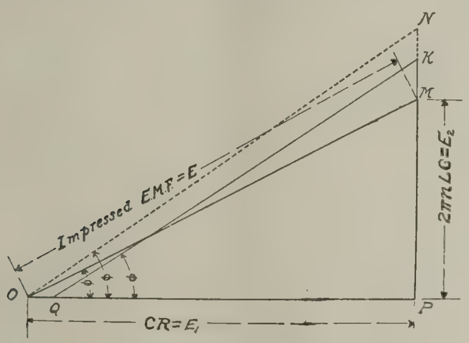


DIAGRAM OF RELATIONS.

The values of E_1 and E_2 will, in consequence, assume new proportions. For, returning to Fig. 1, assume C to be reduced by the inductance, the product of CR will therefore be less. Supose QP is its new value. Take a line QK equal to OM. It will intersect the perpendicular PM in K. An inspection of this change shows that the angle of lag has increased as before. The power factor has decreased, also as before. For OM and QK are equal, but QP is less than OP. Hence QP/QK is less than OP/OM.

The conclusions to be deducted from the foregoing are therefore; 1st, That the addition of inductance to a circuit, with resistance constant, increases the angle of lag; and 2nd, that the addition of inductance to a circuit, with resistance constant, causes the power factor to be diminished. This is about as far as can be gone toward the solution of this question, without more data than has been supplied. All that would be required for this purpose, however, in addition to what has been given, is the impressed E. M. F. and the frequency of the system. With them to help out, the other factors may be computed. For the sake of carrying out this answer to its legitimate end, it will be assumed for this case that the impressed E. M. F., E, is 2,300 volts; and frequency, n, is 60 cycles.

Then, in Fig. 1, the power component $E_1 = E \times \cos \Phi = 2{,}300 \times .82 = 1{,}886$ volts. But $E_1 = CR$; then $CR = 1{,}886$ volts. C has been given at 35 amperes, therefore $R = 1{,}886/35 = 53.89$ ohms. PM, in Fig. 1 represents the wattless component E_2 of the E. M. F. and is by trigonometrical definintion, the sine (sin) of the angle $\Phi = 34° 55'$; its sine is .5724. By trigonometry again, PM is to OM as sin Φ is to 1. From which, $PM = OM \sin \Phi$; that is, $E_2 = E \sin \Phi = 2{,}300 \times .5724 = 1{,}316.5$ volts. But also $E_2 = 2\pi nLC$ so $2\pi nLC = 1{,}316.5$. Solving for L, it is found,

$L = 1{,}316.5/2\pi nC = 1{,}315.5/2 \times 3.1416 \times 60 \times 35 = .0998$ henry.

Here once again, the principles of trigonometry must be used to afford a stepping stone from which to proceed with the calculations. In them the statement is found that the tangent of an oblique angle of a right triangle is equal to the quotient obtained from dividing the side opposite by the side adjacent. Applying this to the triangle OPM, Fig. 1, $\tan \Phi = PM/OP = (2\pi nLC)/CR$, C will cancel out of this expression. Then, simply, $\tan \Phi = (2\pi nL)R$, n has been assumed at 60 cycles; L, has been found for the circuit without the choke coils to be .0998 henry; and $R = 53.89$ ohms. Substituting these values in the equation above for the value of the tangent, it becomes,

$$\tan \Phi = (2 \times 3.1416 \times 60 \times .0998)/53.89 = .7$$

By reference to a table of tangents, it is found that this corresponds to angle 34° 55′, the same as found before with the cosine .82. consequently, the expression must be correct.

Now, suppose the choke coils be added to the circuit, the inductance will be increased to $.0098 + .00167 = .1014$ henry. R is assumed to be unchanged. Then, substituting this new value of L in the equation, it becomes

$$\tan \Phi = (2 \times 3.1416 \times 60 \times .1014)/53.89 = .71$$

From this, it is found by reference again to the table of tangents that, with the choke coils in circuit, the angle of lag, Φ, is 36° 3′. The cosine of this angle is .8085, which is thus the power factor of the circuit with the choke coils in use. A reduction from .82 to .8085.

VICTOR C. VANCE.

[The determination of the exact inductance of coils involves complicated calculations involving many factors. The Bureau of Standards, through Mr. E. B. Rosa has published considerable material on the subject. The following formula of Lorenz is absolute for a single layer coil of any length. However, this formula must be corrected by a table furnished in the Bureau of Standards' circular No. 31,

$$L = (4\pi n^2/3b^2) \quad [d(4a^2 - b^2)E + db^2F - 8a^3]$$

Where a is radius of coil, b the mean average length, d the diagonal of coil, E and F complete eleptical integrals of the first and second kinds to modulus K, where $K = 2a/d = 2a/\sqrt{(4a^2 + b^2)}$.

Mr. E. J. Berg, of the General Electric Company, recommends the following formula for the design of choke coils, $N = 10E\sqrt{(x/lfP)}$. Where N = number of turns per coil, E the line volts, x the per cent of reactance (usually from 3 to 6 per cent), l the diameter of coil in inches, and f the frequency in cycles per second, and P the power rating of generator in K. W. The formula used by Mr. Vance is only approximate; however, a large part of his reasoning shows in general the effect of adding inductive reactance to a circuit.—EDITOR.]

Self-Starting Synchronous Motors, Ans. Ques. No. 249.

Editor Southern Electrician:

In answer to A. L. C.'s question No. 249, in the October issue of the SOUTHERN ELECTRICIAN, I take the liberty of quoting from an article written by Mr. J. J. McIntosh, on Power Factors and Synchronous Motors, read before the Phoenix, (Ariz.) Section of the N. A. S. E.

"When a polyphase synchronous motor is connected to an alternating current line, a starting torque of sufficient strength is developed to bring the motor up to speed under no load. This is accounted for by the fact that as the current of one phase drops to zero value, the hysteresis effect causes the magnetism induced by it in the poles to lag behind the current and this remnant magnetism is therefore acted upon by the incoming phase, or phases, thus producing sufficient torque for starting. In order to increase the starting torque, the field poles of most of the latest types of machines are of some form of special construction. In some designs, to the pole faces are added copper bars which are connected on each end of the pole structure to rings, called short-circuiting rings. These rings completely surround the field. This type of construction not only assists in starting but also tends to prevent hunting, thereby making the machine more stable in its operation." A. H. MITCHELL.

Self-Starting Synchronous Motors, Ans. to Ques. No. 249.

Editor Southern Electrician:

There are two methods in common use for starting polyphase synchronous motors from the A. C. side: (1) By applying polyphase alternating current to the collector rings, the armature is brought up to speed as an induction motor. With the fields unexcited and a polyphase alternating current applied to the collector rings, a rotating magnetic field is produced about the armature core. The elements composing the losses thereby produced in the pole-faces will effect a torque on the armature and cause it to tend to speed up to synchronism. Usually a starting compensator is employed for reducing the applied e. m. f. during the starting period. Under the condition of starting, the step-up transformer action between the field and armature windings causes a relatively large e. m. f. to be generated in each field coil. To lessen the danger of breaking down the field insulation, it is necessary to open the field circuit between each pole. When a shunt to the series coils is used, it must be opened at starting; otherwise the heavy alternating current produced in it and the series coils may cause excessive heating.

(2) Another method extensively employed, is the use of a separate motor for starting. The starting motor, which is usually of the induction type, is mounted on an extension of the synchronous motor shaft. The induction motor is provided with a fewer number of poles than the synchronous motor, so it will be able to bring the synchronous motor up to full synchronous speed. Thus a 12 pole synchronous motor would require a 10 pole starting motor with 16 2-3 per cent slip. A. L. UTZ.

Power Factor and Plant Capacity, Ans. Ques. No. 250.

Editor Southern Electrician:

In making estimates upon the cost of power, the engineer takes into consideration such items as, cost of coal, oil, etc., and all those items that depend more or less on the amount of power generated; wages of employees (including all departments), interest and depreciation charges on the first cost of the whole equipment, including station, lines, etc. It is this last item that makes it necessary to keep as high a power factor as possible, because with a low power factor a larger machine and line is required, and the increased cost causes the interest and depreciation charges (which may be taken as about 12%) to be high.

Also aside from financial considerations, if a company guarantees a certain voltage it is necessary to keep the power factor high, because the drop due to the line and generator reactance is much greater when the power factor is low. It is interesting to note that if the customer can cause leading current by means of rotaries or synchronous motors, he can boost his own voltage, since leading current (power factor) has the reverse effect to lagging current. It will be understood that this drop or boosting effect will also depend on the amount of the line and generator reactance, and may be increased by inserting reactance coils in the circuit.

Rotary Converter Operation, Ans. Ques. No. 251.

In the design of rotary converters, advantage is taken of the fact that the motor currents (flowing against the generated e m f) cause just the opposite armature reaction to that of the generator currents (those flowing with the generated e m f), and therefore there is no armature reaction. The air gap may be (and generally is) made short and the field is not as strong as would otherwise be necessary. If the machine is used as a double current generator, both currents being in the same direction will have the same reaction, and the consequent distortion of the field may cause sparking.

Also when used in the normal way the current in the conductors is the difference between the alternating input and the direct current output, while in the double current generator it is their sum. Consequently when used this way the capacity is greatly reduced because of heating.

A rotary converter or a synchronous motor will take leading current if the fields be over excited, and therefore will compensate the low power factor caused by the lagging current of the induction motors or generators. If it be shut down, the power factor will naturally fall to that of the induction machines, since they are no longer compensated.

If the fields of the rotary are adjusted to where it does not boost the power factor there will be no change when it is cut out. T. G. SEIDELL.

Sizes of Wire For Heating Apparatus, Ans. Ques. No. 252.

Editor Southern Electrician:

In question No. 252 W. R. requests wire sizes for an electric radiator to consume 1,500 watts at 120 volts. The heat generated in any conductor depends directly upon the current flowing and inversely upon the resistance of the conductor (C^2/R). The temperature of a conductor carrying a given current will, therefore, increase as the diameter of the conductor decreases and as the radiating surface decreases. The temperature of conductors in heating apparatus is necessarily limited by the fusing point of the metal used, and the first step in any design of this sort is to select a size of wire which will safely carry the required amount.

In this case the current is 1,500w/120v = 12.5 Amp. Referring to tables furnished by wire manufacturers, we find that the smallest wires capable of carrying 12.5 Amp. with free radiation are: German Silver No. 19 B & S; Driver Harris Nichrome No. 15 B & S; and Iron No. 23 B & S. Experience shows that under working conditions larger sizes should be used, and the following are recommended: German Silver No. 18; Driver Harris Nichrome No. 12; and Iron No. 18.

The resistances of these sizes may be expressed:

	OHMS PER FT.	SAFE WORKING TEMP.
German Silver No. 18	.143*	500°F
Nichrome, No. 12	.089	2200°F
Iron, No. 18	.083*	1000°F

*Note that the resistances of German Silver and Iron wire vary with the composition of the metal. Extra data for particular wire used, must be obtained from the maker.

The total resistance required for the radiator would be found from the formula, R = E/C, or, substituting known values, 120/12.5 = 9.6 ohms. The required amounts of wire are found by dividing the total resistance required, by the resistance per foot of the wire used, therefore: German Siver 9.6/.143 = 67 feet; Nichrome 9.6/,089 = 108 feet; Iron 9.6/.083 = 116 feet. As the Nichrome No. 12 has by far the largest radiating surface and the highest fusing point of the three metals, and in addition is non-corrosive, it will be found much more satisfactory than the cheaper metals.

If inconvenient for mechanical reasons to use wire as large as No. 12, the heating element may be divided into several sections. Each section could carry three or four amperes, using wire as small as No. 22 Nichrome. If connected in parallel, the result would be the same as if the larger wire were used, and the failure of any one section would not stop the operation of the radiator. Further the sections could be separately controlled for regulating the heat liberated.

To find the number of winds per inch if the wire is wound on a cylinder or a flat plate, or in spirals, use the formula:

Winds per inch = (Total resistance (ohms) per section of element × 12)/length of section (inches) × circumference (inches) × ohms per ft. of wire.

Regarding the 12 inch disc stove, we encounter an entirely different problem. In the first place, the resistance element is entirely enclosed, and unless provision is made for carrying off the heat as fast as it is liberated, the temperature of the wire will quickly run above the melting point. Therefore, in choosing our wire, a size must be taken which has a carrying capacity and consequently a radiating surface about twice that required for dissipating the same amount of energy in the open air.

When current flows continuously in a stove of ordinary efficiency (60 to 70 per cent), one watt-hour will raise and maintain the temperature of one square foot of exposed surface about 1.25° F above atmospheric temperature. The area of the top of the stove in question is .785 sq. ft. (12 in. dia.). The energy required to raise its temperature 260° (from 40° to 300°) in ¼ hour would be, .785 × 260°/1.25 × .25 = 645. watts. Knowing the wattage, the size of wire can be computed as above. An exact reply to this part of the question cannot be given as no data is furnished regarding the thermal insulation of the heating element, or the intimacy of its contact with the top of the stove. Unless very well constructed, a higher wattage may be required. Storage capacity would lessen the chance of a burn out and correspondingly lengthen the time required for heating.

German Silver wire would be unsuitable on account of its low melting point. The heating element itself is at a much higher temperature than the outside of the stove. Iron wire has so low a resistance that it would probably be out of the question to get a sufficient amount of it into a disc stove of the size required, to furnish sufficient resistance. Moreover, iron wire oxidizes and disintegrates under repeated subjection to high temperatures. Neither iron nor German Silver are used to any extent in commercial appliances of the types suggested, but rather for testing apparatus where resistance only is required and high temperatures are not met.

M. E. FABER. *Consulting Engineer.*

Power Factor and Plant Capacity, Ans. Ques. No. 250.

Editor Southern Electrician:

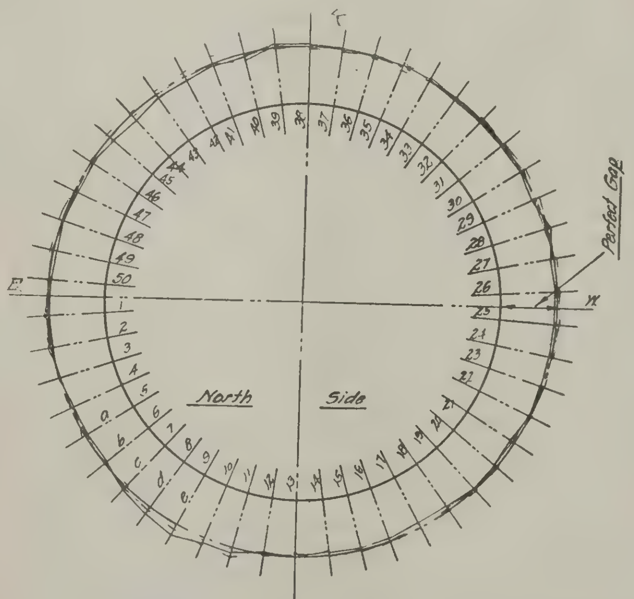
In reply to question 250: A low power factor means that for a given K. W. load more current will be required than if the power factor is at 90% or 100%. This in turn means a larger equipment for the same load and a poorer voltage regulation. There are other reasons, but this will fulfill the question.

JAS. E. KILROY.

An Airgap Recording System.

Editor Southern Electrician:

"In the well organized operating department, tests are regularly made upon the generating equipment, and a record of findings filed for reference. As the caption of this article would indicate, the accompanying offers a suggestion, which has proven thoroughly efficient by service, for recording results of generator, or motor, armature tests. The method is as simple as it is complete, and has great advantage over a tabulating system, and efforts expended in the plotting are many times repaid.



"The diagram shown is practically self-explanatory, it gives the results secured from the readings of three respective tests. A brief mention will suffice. The readings obtained from both sides of the armature at each particular pole, shown by the radial lines a, b, c, etc., are plotted from their respective poles, being based upon the perfect gap, which is noted in the Figure. Two diagrams represent a set, one for each side of the generator; the poles are numbered in order corresponding to the machine, and any portion where rubbing may take place is easily distinguishable.

L. R. W. ALLISON.

New Apparatus and Appliances.

Electric Dining Room Set.

Convenience and utility are combined in the six piece combination table set illustrated below, and offered by the Diamond Electric Company, of Binghamton, N. Y. This set consists of a small electric stove which is furnished with a six cup coffee percolator, tea kettle, saucepan and cover into which may be placed an extra dish, thereby making it a double boiler and a small egg holder which may be used in the single dish for boiling eggs. Each one of these utensils fit on the stove, so that they may not be easily knocked off, and are finished in either nickle or copper. The set is furnished with or without a three heat indicating snap switch, and is all ready to be attached to any electric light socket.

DELCO COMBINATION SET.

This Delco combination set has been adopted by several of the largest electric companies for a special holiday campaign. In considering the combination of very moderate price with the very high efficiency of the stove, it is bound to meet with universal approval.

Illuminated Billboards.

A new type of reflector for billboards, bulletins, walls and other non-illuminated signs of various description has recently been perfected by the Reynolds Electric Flasher Mfg. Co., of Chicago. The illustration herewith shows a sectional view of the reflector itself. This reflector, known as the RECO Mirror Reflector, materially differs from the average reflector in the following particulars: The shape is octagonal, which causes the light to be evenly diffused to every part of the sign or surface to be lighted. The interior is lined with mirror glass, which is known to be the most natural reflector, and which reflects all of the light from the lamp. Mirror glass was found to be superior in every respect to nameled or painted reflectors.

Since the advent of tungsten lamps, there has been a considerable movement in favor of illuminated sign boards; in fact, progressive advertisers are demanding lighted bulletins, claiming that more good advertising results are obtained in a few hours at night than during the entire day. The illuminated billboard serves a double purpose. One is that it permits night advertising, and the other advantage is that it helps light the sidewalk as well as street. The reflector described in this article is made of galvanized iron, thoroughly re-inforced, has a heavy weather-proof brass socket, and wherever used, enjoys unquestioned approval.

RECO MIRROR REFLECTOR.

Kellogg Plug Seat Switch.

Until recently all telephone plug switches were operated automatically by the cord weight when the plug was in place. It has been found by long experience that plug switches constructed according to this general practice have weak contacts, and require a considerable amount of spring adjustment and attention. The Kellogg Switchboard and Supply Co. have recently designed a new plug switch which differs very materially from the type previously used. When plug is returned to its seat, it is necessary for the operator to force it in place in order to operate the plug switch springs. This method of operating makes it possible to use stiff springs, and hence, as platinum is used, the contact obtained is as reliable as that of a switchboard key.

This plug switch is mounted in a vertical position, thus making it practically impossible for dust to collect on the contacts. As it occupies very little space, almost as many plug switches with associated plugs can be mounted upon a plug switch as is possible when plugs with ordinary plug seats are used. When a plug is forced into the plug switch, the sleeve of the plug makes contact with a metal roller, which in turn operates a small lever and closes or opens the plug switch contacts, depending upon the spring combination of the plug switch used.

This company has also devised a new magneto party line indicator, to be used on a standard Kellogg combined drop and jack, fitting around jack sleeve bushing. Indicator points are furnished in four colors, red, white, green and blue.

New Thordarson Transformers.

The Thordarson Electric Manufacturing Company, of 219 South Jefferson street, Chicago, Ill., have added to their line of low voltage alternating current transformers two new type toy transformers, to be known as 1A and 2A. These transformers as illustrated below are equipped with binding posts for low voltage connections and designed to meet the demand for a highly efficient, low priced transformer. These 1A and 2A transformers are identical in every respect to the standard No. 1 and 2, the only difference is in the way the secondary or low voltage terminals are made. The 1A has six secondary voltages and the 2A ten secondary voltages.

Toys and other miniature appliances that require less than 40 watts to operate, usually work as well on alternating current if the current is not over 60 cycle per second, as on battery current. The distinct advantage of low voltage toy transformers over dry cells or storage batteries for miniature apparatus is readily appreciated by the consumer. On a transformer there is nothing to wear out, for the reason that there is no moving parts. The transformer is assembled in a black enameld steel case and is embedded in a hard insulating compound, making the whole construction rigid and durable. With reasonable fair usage it will

THORDARSON TRANSFORMERS.

last a lifetime. As an investment nothing can be purchased for the money that covers as complete a field for study and experimenting for the boy as this little transformer. All transformers are equipped with a flexible connecting cord and attachment plug.

Pendant Shades.

A new article has recently been placed upon the market by the firm of Oscar O. Friedlænder, of 127 Duane Street, New York City, N. Y., which is a pretty decoration for either gas or electric light. This article is known as Pendant Shades, and consists of thin prisms which through their prismatic formation intensify the light. These shades can be purchased reasonably and manufacturers of gas and electric fixtures who are interested in this line, will find it to their interest to investigate them.

PENDANT SHADES.

A Selectively Operated Semaphore and Telephone Equipment.

Since the development of the telephone for train dispatching, a need has been felt for signaling equipment which could be used and operated in connection with a telephone train wire. That is, instead of having a selector on a telephone circuit ring a bell at a way station, it was required that it should throw a semaphore arm. The Western Electric Company, in conjunction with the Union Switch and Signal Company, has for some time been developing apparatus and its uses is here given.

ON STEAM RAILROADS.

Both steam and electric railroads offer an extensive field for use of this selectively operated semaphore in connection with the telephone system. On steam roads it will probably be used exclusively for train order work. In other words, it will be employed as an auxiliary to a regular telephone train dispatching system. When used in this way it will secure a still further saving than is now effected by the telephone.

ON ELECTRIC RAILWAYS.

Since electric railways are now approaching steam railroad practice, the selectively operated semaphore will enter prominently the electric railway field. The application of the semaphore, selector and telephone equipment combined in one piece of apparatus for this class of service is obvious. Their use in this field cannot fail to facilitate the movement of trains and introduce many economies in the handling of traffic. The semaphore can in many places be used as an auxiliary to the regular dispatching system, as it can be located at sidings or at points where the expense of a station and operators is not warranted. It thus forms a safeguard to the system that does not include the human factor. It can also, of course, be used in conjunction with way stations for this same purpose, permitting the dispatcher to throw a signal to "stop" if he, for any reason, cannot reach the operator he desires.

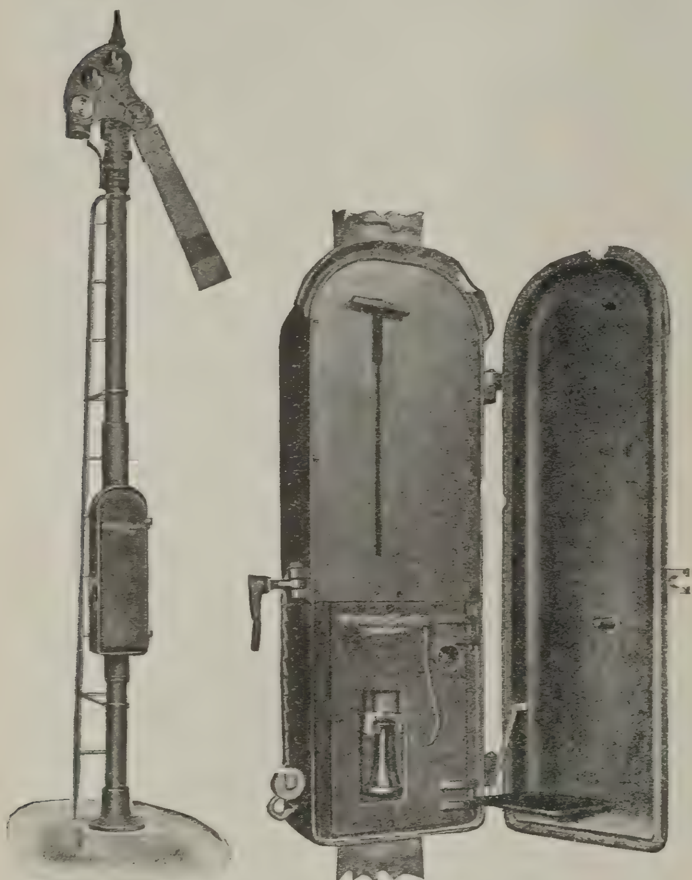
GENERAL DESCRIPTION.

In Fig. 1 the new Western Electric Semaphore is shown complete. The semaphore proper is of standard make and can be furnished in either the upper or lower quadrant types, as desired. A three spectacle casting is provided. The semaphore, selector and telephone equipment are all mounted on the same iron post, and the apparatus is self-contained. The weather-proof box is locked, so that access is obtainable to it only by means of keys which would be furnished to the proper parties. The semaphore blade itself can be furnished of any type or shape desired to conform to the practice of the railroad buying the equipment.

The pole casting contains signal mechanism the telephone and selector equipment. The signal mechanism is of the electrically operated type, but is manually restored. The relay operating this is normally de-energized, and ten dry cells are required for its operation. As this relay will operate on four cells, it is obvious that an ample margin of operation is allowed.

The signal mechanism proper is contained in the compartment at the top of the casting. The only part of this which appears on the surface of the inside door is the handle of the restoring lever. The selector and terminals are readily accessible for maintenance purposes.

One important feature of the selectively operated semaphore is the fact that it gives to the dispatcher an answer back which cannot be mistaken, telling him that one particular semaphore has completed its movement and is at the "stop" position at the time the answer-back signal is received.

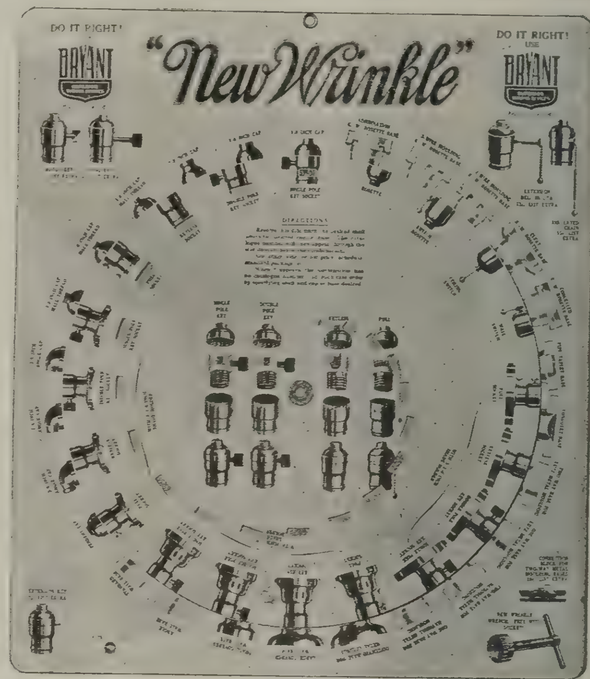


TELEPHONE AND SIGNAL APPARATUS FOR STEAM AND ELECTRIC RAILROADS.

The circuit arrangements of the signaling equipment above described are very similar to the standard train dispatching circuit. The dispatcher operates selector keys in the same manner; instead, however, of a bell ringing at the point called, the semaphore blade moves to "Stop." The answer-back signal returns to the dispatcher clearly and distinctly and then it waits for the crew of the train so signalled to call in. Should he be disconnected from the circuit for any reason the crew can easily call him, but ordinarily operating practice does not require this. Only one pair of wires are needed to extend along the line. As many sets as may be desired can be connected to this circuit, and it is used both for talking and signaling. All equipment is bridged directly across the circuit, and any piece of apparatus can be taken off the line without affecting the rest of the equipment.

Bryant Electric's New Wrinkle.

One of the most ingenious cataloging and advertising schemes for sockets, switches, and interchangeable parts must be credited to the Bryant Electric Company, and particularly to Mr. F. V. Burton, sales manager of the company, originator of the scheme. The accompanying illustration shows the nature of the device. The dimensions of the card are twelve by fourteen inches, with a ten-inch revolving disk, all made of heavy cardboard. On the disk as shown are printed 20 types of shells on the square card 26 types of caps and bases. By revolving the disk, therefore, a combination of 520 complete units can be made and the ordering or catalogue number found from reading the number in the slot of the disk under the unit considered.



BRYANT ELECTRIC NEW WRINKLE.

This device is not only unique, it is useful, takes up little room and can be manipulated with much more intelligence and ease than any catalogue or price list. It should appeal to electrical jobbers and contractors as well as others who handle this line of electrical equipment.

Battery Charging and Generator Panel for Small Gasoline Electric Generator Sets.

In coutry homes and clubs and on farms where central station current is not available the gasolene engine electric generating sets with storage battery equipment have come into extensive use. On the farm the engine has been used for power purposes for sometime. The addition of a generator and battery with battery charging panel provides current for lights at night when the engine is not usually run.

BATTERY CHARGING AND GENERATOR PANEL.

Particularly for this kind of service the Cutler-Hammer Manufacturing Company of Milwaukee has recently put on the market an inexpensive and compact combination battery charging and generator panel. The upper part of this panel carries the terminals, voltmeter, ammeter, voltmeter switch and generator field rheostat, the handle of which is mounted on front of the board. The lower section carries a 4-pole double throw battery switch, a generator switch, low-current cut-out (for batteries) and the necessary fuses. By means of the voltmeter switch the voltage of either half of the battery when charging, the total voltage on discharge or the generator voltage when the main switch is closed can be read. The low-current cut-out provided prevents discharging of battery back into the generator, should the current fail after voltage is adjusted.

NEW SEPARABLE ATTACHMENT PLUG.

The newest addition to the Cutler-Hammer line of specialties is a separable attachment plug, recently developed. Where attachment plugs are used with lighting fixtures considerable side strain is put on the fixture, because the cap of the ordinary separable attachment plug will not separate except when pulled straight out from the base. This new plug has an effective locking arrangement to hold the cap in place but separation can also be effected by pulling in any direction. This prevents the injurious side strain on the fixtures. The area of contact provided is large and

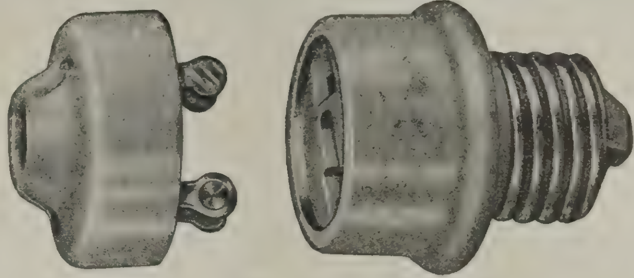


FIG. 2. NEW ATTACHMENT PLUG.

the screw shell is securely attached to the porcelain by two screws so as not to be pulled off through carelessness in screwing the plug into the socket or receptacle too tightly, as in the case where only one screw or rivet is used. The rating is 660 watts, 250 volts.

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.

ANNISTON. As reported in the November issue, considerable activity is reported in regard to street lighting in Anniston. It is now understood that this activity has extended to Blue Mountain City, a town on the outskirts of Anniston, and that energy for lighting the streets and residences of this city will be supplied by the Anniston Electric & Gas Co.

BIRMINGHAM. As recently reported it is now the plans of the Birmingham, Ensley and Bessemer Railway Company to erect a power plant for the purpose of operating an electric railway from East Lake to Ensley.

COLUMBIA. A contract has been made between the city of Columbia and the Omussee Light & Power Company to supply electricity for lighting the streets and residences in Columbia. A 24-hour service will be rendered by the company from the water power development at the falls of Wood Mill on Omussee Creek, three miles from the city. Reports further state that the bonding company has for its purpose the purchase and developing of the entire power available at that site for the purpose of generating electricity to be transmitted to Columbia, Dothan, Lakeley, Georgia, and other places.

HORTSBORO. It is understood that the J. B. McCrary Company of Atlanta has been engaged as consulting engineer in connection with the establishment and construction of an electric light plant.

MULDRO. F. R. Stone, of Lima, Ohio, has secured the contract for the construction of the combined electric light plant and water works pumping station for the city. The cost will be something over $26,000.

PIEDMONT. As reported in the last issue, the electric light plant for which $25,000 in bonds has been voted, will be erected on the site recently purchased by the city. It is understood that the cost of the plant and extensions to the water works systems will amount to $20,000. The street lighting system will consist of 65 lamps, and it is expected that both systems will be completed about the first of the year.

TROY. The contract for the construction of a dam across the Pea River at Elba, has been awarded by the Pea River Power Co. It is expected that 2000 h. p. will be developed and electricity transmitted to Troy, Dothan and Elba.

ARIZONA.

CROWN KING. Plans are being considered by the Arizona Power Company for the extension of a transmission line to Crown King and Portland Junction. The manager of the company isM. C. Watson of Preston.

DOUGLAS. The Douglas Improvement Company plans the enlarging of its power plant and the erection of a transmission line through the surrounding country for the purpose of supplying electrical energy for pumping and irrigation purposes.

PHOENIX. The recently incorporated Arizona Construction & Finance Company contemplates the construction of an electric railway. The incorporators are R. A. Lewis, W. B. Barr, and S. C. Dunlan.

TUCSON. Plans are being considered for the erection of a central electric plant for the Hart Range near Shawnrita to supply electricity for pumping purposes. The engineers are Deitrich & Goetz, of Tucson, Ariz.

FLORIDA.

CALARSVILLE. Reports state that the Edge Dowling Lumber Company will install an electric plant and erect a large factory. The manager is J. Ray Arnold.

MADISON. Arrangements have been made by the city council for the purchase of the local electric light plant owned by the Madison Electric Power Company. The consideration it is understood is $30,000 for the plant, payable at the end of twenty years.

PALM BEACH. It is understood that the Palm Beach, Okeechobee & Western Railway Company has made application for a charter to build a 140-mile electric railway from Palm Beach, west to the Southern shore of Lake Okeechobee. It is further understood that the power station will be built at Palm Beach and another at the South of the lake. The incorporators are R. J. Martin, W. W. Marquis, and John Matthews.

ST. AUGUSTINE. The plant and holdings of the St. John's Light & Power Company have been purchased by the Inter-City Securities Company at a consideration of $180,000. The plant will be operated as at present.

WEST VEOLA. The Board of Commissioners desires to obtain prices for a full equipment suitable for an electric plant. W. J. Lamb of the Board of Commissioners, Improvement District No. 3, can give information.

WINTER HAVEN. Plans are now under way for the installation of an electric light system in this place.

GEORGIA.

ATLANTA. The recently formed company known as the Georgia Railway & Power Company of Atlanta, has purchased the property of the Savannah River Power Company, of Anderson, S. C. The consideration is $1,500,000. This company has applied to the Georgia Railroad Commission for permission to issue $30,000,000 in bonds and $37,000,000 in capital stock.

The president of the Georgia Railway & Power Company is Charles McGee, of Toronto, Canada.

AUGUSTA. According to recent statements the Great White Way proposition for Augusta, is well under way. It is understood that the system will be erected on Broad Street and consist of 44 standards, each carrying two lamps.

ELBERTON. It is understood that the Elberton Eastern Railway Company will soon award contracts for the construction of a railway between Elberton, Tignall and Washington.

FAIRBURN. The construction of an electric light plant for which bonds to the extent of $10,000 have been issued, has been awarded by contract to the J. B. McCrary Company of Atlanta, Ga.

MANCHESTER. An election will soon be called by the Manchester Commercial Club to vote on the proposition of issuing bonds to install a municipal electric light plant.

MARSHALLVILLE. On account of a contract made between the City Council and J. C. Walker, of Marshallville, a stock company capitalized at $40,000 will be organized to construct a plant and furnish the town with water and electricity for street lighting.

PERRY. The city has contracted to purchase electrical energy for an electric light system from J. H. and J. A. Davis of Lakeside. The electrical energy will be transmitted to the city and then connected to its system through a substation.

ROYSTON. It is understood that J. J. Roberts is planning to establish an electric light plant to supply power and lighting for surrounding towns.

SAVANNAH. The Savannah Electric Company has received a franchise from the city to extend its tracks in Savannah.

WASHINGTON. The city has purchased the site on which to erect a municipal electric light plant to cost about $25,000. It is understood that the contracts for the construction of the plant have not yet been awarded.

KENTUCKY.

COVINGTON. It is understood that the Chesapeake and Ohio Railroad Company are making arrangements for the construction of a new power station at Covington. The cost of such a station will be about $15,000 and the plant will supply electrical energy for operating the Chesapeake and Ohio railway electrical systems.

FALMOUTH. A bond issue of $7,500 was voted Nov. 7, for an electric light plant. Mayor N. C. Ridgway can give information.

HICKMAN. The Kentucky Southwestern Railway, Light & Power Company is making a preliminary survey for a proposed electrical railway between Paducah, Ky., and Union City, Tenn.

MILLERSBURG. The installation of a municipal electric light plant in Millersburg is being planned.

PIKEVILLE. A controlling interest in the Mountain Water Company has been purchased by Huffman & Call, and improvements are contemplated.

SUMMERSET. The United Water & Light Company plans the installation of an additional engine in its electric light plant. The need for additional machinery is caused by the rapid increase in business making it necessary to run the present apparatus over load.

WILLIAMSBURG. H. M. Byllesby & Co., of Chicago, is having a survey made of the Cumberland Falls on the Cumberland River near Williamsburg. It is understood that this company proposes to erect a hydro-electric plant should developments show up favorably.

WHITESBURG. An electric light plant is under consideration for Whitesburg. It is undertsood that Jasper Bowens, of Polly, is interested.

LOUISIANA.

GLIDDEN. The installation of a municipal electric light plant is reported to be under consideration for Glidden.

MONROE. The city has recently voted to extend the electric light system.

NEW ORLEANS. The El Salto Power Company has been incorporated with a capital stock of $300,000 by G. M. Lemann and David W. Pikes.

SHREVEPORT. The item published in the November issue stating that the city had voted on a bond issue for the erection of a municipal electric light plant was incorrect in that the voters defeated the proposition to issue bonds at the special election held October 17th. On October 20th at a special election the contract between the city commissioners and the electric light and power company, for lighting the streets of the city for 3 to 6 years, was approved. Under the terms of the contract the company is to supply arc lamps at $62.50 each per year, which is $12.50 per lamp less than the city is paying under the present contract. Further than reducing the price of the service the company agree to install over 60 lamps additional and supply the electrical energy to light the city hall free of charge.

NORTH CAROLINA.

AZALEA. The Azalea Wood Working Company is in the market for a generator and a Corliss Engine.

ENFIELD. Bids will be received by the mayor and commissioners until December 6th for the construction of an electric light plant. The engineer is C. E. Fairbanks, of 417 American National Bank Bldg., Richmond, Va.

MORGANTOWN. Franchise has been granted H. L. Milner to install an electric light system in Morgantown.

MARSHALL. Articles of incorporation have been filed for the Madison Light & Power Company, with a capital stock of $10,000 by J. H. White and others.

SANFORD. According to reports the Carolina Light & Power Company is to install additional machinery in its plant, including transformers and lightning arresters. The president of the company is C. E. Johnson, of Raleigh, N. C.

SELMA. It is understood that the city is soon to open bids for a 60 H. P. boiler and a 60 H. P. engine, a 50 K. W. three phase generator and switchboard, electric wires and equipment. Information can be secured from M. C. Winston.

SOUTH CAROLINA.

CAMDEN. The Camden Water & Light Company has filed articles of incorporation with a capital stock of $70,000. The incorporators are H. G. Garrison, W. M. Shannon, of Camden, S. C., E. G. Brainard of Chicago, Ill.

EDGEFIELD. Contract has been awarded the J. B. McCrary Company of Atlanta, Ga., to construct an electric light plant in Edgefield to cost approximately $14,000.

SUMMERVILLE. The mayor has been authorized by the city council to enter in a contract with the Augusta-Aiken Railway Corporation for electrical energy to supply a street lighting system. It is understood that two thousand tungsten lamps of 60 candle power and about ten arc lamps will be operated. The town is to be rewired throughout, and work will begin in the near future.

TENNESSEE.

CHATTANOOGA. The Loomis and Hart Furniture Company is erecting a furniture factory to take the place of the one destroyed by fire some months ago. The company is now in the market for boilers, electrical equipment, including motors, and wood working machinery. The information can be obtained from the factory manager, J. D. Gahagan.

CHATTANOOGA. The Eastern Tennessee Power Company which is erecting a large power plant on the Ocoee River near Parksville, Tenn., expect to be ready to supply electrical energy in Chattanooga and Knoxville, Tenn., about the first of the year.

CHATTANOOGA. It is reported that the city is contemplating the installation of conduit systems to be rented to public service corporations having wires in the streets.

JOHNSON CITY. The Hice Mfg. Company is building a new power plant for the operation of its mill.

KNOXVILLE. An application has been filed for a charter for the Knoxville Light & Power Company. The company will be capitalized at $500,000 and proposes to control the energy generated by the Eastern Tennessee Power Company.

NASHVILLE. It is understood that the Nashville Armature Works of Nashville is in the market for three 100 H. P. 60 cycle, 110 volt A. C. motors. Also a 40 K. W., D. C. generator, belt driven, 110 volts.

PULASKI. Plans are underway for the rebuilding of the municipal electric light plant, and bids will soon be asked for.

TEXAS.

BROWNSVILLE. Bonds to the extent of $50,000 have been authorized for the purpose of improving a municipal electric light and water works system.

DALLAS. A great white way system for the main street of Dallas is being planned.

GALVESTON. Late reports state that the plant and holdings of the Brush Electric & Power Company, Galveston, Texas, have been purchased by the Newman Interest of New Orleans, La. The consideration is said to be between $750,000 and $800,000.

GIDDINGS. The Giddings Creamery Company has changed its name to the Giddings Creamery, Ice & Mfg. Co., and are recapitalized at $20,000. The plans are to operate an electric light plant in connection with the ice and cold storage business.

HAMLIN. The Hamlin Electric Light, Heat & Power Company has been incorporated with a capital stock of $10,000 by W. W. Johnson, W. Whaley and A. J. Knight.

HARLINGES. It is understood that the city will construct an electric light plant and water works. A bond issue of $32,000 which has recently been voted, the Mayor A. W. Cunningham, and can give other information.

Indicating Fuses that really indicate mean

"ARKLESS"

Mechanical Indicator

It sticks out "like a sore thumb"

¶ Every "ARKLESS" fuse is guaranteed to indicate and does away with testing circuits and hunting around for the blown fuse.

¶ A handsomely illustrated catalogue is just issued.

Detroit Fuse & Mfg. Co.

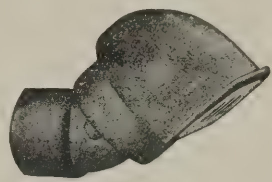
Detroit - - - Michigan

L. M. ROBERTSON, Southern Sales Agent
1312-1314 EMPIRE BUILDING
BIRMINGHAM, ALA.

Weather Proof this Position.

THE SECRET
OF THE
G. V. UNIVERSAL
IS HERE

The coupling turned half way around gives another form such as would be wanted for a horizontal conduit or a conduit laying on a wall just enough offset to carry wires into switch or cut-out. Listed with approved fittings.



Weather Proof this Position.

Write L. M. ROBERTSON, Birmingham, Ala., or

THE GILLETTE-VIBBER CO.
NEW LONDON, CONNECTICUT.

PITTSBURG STANDARD
ENAMELED
CONDUIT
WITH
CLEAN
RUST-PROOF
THREADS

ENAMELED METALS CO.

PITTSBURG, PA.

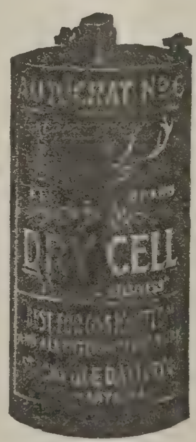
PITTSBURG OFFICE, 61 BRIDGE STREET, ETNA.

Mills at Etna, Pa. Bell Phone, 155 Sharpsburg

L. M. ROBERTSON, Southern Sales Agent,
1312-1314 EMPIRE BUILDING
BIRMINGHAM, ALA.

Autocrat Dry Cell

America's Standard for Gas Ignition



Do you realize that the initial cost of a battery is the smallest consideration in the purchase of dry cells?

You buy batteries for the service they will render and the price of the battery to you, depends upon the length of the service. If you want Quality and long life you will ALWAYS USE AMERICA'S STANDARD—THE AUTOCRAT.

This Dry cell has attained its present popularity through QUALITY alone, and QUALITY means SERVICE.

Make your wants known and we will tell you exactly what the AUTOCRAT BATTERY will do for you.

Stackpole Battery Co.,

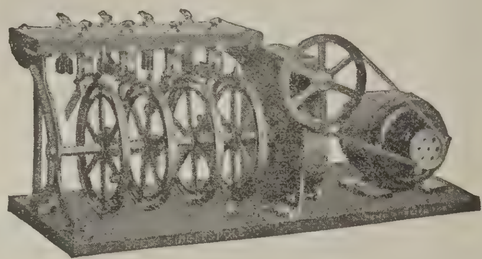
St. Mary's, Pa.

L. M. Robertson, Southern Sales Agent
1312-1314 Empire Building, BIRMINGHAM, ALA.

RECO FLASHERS

For Electric Signs and Displays.

Simple; Strong; Durable; roller bearings; adjustable for speed and various effects.



Secure our Illustrated Bulletins, Showing our immense line of Flashers, also Sign suggestions.

Reynolds Electric Flasher Mfg. Co.

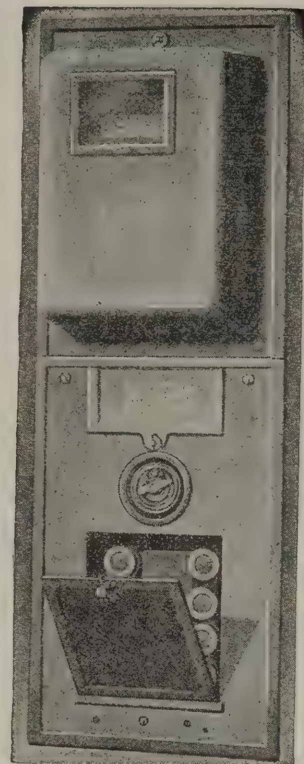
Largest Manufacturers of Flashers in the World.

Also Manufacturers of

Billboard Reflectors, Time Clocks, Transformers nnd Window Displays.

617-631 W. Jackson Blvd. CHICAGO.

1123 Broadway, NEW YORK.



WURDACK

Safety Cabinet

Designed especially to give residences, flats and apartment houses the same effective protection afforded larger installations by the use of panel-board distribution.

The Wurdack Safety Cabinet consists of a small special cabinet contained in a sheet iron fireproof cabinet with space provided for the installation of the current measuring meter in this cabinet. The upper half contains the meter, the lower half has a door covering the main fuses which may be sealed thus preventing tampering with fuses by unauthorized persons. A door over branch fuses is held by a catch, making it accessible to anyone. The cabinet is furnished in black enamel and is provided with a sufficient number of knockouts in the box to permit necessary connections with either ¼ inch loom or ½ inch pipe on branch circuits and ¾ inch pipe on entrance.

Send name and address for Bulletins.

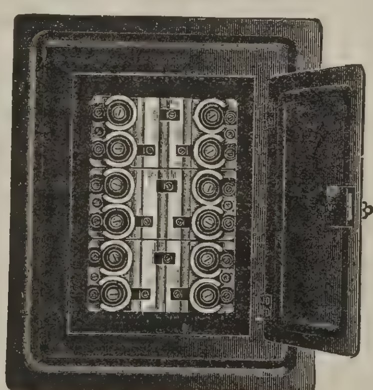
WM. WURDACK ELECTRIC MANUFACTURING CO.

Manufacturers of Switchboards, Panel-Boards, Cabinets, etc.

ST. LOUIS, MO.

Star Metal Box Co.,

201 Fulton Street, NEW YORK, N. Y.



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—Manufacturers of—

STEEL CUT-OUT AND PANEL BOXES KICK PLATES AND SPECIALTIES.

FOR PROMPT DELIVERIES AND LOWEST PRICES

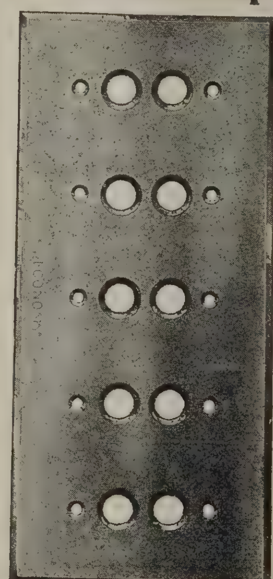
CALL ON US.

Write for Catalogue "D" for full information and description.

E-C-O-N-O-M-Y

Sensible Struck Up Plates

ALL FINISHES



ONE TO FIVE-GANG

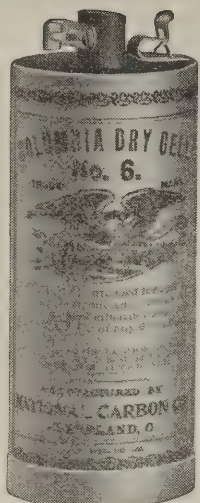
WE ARE THE ONLY MAKERS OF FOUR AND FIVE GANG STRUCK UP PLATES.

THERE'S A REASON

Better get prices before buying elsewhere.
Our facilities for Manufacturing are unlimited.
Largest Presses on Earth. Tools and Dies made to Order.

THE ECONOMY SWITCHBOX & MFG. CO.

5305-7-11 Sweeney Ave., Cleveland, Ohio.



COLUMBIA DRY CELL

"A Recognized World Leader."

Many claim superiority. Only one can lead. Columbia does lead and has done so for many years. Best material, longest life, lowest cost in the end, and most satisfactory service given have all lent their part in accomplishing this leadership.

Columbia is particularly adapted to all forms of open circuit service. On telephones, door bells, alarms, signals, buzzers, electrical clocks and toys it has no equal. Try a set to prove these statements. You cannot lose, for we stand back of every cell.

Get Columbia from your Dealer or Address S. E. —11

NATIONAL CARBON COMPANY

Cleveland
Sixth City

KLEIN TOOLS
EST. 1857
TRADE REG. MARK

TRIED OUT TEN YEARS

Pronounced Satisfactory **Wants More**

Looking through an electrical magazine, I notice your ad. of M. KLEIN & SONS tools and as I am a user of M. KLEIN & SONS tools only, I am interested in that line. I have now a good assortment of tools, but as there are a few articles that I would like to have yet, I would appreciate your kindness if you would send me one of your tool catalogues. I have now, as near as I can remember, about $90.00 worth of your tools, and can recommend them to anyone at any time, as I have been using them now for about ten years.

Hoping to hear from you soon, I am sincerely your friend and a booster of M. KLEIN & SONS tools.

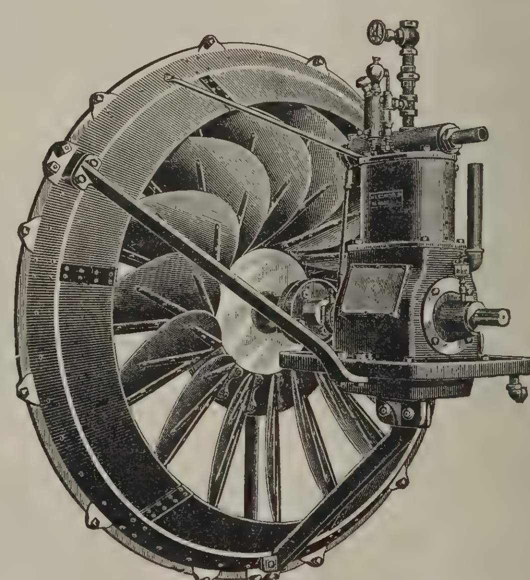
GEO. WILLIAMS.

MATHIAS KLEIN & SONS

Station U, Chicago, Ill.

FANS

ALL SIZES. 18 inches in diameter up to 240 inches for ALL KINDS of HARD WORK.



Direct Connected

Steam Fans
Electric Fans
Water Motor Fans
Steam Turbine Fans

BELTED FANS IN FOUR HUNDRED STYLES AND SIZES.
TELL ME YOUR REQUIREMENTS AND I WILL MAKE YOU A LOW PRICE ON A FAN THAT WILL DO YOUR WORK.

JAMES M. SEYMOUR, JR.,
51-53 Lawrence Street,
Newark, New Jersey.

J.P.Co. REG. IN U.S. NOARK PAT. OFF. FUSE

J.P.Co. REG. IN U.S. NOARK PAT. OFF. FUSE

Buy "NOARK" Fuses and Be Safe

These well known fuses are the result of years of pains-taking work in the producing of a perfect fuse.

"NOARK" FUSES

are the standard by which others are judged.

Made to suit every conceivable condition and with contacts designed for voltages in all ampere capacities. These are of the enclosed type and operate as the name implies---with "no-arc" or flash.

The tubes are made of the highest grade of selected fibre, and end ferrules are securely fastened to them.

We "spot" the label of every fuse so that you can spot the fuse that's blown.

Specify "Noark" Fuses and protect your circuits.

Write nearest branch for Booklet.

H. W. JOHNS-MANVILLE CO.

Manufacturers of Asbestos and Magnesia Products **ASBESTOS** Asbestos Roofings, Packings Electrical Supplies, Etc.

Baltimore, Boston, Chicago, Cleveland, Dallas, Detroit, Kansas City, Los Angeles, Milwaukee, Minneapolis, New Orleans, New York, Omaha, Philadelphia, Pittsburgh, San Francisco, Seattle, St. Louis

1199

NEW WAREHOUSE NECESSARY

The establishment of the Kellogg Switchboard and Supply Company's Kansas City office in its new building on the first of the coming November, marks another stage in the advancement of Kellogg's high grade equipment in the telephone field.

The new building will provide six times the floor space now occupied. Telephones and switchboards complete will be carried together with a large and complete stock of construction and supply material, all located on track.

Five years ago the Kellogg Company opened the present Kansas City office with the intention of handling only telephone and switchboard apparatus but as construction material and supplies were so much in demand in addition to the regular telephone apparatus, the new building is now very necessary.

Telephone companies in the South and Southwest should realize and appreciate the Kellogg Company's confidence in their territory and the stability of the independent telephone business.

This new institution, with its complete stock of telephone equipment, is capable of serving its patrons with promptness and dispatch—and—with the best and most satisfactory apparatus on the market.

"BEST SHIPPING FACILITIES."

KELLOGG SWITCHBOARD & SUPPLY CO.

Chicago

Kansas City, Mo. San Francisco, Cal.

Talk About

MR. GLANCY

and

The Marquette

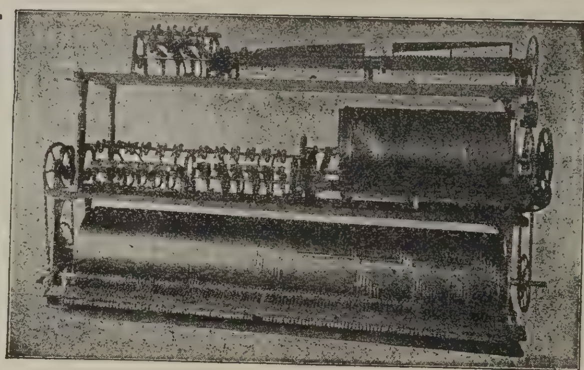
The Original First-class Popular Price Hotel in America, 400 Rooms, at

ST. LOUIS, MO.

A Hotel for your Mother, Wife and Sister.

Builders of the Largest Flasher in the World

This machine operates the large spectacular "Fair" sign located in Chicago and is the largest flasher ever constructed



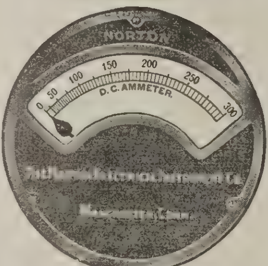
90% of the large spectacular signs throughout the country are operated with our flashers

Nothing too large or too small for us

Reynolds Dull Flasher Co.

16-18 5th Avenue, Chicago

NORTON



VOLTMETERS

—AND—

AMMETERS

FOR A. C. & D. C. CIRCUITS

THE NORTON ELEC'L INST. CO. MANCHESTER, CONN.

ANTI-CORROSIVE CYLINDER OIL

TRY A BARREL FOR 60 DAYS.

If it does not come up to your standard of what a good lubricating oil should be, and you consider that it is not worth our price---put your own value on it and remit on that basis. Isn't that a fair proposition? "A. C. C." will pare down your oil and cylinder repair bills ---save your piston packing, too. It has been doing this for forty years, it will effect such a saving now---just give "A. A. C." a chance.

May we go into the subject with you?

ANTI-CORROSIVE CYLINDER OIL MANUFACTURED ONLY BY E. H. KELLOGG & CO. 243 244 SOUTH ST. NEW YORK, U.S.A.

E. H. KELLOGG & CO. 243 SOUTH ST. NEW YORK, N.Y.

You can SAVE MONEY by using

The "DAUM" Refillable Cartridge Fuse Shells

FOR ELECTRIC LIGHT AND POWER CIRCUITS

All Sizes N. E. Code Standard

The only Fuse on the market that can be inspected and refilled (with tested fuse wire) without tools. Some shells have been blown 25 times, and are still on the job. "We have the goods." Used by some of the largest railroads and industrial corporations in the United States and Canada. Why not cut your fuse expense? If not satisfactory, return. Send for booklets and samples.

A. F. DAUM CO.

Pittsburg, Pa.

BOOK REVIEWS.

DIRECT AND ALTERNATING CURRENT MANUAL, WITH DIRECTIONS FOR TESTING, AND A DISCUSSION OF THE THEORY OF ELECTRICAL APPARATUS. By Frederick Bedell, Ph. D. Published by D. Van Nostrand Co., New York City, second edition revised and enlarged, 360 pages, Ills. Price $2.00. While this manual was originally prepared for students, the completeness of the series of tests given in it, for both direct and alternating current apparatus, has made it a practical and useful work to all connected with electrical testing. The long and successful experience of the author as a teacher of advanced electrical engineering, and the breadth of viewpoint which he has acquired through careful research and directing commercial tests, has enabled him to incorporate in this work, material in such form as to be of ready benefit to any one soliciting definite information and authoritative methods on which questions of doubt may be settled. While no attempt has been made to make the work exhaustive, so many references are made to standard and reliable works from which the details may be obtained, that it is especially valuable on this account. This is not a volume filled with elementary matter and detailed directions that the average tester knows, but arranged in such a way as to help him interpret and draw the correct conclusions from his data. The subjects treated are: Direct current generators; direct current motors; synchronous alternators; single-phase currents; transformers; polyphase currents; phase changes and potential regulators; induction motors; frequency changers and induction generators; synchronous machines; wave analysis.

REVISED EDITION OF NATIONAL ELECTRICAL CODE. The changes made in the rules for installation as presented in the 1909 edition are especially worthy of careful study since there has been an evident tendency to make the rulings definite and eliminate the non-important requirements. Many of the rules have been given new numbers so that those readers who recognize such by the number should become familiar with the changes. It is to be remembered that the rules as now issued are recommended by the National Fire Protection Association, which association has taken over the work of the Underwriters National Electric Association and that of the National Conference.

Alphabetical Index to Advertisers.

HAND-BOOK OF WIRELESS TELEGRAPHY, ITS THEORY AND PRACTICE. By James Erskine-Murray, D. Sc. Published by D. Van Nostrand Co., New York City, third edition revised and enlarged, 388 pages, 180 illustrations. Price $3.50.

This work is written for the use of electrical engineers, students, and operators, and as a manual for these readers, it is most complete and instructive. The third edition has been found necessary from the rapid progress in the subject treated. The revision has been most thorough and the volume now stands as an up-to-date and authoritative treatise.

THE COPPER HANDBOOK, edited and published by Horace J. Stevens, Houghton, Mich. Price in green buckram binding, $5.00; in full library morocco, $7.50.

The tenth annual edition of the Copper Handbook has just been received. This standard authority on copper and copper mines for the entire globe, possesses its usual valuable characteristics and presents the vital data in a manner that bespeaks the author's wide acquaintance with the subject and the information at his command. The volume contains 1902 pages and lists and describes 8,130 copper mines and companies. In addition to this material there are 24 miscellaneous chapters in the book treating the subject of copper from all possible viewpoints, there being chapters on the history, chemistry, mineralogy, metallurgy, brands and grades, alloys and substitutes for copper, with a copious glossary, and a chapter of statistics ending the book that contains 40-odd tables, thoroughly covering copper production, consumption, movements, prices, dividends, etc. The Copper Handbook is sold on the unique plan adopted nine years ago, the publisher sending the book by mail, prepaid, to any address ordered, without advance payment of any sort, and subject to return after a week's inspection.

PERSONALS.

MR. F. X. CLEARY has resigned his position as Advertising Manager for the Western Electric Company, to engage in special advertising and sales promotion service. Mr. Cleary's long service as salesman, sales manager and advertising manager has given him a wide experience and acquaintanceship in the electrical field, which will continue to be his line of future effort. Mr. P. L. Thomson, formerly manager of the Western Electric Company's Pittsburgh house, has been appointed Advertising Manager.

MR. ALBERT SCHEIBLE, of 17 N. LaSalle St., Chicago, is devoting his time to a novel phase of the rapidly expanding scope of engineering. The title of "Research Engineer" has been adopted by Mr. Scheible who makes a specialty of reporting to manufacturers and inventors on manufacturing and inventive problems. Besides having had long practical experience in developing crude ideas into finished devices that were not only patentable, but easy of manufacture and commercially profitable, Mr. Scheible is familiar with the practice of European manufacturers which so often offers valuable suggestions for those interested in devising or manufacturing up-to-date articles. In view of the great waste of time and money in duplicating steps which have already been tried abroad, or which are not new in other lines, the new class of engineering in which he is the pioneer ought to fill a decided need and one by which some of our progressive Southern manufacturers may want to profit.

MR. J. M. KLINGELSMITH, formerly connected with the Lansden Company, of Newark, New Jersey, and lately in charge of the electric truck department of the Anderson Electric Car Company, of Chicago, has been appointed Western Representative of the Edison Storage Battery Company, with headquarters in the People's Gas & Coke Company building, Chicago, Illinois.

INDUSTRIAL ITEMS.

THE BYCK ELECTRIC SUPPLY CO., of Waycross, Georgia, has secured the contract for electrical work to be installed in the Bunn building in that city. The building is to be six story, fire proof and modern in all particulars. Telephones are to be installed in every office, also elevator service.

THE ESTERLINE COMPANY, of LaFayette, Indiana, manufacturers of the Esterline graphic meter and the Berdon Electric Lighting System for motor vehicles, announces the appointment of the following sales representatives. These concerns will handle a complete line of Esterline Company's product in the cities named, and will give the company's customers technical service of every kind and character. New York City—Mr. Mortimer L. Newman, 114 Liberty St.; Atlanta—The Automobile Specialties Co., 222-224 Peachtree St.; lanta, Ga.—The Automobile Specialties Co., 222-224 Peachtree St.; Denver, Col.—Western Engineering & Specialties Company, 1732 Glenarm St.; San Francisco, Cal.—The Symonds-Berle-Kirkpatrick Company; Los Angeles, Cal.—The Symonds-Berle-Kirkpatrick Company; Cleveland, Ohio—Chas. F. Saenger & Company, 210 Electric Building; Boston, Mass.—The Standard Engineering Company, 53 State Street; New Haven, Conn.—The Standard Engineering Company, 810½ Chapel St.; Waterbury, Conn.—The Standard Engineering Company, 16 East Main Street.

CLASSIFIED INDEX TO ADVERTISERS.

Air Compressors.
Allis-Chalmers Co.
Janette Mfg. Co.
Leiman Bros.

Alarms.
Western Electric Co.

Armatures—Repaired.
Chattanooga Armature Wks.
Oliver Electric & Machine Co.
Selman H. & P. Co.

Ammeters and Voltmeters.
Dongan Electric Co.
Norton Electrical Inst Co.
Westinghouse El. & Mfg. Co.
Weston Electrical Instrument Co.

Anchors—Screw.
Klein & Sons, Mathias.

Automobile Accessories.
National Elec. Supply Co.
Providence El. Mfg. Co.

Batteries—Dry.
American Carbon & Battery Co.
Johns-Manville Co., H. W.
National Carbon Co.
Nungesser Elect. Battery Co.
Providence El. Mfg. Co.
Southern-Wesco Supply Co.
Speer Carbon Co.
Western Electric Co.

Batteries—Autocells.
American Carbon & Battery Co.
Baltimore Electrical Supply Co.
National Carbon Co.
Providence El. Mfg. Co.

Battery Connectors.
National Carbon Co.
Baltimore Electrical Supply Co.

Batteries—Storage.
Cosmos Elec. Co.
Electric Storage Battery Co.
National Carbon Co.

Bell Ringer.
Mohawk Elec. Co.
Rippell Electric Co.
Thordarson Elec. Co.

Binding Posts.
Cohen & Co., S. M.

Boilers—Repaired
Alabama Boiler Works.

Boxes—Cutout
Frank Adam Electric Co.
Chicago Fuse Mfg. Co.
Columbia Metal Box Co.
Economy Switch Box Co.
Star Metal Box Co.

Boxes—Meter.
Frank Adam Electric Co.
Hart Manufacturing Co.

Boxes—Outlet.
Frank Adam Electric Co.
Chicago Fuse Mfg. Co.
Columbia Metal Box Co.
Cutter Co., The George.
Economy Switch Box Co.
Johns-Manville Co., H. W. Co.
Star Metal Box Co.

Brushes—Motors and Generators.
American Carbon & Battery Co.
Baylis Company.
Cutler-Hammer Mfg. Co.
Dixon Crucible Co.
Holmes Fibre-Graphite Mfg. Co.
Speer Carbon Co.
Stackpole Carbon Co.

Cable—Aerial Power.
American Electric Works.
Bay State Insulated Wire & Cable Co.
Electric Cable Co.
Indiana Rubber & Insulated Wire Co.
National India Rubber Co.
Okonite Company., The
Simplex Electric Co.

Cable Connectors.
Dossert & Co.

Cable—Telephone.
Bay State Insulated Wire & Cable Co.
Indiana Rubber & Insulated Wire Co.
Okonite Company, The

Cables—Submarine and Lead-Covered.
Indiana Rubber & Insulated Wire Co.
Moore, Alfred F.
Okonite Co., The.

Simplex Electric Co.
Standard Underground Cable Co.
Waterbury Co.

Cabinets.
Frank Adam Electric Co.
Columbia Metal Box Co.
Empire Electric Mfg. Co.
Wurdack Electric Mfg. Co., Wm.

Carbons—Arc Light.
American Carbon & Battery Co.
Hirschberg, H. M.
National Carbons Co.
Southern-Wesco Supply Co.

Carbons—Brushes.
Dixon Crucible Co.
National Carbons Co.
Speer Carbon Co.
Stackpole Carbon Co.

Carbon—Rings.
National Carbon Co.

Castings.
Phospher Bronze Smelting Co.
Morris Iron Co., The
Wallwork Fdry. Co.

Circuit Breakers.
Condit Electric Mfg. Co.
Cutter Co.
Cutler-Hammer Mfg. Co.

Cleats—Fiber.
Blake Signal & Mfg. Co.

Cleats—Wood Knobs.
Blake Signal & Mfg. Co.

Coils—Armature and Field.
Oliver Electric & Machine Co.

Coils—Spark.
National Carbon Co.
Packard Electric Co., The.

Commutator Truing Devices.
Jordan Bros., Inc

Commutator Compounds.
Goldmark Co., The James

Condensers.
Allis-Chalmers Co.
Marshall, Wm.

Conduit Benders.
Rittenhouse, The A. E.

Conduit Fittings.
Bond & Co. H. L.
Electrical Eng. Equip. Co.

G. & W. Elec. Spec Co.

Conduit—Flexible.
American Conduit Mfg. Co.
Flexible Conduit Co
National Metal Molding Co.

Conduit—Rigid.
American Conduit Mfg. Co.
Clay Product Co.
Enameled Metals Co.
Johns-Manville Co., H. W.
National Metal Molding Co.
Turner Improvement Co., J. W.

Connectors—Battery.
National Carbon Co.
Cohen & Co., S. M.

Controllers.
Cutler-Hammer Mfg. Co.
Independent Electric Mfg. Co.
Monitor Controller Co.

Cords.
Boston Insulated Wire & Cable Co.
Moore, Alfred F.
Samson Cordage Works.
Standard Underground Cable Co.

Cord—Telephone.
Moore, Alfred F.

Cord—Flexible.
Marion Insulated Wire & Rubber Co.
Okonite Co., The
Samson Cordage Works.

Construction Material.
Southern-Wesco Supply Co.

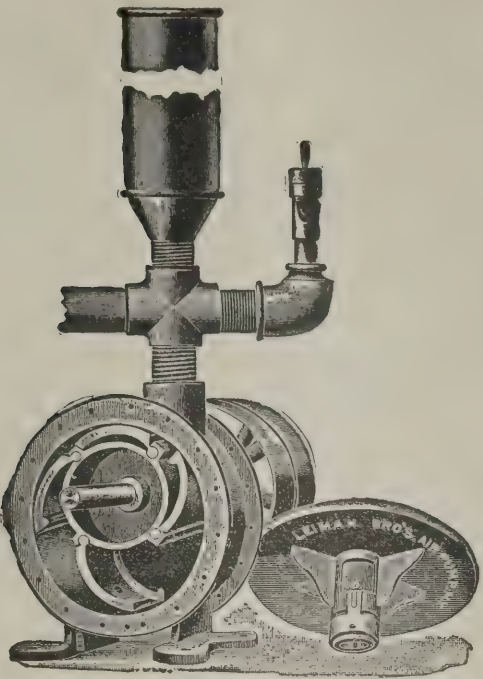
Cooking Apparatus—Electrical.
Cutler-Hammer Mfg. Co.
Diamond Electric Co.
Simplex Electrical Heating Co.

Couplings.
Bond Co., Chas.

Cross-Arms.
Morris Iron Co., The.
Southern Exchange Co., The.
Western Electric Co.
Southern-Wesco Supply Co.
Stevens Stave Co., B. F.

Cut-Outs—Arc.
Ft. Wayne Electric Works.

(Continued on Page 64.)



CLASSIFIED INDEX---Continued.

Demand Devices—Electrical.
Henry Thermo Electric Co.
Diaphragms—Telephone.
National Carbon Co.
Discs—Telephone Transmitter.
National Carbon Co.
Dynamos and Motors. (Second Hand).
Paul Stewart Co.
Oliver Electric & Machine Co.
Dynamos and Motors.
Allis-Chalmers Co.
Bell Electric Motor Co
Chattanooga Armature Wks.
Century Electric Co.
Crocker Wheeler Co.
Ft. Wayne Electric Works.
National Elec. Supply Co.
National Stamping and Electric Works.
Rochester Electric Motor Co.
Star Dynamo Company.
Richmond Electric Co.
Southern Electric Co.
Southern-Wesco Supply Co.
Western Electric Co.
Westinghouse El. & Mfg. Co.
Electrical Castings.
Wallwork Fdry. Co.
Electric Fixtures.
Frank Adam Electric Co.
National Elec. Supply Co.
Economy Electrical Specialty Co.
Electrical Repairing.
Oliver Electric & Machine Co.
Electric Sign Flashers.
Reynolds Dull Flasher Co.
Engines—Steam.
Allis-Chalmers Co.
Ball Engine Co.
Engineers—Consulting.
Byllesby, H. M. & Co.,
Dixon-Smith Engineering Co.
Electro-Mechanical Engineering Co.
Fowle, Frank F.
Fryer, Roy C.
Hallberg, J. H.
Humphrey, Henry H.
Jackson, D. C. and Wm. B.
Light, Heat and Power Corporation.
Mullergren Engineering Co.
Pillsbury, Chas. L.
Ruebel & Wells.
Scheible, Albert.
Spiker, William C.
Stone & Webster Engineering Corporation.
White & Co., J. G.
Woodmansee, Davidson & Sessions.
Zabel, Max. W.
Zimmerman Co., W. H.
Engravings, Stationary
Alabama Engraving Co.
Fans—Exhaust.
Century Electric Co.
Western Electric Co.
Fan Motors.
Carleton Co., The
Ft. Wayne Electric Co.
Southern Electric Co.
Southern-Wesco Supply Co.
Western Electric Co.
Fibres.
Standard Underg'd Cable Co.
Fire Extinguishers.
Pyrene Mfg. Co.
Fixtures—Lighting.
Cutter Company, George.
Economy Electrical Specialty
Fulton Electric Co.
Co.
Frank Adam Electric Co.
Johns-Manville Co., H. W.
Morris Iron Co., The
Phoenix Glass Co.
Southern Electric Co.
Southern-Wesco Supply Co.
Wakefield Brass Co., F. W.
Flashers—Electric Sign.
Campbell Electric Co.
Reynolds Dull Flasher Co.
Reynolds Elec. Flasher Co.
Flashlights.
National Carbon Co
Providence Elec. Mfg. Co.
Alfred Wolff & Co.
Flat Irons.
Cutler-Hammer Co.
Simplex Electric Heating Co.
Fuses—Electric.
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Daum & Co., A. F.
Detroit Fuse & Mfg. Co.
Johns-Manville Co., H. W.
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Allis-Chalmers Co.
Generator Brushes.
Dixon Crucible Co.
National Carbon Co.
Speer Carbon Co.
Stackpole Carbon Co.
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Gillinder & Sons, Inc.
Krakno Glass Co.
Globes—Arc Lamp.
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Lombard Governor Co.
Grate Bars.
Wallwork Fdry. Co.
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Standard Undergr'd Cable Co.
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Acme Electric Heater Co.
Cutler-Hammer Mfg. Co.
Diamond Electric Company.
Hughes Electric Heating Co.
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Packard Electric Co.
Indirect Lighting Units.
National X-Ray Reflector Co.
Instruments Electrical.
Dongan Electric Co.
Duncan Electric Mfg. Co.
Henry Thermo-Electric Co.
Johns-Manville Co., H. W.
Norton Electrical Inst. Co.
Southern-Wesco Supply Co.
Weston Electrical Instrument Co.
Western Electric Co.
Westinghouse El. & Mfg. Co.
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Brock Rubber Co., A. S.
Brookfield Glass Co.
Cook Pottery Co.
Johns-Manville Co., H. W.
Insulating Machinery.
New England Butt Co.
Insulating Material.
Dickinson Mfg. Co.
Johns-Manville Co., H. W.
Moore, Alfred F.
Okonite Co., The.
Packard Electric Co., The.
Standard Underground Cable Co.
Insulator Brackets.
National Elec. Supply Co.
Stevens Stave Co.
Insulator Pins.
National Elec. Supply Co.
Southern Exchange Co., The.
Lamp Cord.
Marion Insulated Wire & Rubber Co.
Moore, Alfred.
Lamps—Carbon Arc.
Adams-Bagnall Electric Co.
Fort Wayne Electric Works.
Southern-Wesco Supply Co.
Western Electric Co.
Lamps—Flaming Arc.
Adams Bagnall Electric Co.
Western Electric Co.
Lamps—Incandescent.
The Beers Sales Co.
Boston Incandescent Lamp Co.
Economy Electric Co., The
Franklin Elec. Mfg. Co.
Hygrade Inc. Lamp Co.
Liberty Elec. Co.
Johns-Manville Co., H. W.
National Elec. Supply Co.
New York Incandescent Lamp Co.
Shelby Electric Co.
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Morris Iron Co., The
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Worcester Machine Screw Co.
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Paul Stewart Co.

(Continued on Page 65.)

CLASSIFIED INDEX.---Continued.

DIRECTORY OF CONSULTING ENGINEERS ARCHITECTS and CONTRACTORS

225-60 WATT

Ray Do.

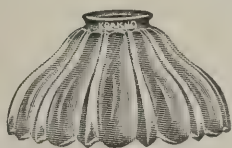
HAS NO EQUAL FOR

Tungsten Lighting

When EFFICIENCY and BEAUTY are any consideration. Be convinced,

WRITE TO

Krakno Glass Co.
Pittsburg, Pa.



No. 234 SHADE

Wakefield

STANDARD UNIVERSAL LIGHTING FIXTURES.

STANDARD means a model or rule from which or by which something is made. In this particular instance it stands for a high degree of efficiency, which Wakefield Fixtures have established.

UNIVERSAL means in simpler terms INTERCHANGEABLE, i. e., all standard parts of Wakefield Fixtures are Interchangeable.

STANDARD UNIVERSAL, means, therefore, that it is possible for us to offer you a high grade article at a medium price with a number of specific advantages, chief of which is the possibility of changing the fixtures into at least five times as many designs as with the same investment in ordinary fixtures.

This sounds logical if you understand. If you don't understand, we will gladly explain and send you a copy of our catalogue upon request.

The F. W. Wakefield Brass Co.
Vermilion, Ohio.

THE PERFECT READING LAMP

The Page always illuminated The Eyes always shaded

THE LYHNE LAMP PUTS THE LIGHT WHERE YOU WANT IT--- NOT IN YOUR EYES

UNSURPASSED FOR OFFICE WORK
Transforms night into day • Makes work easy

THE LYHNE LAMP

PRONOUNCED ("LINE")

WILL MAKE MORE SALES FOR YOU AND EASIER SALES THAN ANY OTHER LAMP. Its strong selling points are so valuable, so distinctive and so quickly appreciated by prospective buyers that you can sell MORE lamps with LESS effort.

The Lyhne Lamp has a reflector and adjustable revolving shade. The reflector being a perfect parabola magnifies and concentrates the light. The shade directs it to the exact spot where it is wanted and keeps it from the face and eyes. It is equally useful in the office or home, on a roll top desk or table.

The retail price is reasonable and your profit good.

Send for descriptive booklet and liberal dealers' discounts.

THE BEERS SALES COMPANY

62 CANNON STREET, BRIDGEPORT, CONN.

SHELBY

DEALER CO-OPERATION.

These four publications are but part of our elaborate and expensive campaign to help you, Mr. Dealer and Contractor, to build up **your** business.

Our business-getting campaign extends over a period of 40 weeks, and being of a local nature it will mean immediate profit to those who co-operate with us.

This campaign is accomplishing for our customers what no other lamp manufacturer has ever before accomplished in such large measure for his customers—your share of the benefits are offered to you. Will you accept?

DEALERS: If you want better **lamp service and co-operation** write us to-day for our **special proposition.** If you desire better business, our offer is worth investigating to-day.

Use this Coupon for Your Convenience in writing.

*Date*________________

THE SHELBY ELECTRIC CO.,
Shelby, Ohio.

Your special proposition will receive my consideration. Please send it to me and oblige.

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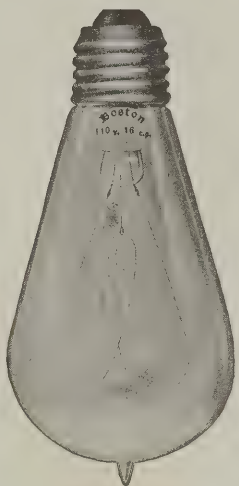
THE SHELBY
ELECTRIC CO.,
SHELBY, OHIO.

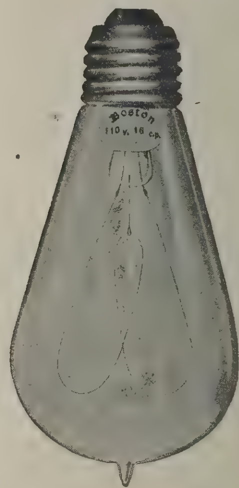
For Economy's Sake Use

"Boston" Lamps



AT

9c



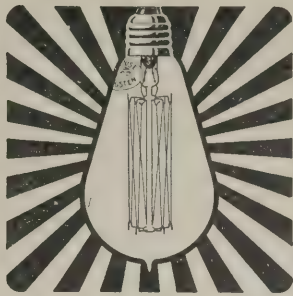
We market our product of 16 c. p., 100-130 volt, lamps at 9 cents and guarantee quality and selection.

"BOSTON" Lamps are known as the highest quality renewed lamps on the market. Our daily capacity is so great that we can dispose of all odd voltage lamps and ship the required selection immediately upon receipt of orders.

Every shipment we make is absolutely guaranteed as to satisfaction. If you are in the market for a quality renewed lamp, write us for a trial shipment on condition that the lamps may be returned without expense to you if they prove unsatisfactory. We ship all orders with that understanding. Will you try a case to-day—remember, "BOSTON QUALITY," and only 9 cents in price.

Boston Incandescent Lamp Company

128 Maple Street, Danvers, Mass.



Westinghouse Incandescent Lamps have always been sold and always will be sold as Westinghouse Lamps by the Westinghouse Company

Westinghouse lamps are mighty good lamps and we are proud to have the name on them. It is a matter of pride with us and a matter of protection for the buyer.

Take the tungsten. The man who buys a tungsten lamp with the Westinghouse label knows that he is getting the original continuous filament tungsten---the one that has a two years' record for strength in all classes of service---on railroads, in trolley cars and in mills where vibration keeps up every minute of the day.

The wise lamp buyer looks for the name and it's a hard matter to get him to accept a substitute for the Westinghouse Wire Type Tungsten.

The Central Station man who supplies Westinghouse Wire Type Tungstens will tell you of enthusiastic customers and of many new contracts due to Wire Type strength.

We have a booklet on House Lighting which we want you to have. Ask for folder 1516H.

Westinghouse Electric & Manufacturing Co.

Incandescent Lamp Dept. (Westinghouse Lamp Co.), Bloomfield, N. J.

Rush Hospital Phila. Pa.

Gotham Hotel New York City

U. S. P. O. Anniston Ala.

Elks' Club Washing-on, D.C.

42nd St. Bridge Philadelphia, Penn.

A Central Station

CAN Build up the DAY LOAD
Please the CUSTOMERS
Make a good PROFIT

AND

Have no Money Invested

Mail one of our Circulars to each of your customers with the monthly bills

IT COSTS NOTHING

We will ship one of our Washing Machines to any of your reliable customers for a thirty days' trial

FREE OF CHARGE

We are making this most liberal proposition because we have faith in our machines. We know that they will give perfect satisfaction, with a fair trial.

All we ask of the Central Station is to mail out our circulars and take orders for the machines. We will fill these orders direct and will remit a commission on each sale.

Can you afford o neglect this opportunity?

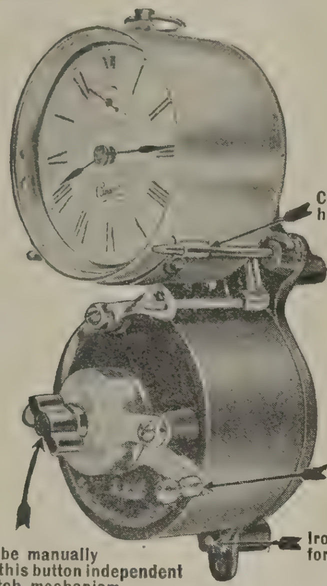
WR TE TODAY

The NINETEEN HUNDRED WASHER CO.

BINGHAMTON. N. Y.

TRANSFORMERS
TIME SWITCHES
THERMO FLASHERS

Spotlights Searchlights Bell Ringers



ONE-DAY TIME SWITCH
TYPE "A"

Send for Catalogues and Trade Discounts.

Campbell Electric Co., Lynn, Mass.

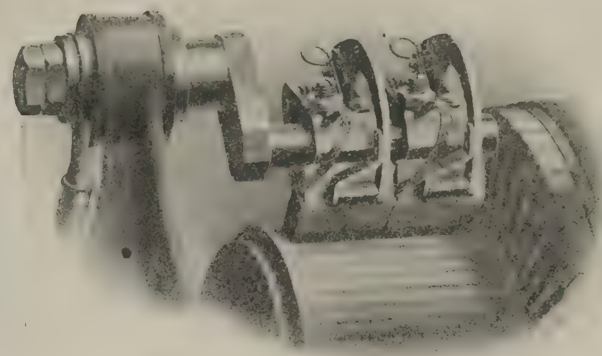
DUNCAN TRANSFORMERS

We are not selling the best transformer in the world for nothing, neither are we guaranteeing it for a thousand years. Only those without sense, without honor and without capital can afford to do such things.

The Duncan Transformer is recognized by nearly 1400 users, also by the Government, as being capable of complying with every possible up-to-date requirement, no matter how exacting. Our transformers are built in a scientific way, and impregnated, and are not thrown together in a haphazard manner, then soaked in cheap crude oil as the only insulation. It is for this reason that we have to charge a fair price, but the purchaser is always protected by the high quality.

FULL LINE CARRIED IN STOCK BY
PIEDMONT ELECTRIC COMPANY,
SHEVILLE, N. C.

DUNCAN ELECTRIC MFG. CO., LaFayette, Ind.



Do your COMMUTATORS run HOT?

Do you have DESTRUCTIVE SPARKING?

Are your BRUSHES wearing GROOVES?

Are your Machines NOISY?

ELIMINATE ALL these troubles and PROLONG the LIFE of Machines by equipping them with

REACTION BRUSH HOLDERS

We refer to our many CUSTOMERS for whom we have SAVED THOUSANDS of DOLLARS.

Let us equip a Generator or Motor for you. Make its final acceptance subject to your entire approval after any reasonable period of operation.

THE

Baylis Company

65 Nelson Street,
BLOOMFIELD, - N. J.

No. 2A.

This Is the Thordarson Toy Transformer

Rather a business-like affair, don't you think? It is a little brother to larger transformers. Conforms to the same standard of workmanship in every respect and does precisely the same work on a much smaller scale. Fine for operating bells, buzzers, electricaltoys and the like. Exceedingly attractive and practically indestructible. Made the Thordarson way—the best way.

Style	*Watts*	*Price*
No. 1	60	$ 8.00
No. 1A	60	$ 5.00
No 2	120	$10.00
No. 2A	120	$ 7.00

In addition to long connecting cord, Style No. 1 is equipped with 3, and Style No. 2 with 5 flexible plug contact cords. No. 1A and No. 2A are each equipped with long connecting cord, and have binding posts only.

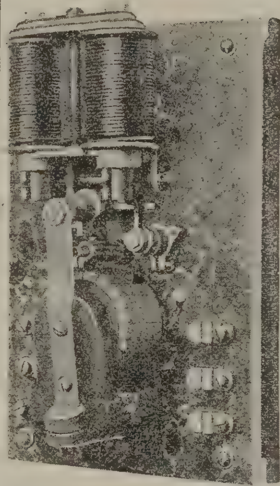
Write today for particulars

Thordarson Electric Mfg. Co.

219 So. Jefferson St., CHICAGO, ILL.

Just Press a Button!

MONITOR Automatic Controllers



Bulletin No. 24.---Automatic Starter for Remote control of Direct Current Motors, Driving Machine Tools, etc. Has powerful Magnetic Switch, Magnetic Blow-out, and is adapted to the most exacting requirements.

You can use untrained labor and get skilled results, because the knowledge, experience, skill and discretion are all in the controller.

No Sliding Contacts

No Arcing

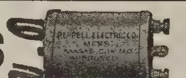
Positive Action

Send for Catalog

Orders for Sample Controllers solicited, giving privilege of return after thirty days if not satisfactory.

MONITOR CONTROLLER CO.

No. 106 Gay St., BALTIMORE, MD.

Reppell's  Bell Ringer

Does away with batteries. Attached by any one to lighting circuit. Operates buzzers, alarms, toys, bells, medical coils, etc., at a cost of

ABOUT ONE CENT A YEAR

LIST PRICE $2.75

REPPELL ELECTRIC COMPANY, 7 West 31st Street, KANSAS CITY, MISSOURI

OAK INSULATOR PINS & BRACKETS

MANUFACTURED BY

B. F. STEVENS STAVE COMPANY

MARTINSVILLE, VA.

Marshall's Electrical Condensers

FOR TELEGRAPH, TELEPHONE, ELECTRIC LIGHT, X-RAY, EXPERIMENTAL AND WIRELESS SYSTEMS.

Sending Condensers for Wireless made to stand any voltage required.

Standard Condensers a specialty. These Condensers are used in all Telegraph offices in America where Standard and ordinary Condensers are required.

CONDENSERS AND ARTIFICIAL LINES for Submarine Cables and Land Lines. Send for Catalogue.

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Address: WM. MARSHALL, 709 Lexington Avenue, near 57th Street, NEW YORK.

Make Your Xmas Toy Operation and Tree Illumination Safe

and devoid of bother and limitations attendant upon battery operation—Advocate the use of current from lighting circuit fed through a

Rollinson Toy Transformer

made for various voltage combinations from 3 to 26 volts.

Prices $5.00 to $12.00 ready for use. No moving parts or parts liable to disarrangement.

MOHAWK ELECTRIC COMPANY,
65 Shipmen St., Newark, N. J.

Distributors:

Boston: Electric Sales Co., 176 Federal St.
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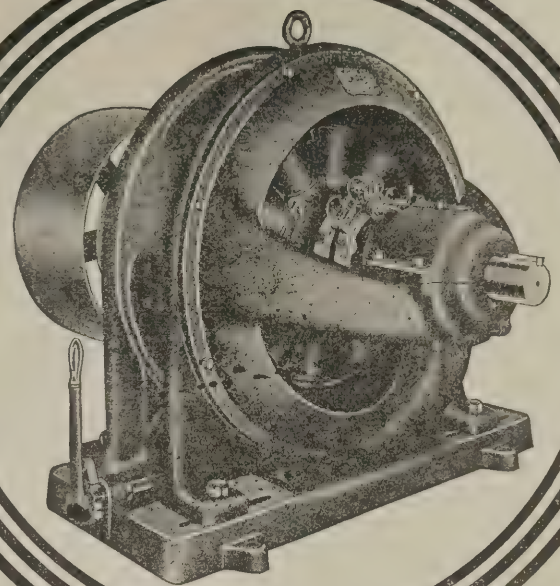
Chicago: C. A. Robinson, 227 West Van Buren St.

Do You Want More Power?



Has the load on your power plant increased so that now you ought to have additional generator capacity? Perhaps you don't want to invest much in new equipment just now.

You Can Save a Lot of Money On This Alternator

The price is low---not that we have slighted material or workmanship---but because of the reduced number of poles and the resultant speed which permits the use of minimum material for the given output.

That's how you save on the original cost, but that's only one point.

Another is its flexibility which allows you to handle motors, series arcs and incandescents from it all at the same time.

There are many other points explained in our Bulletin 1104, and it will pay you to send for a copy. It's free.

FORT WAYNE ELECTRIC WORKS

Of General Electric Company

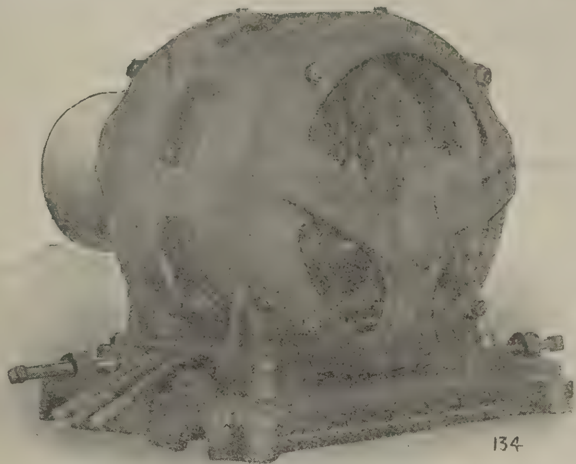
1621 Broadway, Fort Wayne, Indiana.

BRANCH OFFICES IN MOST LARGE CITIES

A14

MOTORS---GENERATORS---TRANSFORMERS

INDUCTION MOTORS



Long Life Bearings

High Power Factor

Great Overload Capacity

Conservative Rating

Extra Strong Starting Torque

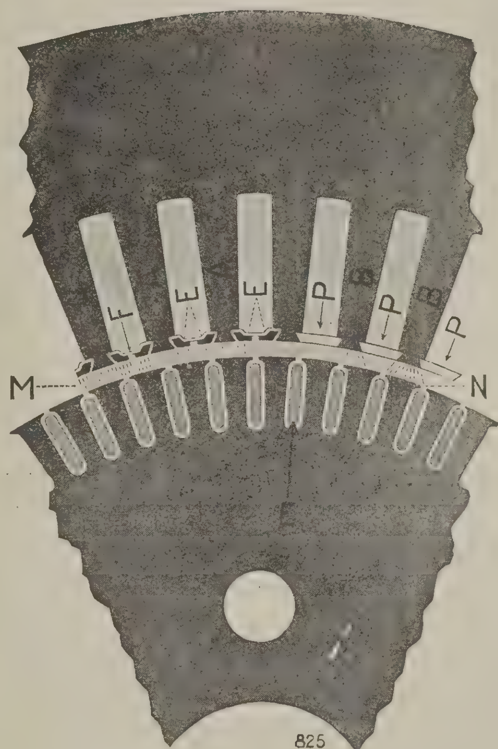
Unusually Heavy Insulation

Convenience of Repairs

Efficient Ventilation

The manufacturers of induction motors may be divided into two schools:

Those who prefer the "open slot" construction and hose who build under the "closed slot" principle. Each of these contends that their extreme is better than the other. The "open slot" advocates sacrifice electrical qualities to mechanical convenience. "The closed slot" adherents gain the highest electrica advantage, but have a motor which is very inconvenient mechanically.



In the C-W motor the slots are first made open, allowing plenty of space for the inserting of heavily-insulated formwound coils, and are then closed by magnetic wedges which give all the electrical advantages of "closed slot" construction. The cut shows how the magnetic wedge "E" increases the distributing area of the tooth and allows the flux to travel a shorter path than is the case where the wood-wedge "P" is used.

For a futher discussion of this subject and other interesting advantages of these motors write for induction motor booklet "E"

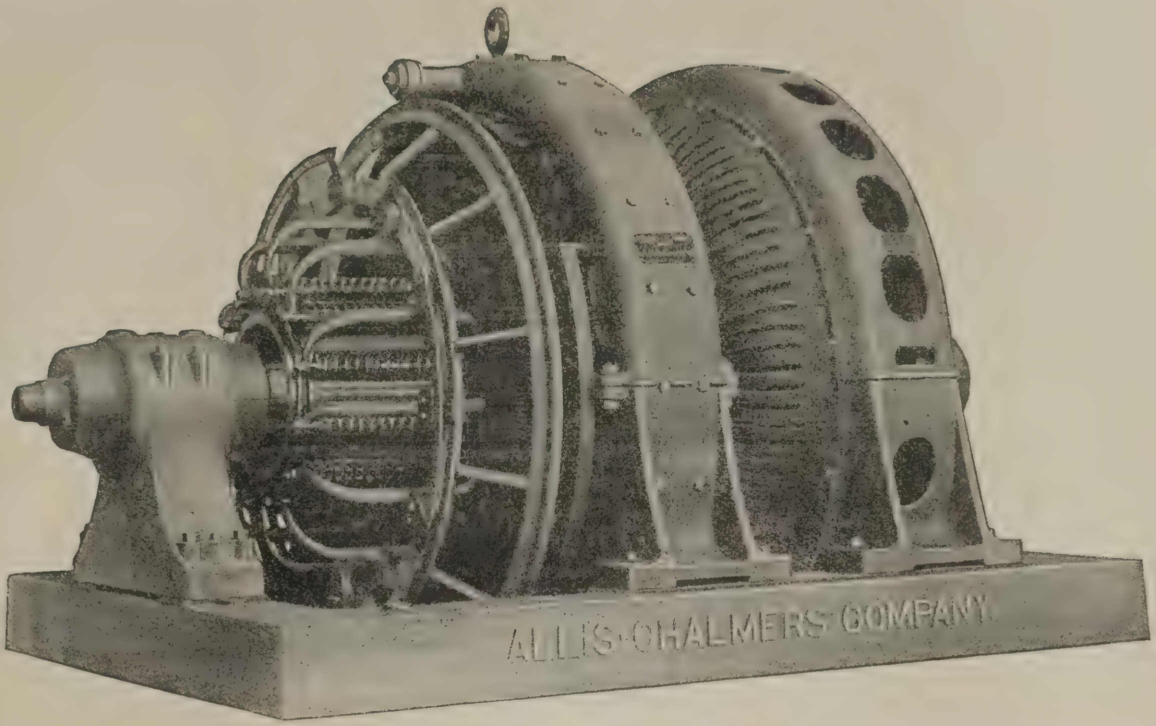
CROCKER-WHEELER CO.

AMPERE, N. J., BOSTON, CHICAGO, CLEVELAND, DENVER, DETROIT, NEWARK, NEW HAVEN, PHILADELPHIA, PITTSBURG, SAN FRANCISCO, SYRACUSE.

BIRMINGHAM, ALA:—Brown-Marx Bldg.

LOCAL ADDRESSES AT:—Baltimore, Rquitable Bldg.; Washington, D. C., 518 Tenth St., N. W.; Charlotte, American Bldg.; Huntington, W. Va., Robson-Prichard Bldg.

Local Selling Representative: Tel. Electric Co., Houston Texas.



1000 K. W. Synchronous Motor Generator Set, 11000 Volts A. C.—250 Volts D. C.