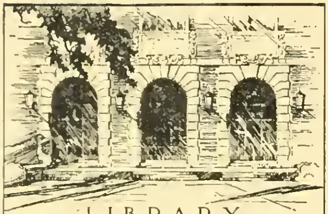

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THE

TECHNOGRAPH

PUBLISHED QUARTERLY BY THE STUDENTS OF THE COLLEGE OF ENGINEERING UNIVERSITY of ILLINOIS

November

1925

MEMBER OF THE ENGINEERING COLLEGE MAGAZINES ASSOCIATED

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The TECHNOGRAPH

UNIVERSITY OF ILLINOIS

Member of the Engineering College Magazines Associated

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Contents for November

Members of the Engineering College Magazines Associated

Chairman: Prof. Leslie F. Van Hagan, College of Engineering, Madison, Wisconsin

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Ira Osborn Baker
1853-1925

Ira Osborn Baker

September 23, 1853 November 8, 1925

In the death of Dr. Ira Osborn Baker, Professor emeritus of civil engineering, all to whom the University of Illinois is dear feel an overwhelming sense of loss. In his passing the University has lost a distinguished intellectual leader; the community, a good neighbor and lovable friend; the profession, an illustrious examplar of its best ideals; and the state, a worthy and valued citizen. His brilliant career of fifty-one years on the faculty constitutes one of the high towers about which the University is builded. Spanning the formative period of engineering education, his half century of instructional service largely gave form and character to engineering education at Illinois and was moreover a potent factor in national circles as well. With a clear conception of the primary objectives of engineering and the ability, through kindliness and charm of manner, and tenacity of purpose, to convince others, his views were widely accepted and influenced notably the foundations and framework of the educational structure. Through the press and public addresses as well as by direct personal intercourse, his message of ethics and ideals found lodgment; through technical articles, treatises and text-books, he contributed largely to the substance of engineering education and practice; through the minds and affections of his students, he created much of that intangible invisible spirit, which is the essence of the profession.

A painstaking scholar and scientist, an inspiring teacher, an administrator with vision, a citizen worthy of emulation, a man of stainless personal life, an unselfish and loyal friend, a devout and reverent Christian, Professor Baker lived the abundant life. When present, he had affection for his friends and wisdom for his profession; in memory, he leaves enrichment of soul for his friends and ennoblement for the profession.

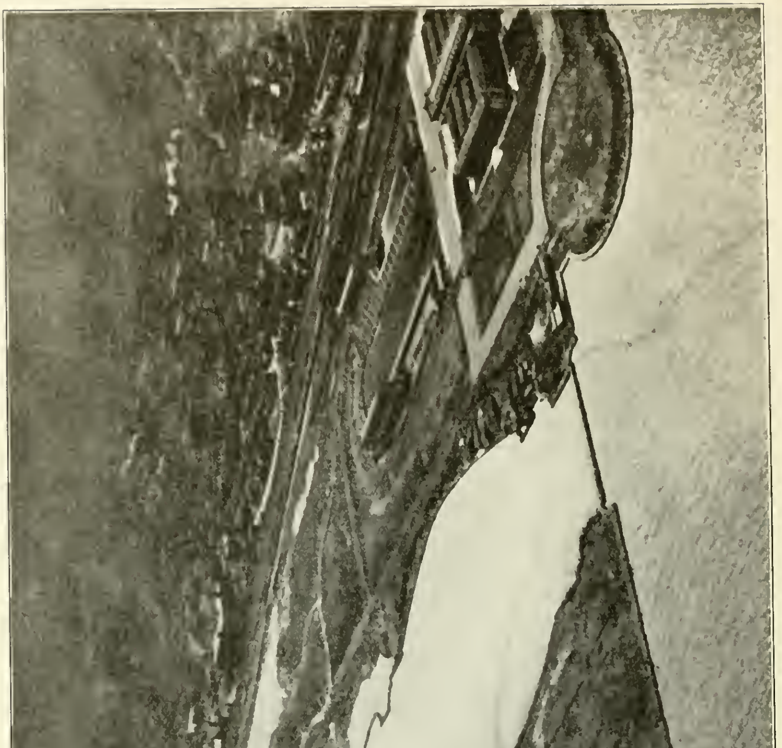


Fig. 2 Aeroplane View Showing Present Status of Chicago Lake Front Improvement

THE TECHNOGRAPH

Published Quarterly by the Students of the College of Engineering—University of Illinois

VOL. XXXVIII NOVEMBER, 1925 NUMBER 1

The Chicago Lake Front Development

H. E. WESSMAN, M.S.

Ten years ago the visitor to Chicago, who had occasion to enter the city over the Illinois Central Railroad, saw little of interest in the panorama unfolded to him on the east side, from Jackson Park northward to the Twelfth Street terminal. He may have noted a casual dredge or pile-driver out in the lake, engaged in apparently aimless work, or a lone fisherman seated on a pile group. If he looked eastward again, just before reaching the station, the visitor probably noted several dump wagons traversing a desolate waste stretching from the tracks to the lake. The picture was anything but beautiful, and the reaction was often depressing.

Today, however, the observer obtains some conception of what the activity on the South Side Lake Front means, and to what end it is pointing. The Field Museum, the Stadium, the drive down to the Twenty-Third Street Viaduct, the inner breakwater winding down to Fifty-Seventh Street, the outer breakwater just beginning to take form from Twelfth Street down past Sixteenth Street, and the grading in Grant Park, give some basis for picturing the comprehensive Lake Front Park System which will be a beautiful reality not many years hence. It will not only be a beautiful reality; it will be immensely useful, for it will offer new recreation areas for Chicago's growing population and will open up new traffic arteries from the North to the South sides, thereby relieving the congestion which is choking Michigan Boulevard at the present time.

The scope of the completed project is best comprehended by noting Figure 1. In general, the plan proposes a park development upon land reclaimed from Lake Michigan from Randolph Street to Jackson Park. There will be an inner drive east of the Illinois Central Railroad right-of-way, a lagoon east of the inner drive and separating it from an outer drive located adjacent to the new shore line which will be approximately 2500 feet out in the lake from the old shore line. As indicated on Figure 1, both drives are connected at frequent intervals with intersecting drives across the lagoon and Illinois Central right-of-way to the street system of the city proper. At the south end the outer drive closes in to the inner drive which in turn leads to the boulevard system of Jackson Park. At the north end both drives connect with Roosevelt Road, also known as Twelfth Street, which is to be opened across the location of the present Illinois Central Railroad terminal to connect with Michigan Boulevard in line with East Roosevelt Road produced.

Drives north through that part of Grant Park east of the tracks will discharge into Michigan Boulevard via intersecting streets at Seventh, Congress, Jackson, Monroe and Randolph Streets, and will also lead directly into the Lincoln Park Boulevard System across a new link bridge at the mouth of the Chicago River. This bridge is to be built in the near future.

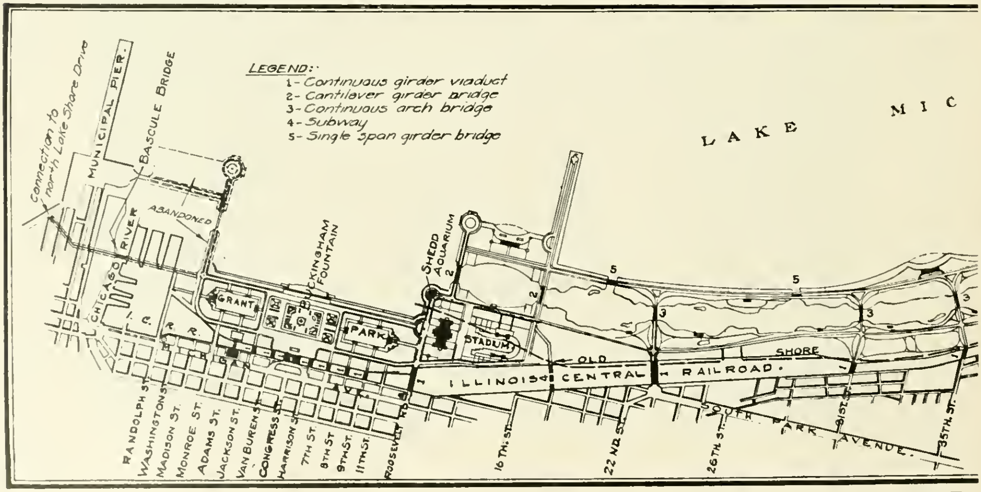
Figure 2 is an interesting aeroplane view showing the present status of the reclaimed area, from Roosevelt Road south. Note the Field Museum at the extreme right and the Municipal Stadium, now known as Soldiers' Field, behind it. The circular raised area in front of the Field Museum is the site for the Shedd Aquarium, referred to later on. Note the outlines of the lagoon beginning to take form and the inner bulkhead winding southward. The inner drive is dimly visible down to the Twenty-Third Street viaduct beyond which point the filling behind the inner bulkhead is just beginning to appear above the lake level.

In brief, the process of reclamation consists of driving two parallel rows of fifty-foot piles about twenty feet apart, the piles in each row being placed as close together as possible. The intervening space is then filled with rock to form the bulkhead projecting about 3 feet above the surface of the lake. Wakefield sheet piling is usually driven outside of the outer row and securely bolted to the piles. The area within the bulkheads is then filled by hydraulic dredges which pump material from the lake bottom outside the enclosure. Material excavated from the foundations in the downtown district is also used. Care is taken to keep heavy loads off the fill until after a period of settlement because of a layer of plastic clay underlying the lake bottom which is approximately fifteen feet below the surface of the water. In some cases the fill varies from thirty to forty feet above water level, placing an enormous load upon the old lake bed. On one occasion the resulting horizontal pressure was so great that a section of bulkhead east of the Field Museum was moved fifty feet east and lifted vertically twelve feet. Eighteen to twenty miles of bulkhead at a cost of $100 per lineal foot in place, will be required before the project is completed. About seven miles of this is now complete or under contract. Hydraulic fill costs 60 cents per cubic yard.

When finally completed, the outer park system south of Roosevelt Road will contain 1139 acres of land and 343 acres of enclosed waterway. The waterway in the shape of a long narrow lagoon, from Twelfth Street south to Jackson Park will offer in addition to the usual boating facilities, a six mile course for speedboat races and aquatic sports. The land will be developed into beautiful park areas and gardens where Nature will run riot, athletic fields, picnic grounds, winding walks and drives. Several new beaches will be opened on the lake side and bathing pavilions erected. A landing field for aeroplanes may be provided in the vicinity of Twelfth Street.

Several structures of monumental nature, exclusive of the bridges which are taken up in detail later on, constitute the crowning features at the north terminus of the new lake front park. The $10,000,000 Field Museum of Natural History and the greater part of the $6,000,000 Municipal Stadium are already completed. The early future will see commencement of work upon the $2,500,000 Shedd Aquarium, an immense, octagonal structure of white marble to be located on the Grant Park waterfront, several hundred feet northeast of the Field Museum. It will harmonize with the classic Greek architecture of the Museum and Stadium, and will surpass in size and beauty any other aquarium in the world today. Living sea inhabitants from all parts of the globe will be brought here to take their place among the educational features made possible by this structure.

The electrification of the Chicago Terminal area and the completion of the proposed new passenger station by the Illinois Central Railroad will add the finishing touches, ten or fifteen years hence. The station will be an imposing building located just south of Roosevelt Road and harmonizing in architecture with the other structures mentioned above. Figure 3 shows an artist's conception of the new terminal with the Roosevelt Road Viaduct in the foreground. To the left is the Field Museum with the Stadium in the background. Although the



FIGURE

final plans for the station may be quite different from those indicated in Figure 3, yet to one who is familiar with the present station building site, the contrast between the old group and that proposed is decidedly striking.

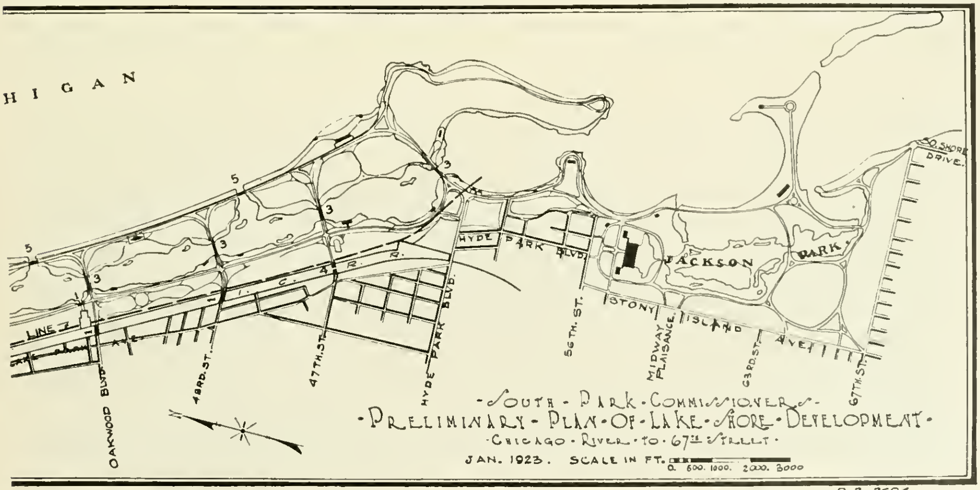
Grant Park, north of Twelfth Street, is destined for exceptional aesthetic treatment. As shown in Figure 1 the architectural design is centered on the outstanding feature, viz., the Buckingham Memorial Fountain located in line with Congress Street. This fountain, placed in an ornate garden setting, will rival the famous one of Latona in the gardens of Versailles, France. It will be built of marble supported by reinforced concrete. Over 360 feet in diameter, it will contain about 72 jets of water, arranged so that the outline of the discharging water will form a series of dome-like terraces converging at the center to a great central column of water 95 feet high. In full operation, the fountain will discharge about 5500 gallons per minute. A unique system of illumination will produce beautiful and striking effects at night.

The main gateway to the Buckingham Fountain is at Congress Street, across the big double bridge which is now in process of construction. The approaches from Michigan Boulevard will rise in sweeping curves, enclosing a plaza, to meet with the bridge roadway. Two large pylons at the west end of the bridge with main shafts approximately 24 feet square and 65 feet high, colonnades on both sides of the bridge at the east end, and the bridge itself have all been designed to make a monumental approach to the fountain. A formal garden, athletic fields to the north and south, the Art Institute, and several statues, including one of Abraham Lincoln, will complete the artistic remodeling of Grant Park.

It is evident from a brief study of Figure 1 that the proper development of the boulevard system on the lake front involves a bridge program of some magnitude. Numerous crossings are required over the Illinois Central Railroad right-of-way and the Lagoon to give necessary traffic outlets. The locations and types of the various bridges are indicated in the legend, Figure 1. This article does not propose to take up any one design in detail, but to give a general idea of the governing conditions leading to the selection of the particular types chosen and the problems involved in the design of those types.

Three and one-half years ago the South Park Commission had no structural department of its own. Traffic congestion on Michigan Boulevard demanded an opening to the Lake Front as soon as possible and so the firm of Condron & Post, consulting engineers, was retained to design the Twenty-Third Street viaduct, the first of the new bridges. The number of proposed bridges however warranted the development of a structural department under the direct supervision of the chief engineer of the South Park commissioners, so consequently all subsequent designs are products of a structural organization only two and one-half years old.

Referring to Figure 1 again, it is seen that continuous girder highway bridges, crossing the Illinois Central tracks, are to be located at 43rd Street, Oakwood Boulevard, 35th Street, 31st Street, 23rd Street, Roosevelt Road, 7th Street, Congress Street, and Jackson Street. Continuous



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foot bridges with step approaches are located at Van Buren Street, Harrison Street, 8th Street, and 9th Street. There will also be a continuous girder highway bridge over the Sanitary District intake at 39th Street.

An ordinance passed by the city of Chicago in 1919 established the grades for the above enumerated bridges and their approaches. To conform to these grades and yet allow sufficient clearance beneath for train operation, necessitated extremely shallow girder spans. Full development of the track area limited the width of the supports within the right-of-way and required as few as possible, consistent with safe design. Simple plate girder spans demanded a maximum number of supports and even with a minimum span, required such an extremely heavy section for the shallow depth established, that excessive deflections resulted. Consequently they were eliminated from further consideration. Flat arch spans could not be designed to conform with the established grades and aesthetic considerations barred truss spans. The shallow depth of girder, long spans, and inability to use falsework because of the reduced lateral track clearance, eliminated reinforced concrete girders. At some of the three span crossings, particularly north of Twelfth Street, a cantilever design was investigated. This consisted of a girder span fixed at the abutment and cantilevering over a column from each end. A suspended span was then to be swung between the cantilevered girders with a pin connection at one end and a rocker connection at the other to care for temperature movement. This involved costly details at the pins and roller, unsightly joints in the concrete encasing, a greater depth of girder, and steeper approach grades. Continuous steel girders, encased in concrete and gunite offered the most rational solution. They permitted longer spans, lighter and better balanced sections because of the reduction of positive moments at the span center and introduction of the negative moments at the supports and gave a more rigid structure with less vibration and deflection than a series of simple spans.

All of the continuous girder bridges mentioned have been designed or are now in process of design. The 23rd Street viaduct, Figure 4, is already a material reality open to traffic. This viaduct is the longest one south of 12th Street and consists of three three-span continuous girders, in all nine spans. The span lengths vary from 33 ft. to 96 ft., the total length being 635 feet. The cost was $1,500,000. Thirty-First Street and Oakwood Boulevard viaducts are 4-span continuous structures 272′ 6″ and 256′ 6″ in length. They will cost $450,000 and $400,000 respectively. Forty-Third Street viaduct is a 5-span continuous bridge 349′ 8″ long. The bridges north of 12th Street are all 3-span continuous girders 206′ 3″ long. It is estimated that these bridges, plus the ornamental concrete work in that part of Grant Park west of the I. C. R. R. and from 12th Street north to the Art Institute, will cost $2,000,000. The bridge at 39th Street over the Sanitary District Intake is a 2-span continuous girder 195 ft. long, to cost $200,000. All of the bridges are designed for a uniform live load of 125 pounds per sq. ft. over the roadway, and 100 pounds per sq. ft. over the sidewalks, in addition to a 24 ton truck load and in some cases a double string of 50-ton street cars.

A brief resumé of the preliminary design progress to-date on the Roosevelt Road viaduct will illustrate some of the problems involved in the design of these continuous girder bridges. Wider and longer than any of the aforementioned bridges, and occupying a prominent place at the head of Grant Park

Fig. 3 Artist's Conception of New Illinois Central Railroad Terminal

across the north facade of the new Illinois Central terminal, the Roosevelt Road bridge naturally becomes the outstanding example of the continuous girder type. The total cost of the bridge will be approximately $1,750,000. The east portion of the structure will consist of a 5-span continuous girder bridge, 355 ft. long with span lengths varying from 64½ ft. to 78½ ft., the average being 71 ft. The west portion involves another continuous section, a flat slab section and a flat slab approach. The length of these sections have not yet been established, due to the necessity of temporary construction pending the final design and completion of the terminal building. The Illinois Central tracks are not perpendicular to the line of Roosevelt Road and since column bents must parallel the tracks, a skew bridge has to be provided.

The city ordinance referred to above has set the elevation of the top of the curb at the east end of the bridge at plus 33.00. The bottom encasing line cannot go below elevation plus 28.50. In order to conform with the horizontal lines of the new terminal, no vertical curve could be introduced into the grade of the bridge roadway. It had to be level until it intersected the west approach grade. Consequently, the total depth of girder plus concrete covering on top and bottom could not exceed 4½ ft. at any point. This limited the girder section to 38½″ back to back of angles.

A 3-span continuous girder with equal span lengths 95′ long was first considered. The resulting flange area required for this span length and the established depth was so great that special rivets were required. Field splices presented further difficulties because of the extremely long rivets. A 4-span system having shorter spans was then proposed. This placed the double rocker bent for expansion within the track area and increased the track spacing. To bring the expansion joint at a passenger platform where it would not interfere with the track layout, a 5-span system was adopted, of lengths as indicated above. The resulting girder sections were found to be satisfactory.

Several methods were used in the analysis of moments and reactions for the 5-span continuous girder. The three moment equation, area moments, Clayton-Fidler's graphical method, and a method of analysis developed by Professor Hardy Cross, head of the department of structural engineering at the University of Illinois, were all used at various times. It may be of interest to know that the last method saved considerable time in computation and was the method used in the final determination of influence lines for moments and reactions. Because of street-car loadings it was necessary to construct the influence lines quantitatively to attain an absolute maximum moment curve. In previous designs it was found that correcting the moments for variation of moment of inertia over the length of the girder made little difference, especially where the depth of girder was constant. Consequently a uniform moment of inertia was used throughout.

Columns presented several interesting problems. Fixing the columns to the girders threw too much moment into the columns and increased the dimensions beyond the limits allowed by the Illinois Central Railroad for clearance. To eliminate this, a

Fig. 4 The 23rd Street Viaduct

ball and socket joint was used at the top of the columns. A ball joint, rather than a pin, was needed because the bridge is on a skew with the column bents. Some moment was transferred into the column by friction at the ball, but it was found negligible. This left moment due to temperature movement, traction, and eccentricity to be provided for, in addition to the direct load. The length of the 5-span section is too great to care for all the expansion at one end, so both ends were left free to expand. This required the interior column bents to take all the traction forces. The center column bents which had least temperature moment, were consequently designed to take most of the traction. Because of the skew location, the columns had to be analyzed for unsymmetrical bending. Design was further complicated by the introduction of transverse girders at the column bents to eliminate alternate columns and reduce the caisson cost. At the expansion bent it is proposed to use a continuous transverse box girder, pin-connected to single columns. The box girder will be wide enough to seat two rocker nests in line ,thus caring for the expansion or contraction from each side. This outline of the design features at Roosevelt Road viaduct, though extremely sketchy, will give some impression of the problems encountered in all of the continuous bridges noted above.

Two three-span cantilever girder bridges, costing $1,300,000 each, are to span the north end of the lagoon at 12 Street and 16th Street. The over-all length of each, including anchor arms which ex-

(Continued on Page 44)

Illinois Highway Inspection

D. R. Connor, c.e., '26

Having performed the duties of Inspector on a paving section for the State Highway department during the summer months, I thought that it might be of interest to some of those taking engineering to know the requirements of the department in this type of inspection work. To those who have held similar positions, and who may disagree with me on some of my statements, I can only offer the excuse that they were the principles adhered to in the district where I was employed.

When the inspector first goes on the job, and before work is begun, it is his duty to see that the contractor has all the necessary equipment to carry out the work, and that it meets the requirements of the State Highway Department. The most important of these requirements to look out for are: first, be sure that the contractor has an approved type of mixer—the specifications saying that "no mixer shall be used that require more than 5 bags per match. The mixer must also be equipped with an automatic timing device, for timing each batch of concrete. Second, see that he possesses a suitable subgrade template which rides the forms and which discloses any high spots on the subgrade. Third, check up the finishing machine to see that the temper and the strike off are set to the proper crown, and that they agree to the crown setting on the subgrade template. Fourth, see that the contractor has a handbelt and floats of the type specified in the book of specifications issued by the department.

The contractor should not begin work until all of this equipment has been approved, and in case any of it does not meet the specifications, he should not be allowed to commence work until all of the requirements have been met.

After the equipment has been passed upon and the contractor has begun to pour concrete, it is the inspector's duty to straight edge the pavement each morning, marking any places where the surface varies more than one-fourth of an inch in ten feet. Upon finding variations which exceed this amount it is his duty to mark these points and have the contractor rub them down. It is also required that three readings be taken on the subgrade each day and on the pavement at the same points in order to determine whether or not the required thickness is being obtained. Should the reading continually show thin pavement, the inspector must order the contractor to reset the blades on the subgrade machine and the pins on the scratch board. A report of the thickness tests must be sent in each day to the district office and to the main office at Springfield, Illinois.

A record must be kept of the number of men working, delays during the day, the lineal measure of pavement laid and the number of batches going through the mixer each day. It is very essential that the number of feet laid and the number of batches mixed be recorded in order to determine whether or not the proper amount of material is being used for the amount of concrete laid. Should the contractor use over four percent of the theoretical amount of cement required to lay a certain number of feet of pavement, the price of the extra cement is deducted from the money due him for his work. Aside from these routine duties, there are many other things on the job which require constant attention.

The mixer should be timed at least twice a day in order to see that the material is being mixed the required length of time. The time the concrete should mix after all the material, including water, is in the mixer, is one minute. Many contractors, in their effort to make record runs, are inclined to shorten this period to less than a minute; then the inspector must make an extra effort to see that no concrete is laid which has not been mixed the required time.

Another requirement which the contractor is liable to neglect is that of keeping the subgrade wet down. On extremely hot days the subgrade dries out rapidly and absorbs a great deal of water from the concrete. To avoid this the inspector must see that the subgrade is sprinkled immediately before laying the concrete.

Aside from these duties, the inspector must see that good alignment is obtained on the forms, that the pavement is covered with wet burlap just as soon as it has set enough so that the surface will not be marred, and insist that the pavement laid one day be covered with calcium chloride, for curing purposes, by ten o'clock the following morning. Particular attention must be given to the fact that a well spaded edge is essential. If this is not done a honey-combed edge will result and will cause a great weakness at a point where the pavement should be strongest.

These are a few of the more important duties required of an inspector working for the State Highway Department.

Radio Station WOK

Paul Tartak e.e. '27

"This is WOK, the Neutrowound Radio Station, broadcasting from our Terrace Garden studio in the Morrison Hotel, Chicago."

The studio of this station is located in the northwest corner of the Terrace Garden. It is a brilliantly lighted stage above and to one side of the orchestra pit, and its interior is visible from all parts of the Garden. It is partitioned off from the main room by a double glass wall which, though it permits the diners to observe the artists at work, effectively prevents any sounds from the outside from being heard in the studio. The ceiling of the studio is covered with sound-deadening fibre board, and this covering, together with the double plate glass walls and the velvet draperies, keep all undesirable sounds from affecting the microphone.

Five microphones are used, any one being connected into circuit by a switch on the announcer's desk. Two are in the studio, two outside in the Terrace Garden; the fifth is used by the announcer. One of the studio microphones is placed near the piano an dthe other on a movable, adjustable stand before which the artist stands while performing. One of the outside microphones is hung above the orchestra pit and the other picks up the music of the organ.

The announcer's room is at one side of the studio behind a plate glass partition through which he can observe what is taking place in the studio. The voice currents are stepped up by a five step amplifier before being sent to the station; the announcer has the dual duty of announcing and of controlling the modulation, which he is enabled to do by listening to the loudspeaker connected to the line and by using his amplifier controls to correct variations in tone. In the announcer's room there are three phones and three colored lights. One phone goes to the station, one to the orchestra, and

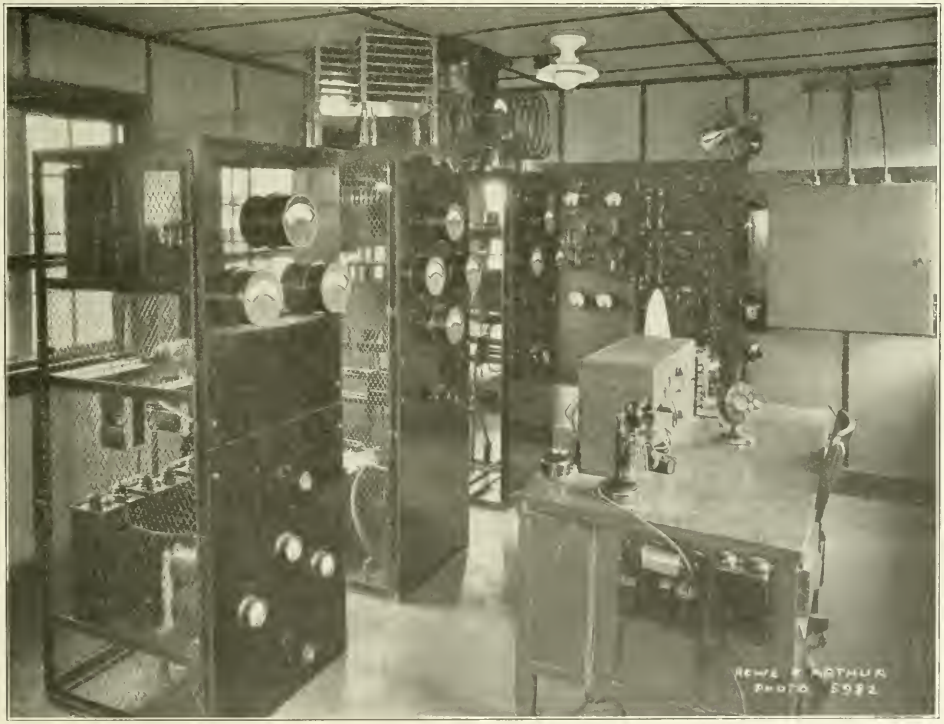

Fig. 2 View of Transmitting Room

one to the organ. While music is being broadcast, these phones call by means of colored lights, instead of bells. A large reception room, placed at one side of the studio, is furnished with comfortable chairs and divans, and an office is provided for the transaction of studio business.

The station proper, at Homewood, Illinois, is connected to the studio by a direct wire line. The

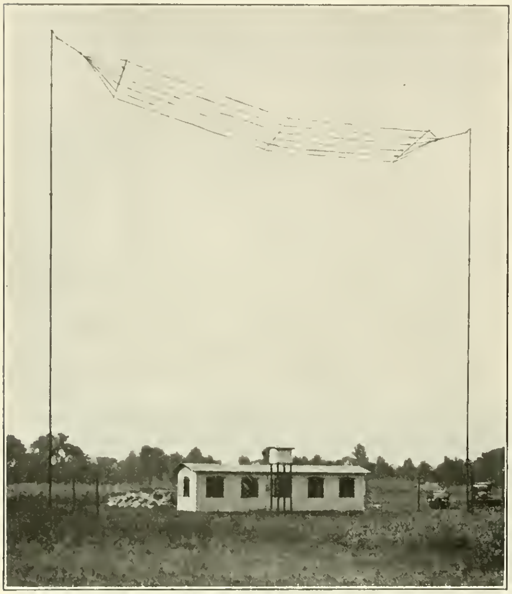

Fig. 1 Broadcasting Station of WOK

voice currents pass over this twenty-five mile line and are sent through another five stage amplifier before being put "on the air." A four wire cable provides extra lines that may be put into service if trouble develops on the ones in use, and carries the direct telephone wires between station and studio.

The antenna, of the six wire "T" type, is located in a clearing, well away from other structures so that absorption will be minimized. The antenna towers, one hundred feet tall, are of steel, set in concrete, and well guyed, as may be seen from Figure 1, which shows the antenna system and the operating room. A counterpoise and a ground complete the external radiating system, which is coupled to the oscillator by means of a tank circuit. This tank consists of a coil and a condenser; it receives the energy from the oscillator and passes it on to the antenna, to which it is coupled by only one wire, connected to the nodal point of the radiating system. This tank circuit insures loose, yet sufficient coupling between oscillator and radiator, giving stable operation and freedom from unwanted harmonics.

The operating room is housed in a small stucco building of the bungalow type, divided into the transmitting and battery rooms. Figure 2 shows the transmitting room. The unit at the right is the oscillator, employing two 5,000 watt water cooled tubes, along with their associated apparatus, in the Hartley circuit. The large meter above and to the left of the oscillator panel shows the amount of current flowing into the tank circuit, which is housed in the next panel and tuned by means of the large variable air condenser mounted on top. In this panel is located the modulator, which also consists of two 5,000 watt tubes. These tubes are of about the same size as an air cooled tube rated at 250 watts, but can handle twenty times that amount of power because the constant flow of water carries off the terrific heat liberated in the tube, and provision need not be made to dissipate this by radiation. A mercury pilot relay guards against overheating of the tubes in case of the failure of the water supply, the contacts of the relay remaining closed and allowing plate current to pass only when there is a sufficient flow of water.

The remaining unit is the speech amplifier, divided into two parts. The lower section uses 50 watt tubes and the upper a 250 watt, mounted in back of the panel together with the necessary impedances and condensers.

A circuit breaker is provided, which, in case of any trouble in any part of a circuit, or at the touch of a button on the operator's desk, opens all of the supply lines. This breaker is placed in the steel box shown in Figure 2.

The operator's desk has placed on it the five stage line amplifier, announcing microphone, specially designed receiving set with loud speaker for monitoring the output, a telephone control box, and two telephones. One is the direct line to the announcer at the Terrace Garden studio, the other a regular subscriber's phone.

The other room in the house is for the batteries. There are two sets, one for the high voltage plate power and one for the filament heating. Enough "B" batteries are furnished to make 4,000 volts, and each cell is almost a foot high, having a rating of twenty-four ampere hours. After a normal day's run, these cells require about ten hours charging to get them up to full charge. The "A" batteries are very large. Each two volt cell is rated at 550 ampere hours, and the bank is connected in series parallel so that 1100 ampere hours may be obtained with a steady potential of eighteen volts. These batteries must be charged once a week for about

(Continued on Page 45)

The Navy Cruise for Engineers

G. W. Lyons, r.e.e. '24

About next April, when the seniors are waiting for the good jobs that will not "turn up", there will probably be a notice announcing a fifteen day cruise with the fleet for the purpose of studying naval installation. The boys would be enthusiastic but for the line reading as follows: "The Navy Department regrets that there are no funds available for this purpose but the appointees are privileged to pay for their rations at $1.50 per day." I signed the application during my senior year, and when June came around my problem was to get to Newport without a ticket. I rode the "Central" to Albany with stop-offs here and there, often by urgent request. The service on the N. Y. C. is very good but I did wish they had roofs between the baggage cars when they took water on the fly.

From Albany to New York City, via the Hudson, the passage was legitimate which means there is no way to ride the boats without tickets. The trip down the Hudson was worth being honest, however, because of the scenery. There were the estates of the Dutch patroons, the cottage of John Burroughs, West Point, with its chapel way up on the bluff, the new Poughkepsie bridge, and lastly the electrified division of the N. Y. C. It was great to see long trains "tearing" along the east bank of the river, silently and without smoke. The trip to Newport was by way of Long Island Sound. I reached there in time to see the U. S. S. Colorado, pride of the Navy, weigh anchor and leave for the orient. The following description of her is found in a handbook: "Majestic monster, $40,000,000 worth of defense; 42,000 tons; 8-16″ guns."

I was sent aboard the Florida, Figure 1, for assignment. Young officers from the Academy are usually placed on this type of ship. As it is one of the second or third class battle ships dating from 1911, it was considered obsolete and was to have been scrapped that fall. There is a great deal of work to be done on such a ship, as they are forever scouring the most remote corners of the double bottom. A "Field Day" was in progress when I went aboard which meant scrubbing everything from stacks to the running boats and from the eyes to the counter. A party of Naval Reserve officers, to-gether with two students came aboard and a general introducing fest followed. One student was from Princeton, not an engineer, and what was worse shook hands with his fingers only. The other civilian was from Rennselaer Polytech. and together we three represented the bulk of the response to the student cruise offer. Commander Munn of the Florida was rather disappointed with both the quality and quantity of the appointees.

The party inspected the Florida and in relating this I must betray my lack of data. I took no notes, but anyone who is interested will find handbooks in any library which contain this information. The two things of particular interest were the gyroscopic compass of a new improved type and the fire (gunnery) control rooms. The improved gyro-compass has two spinning elements which form two sides of an equilateral triangle whose vertex is at the north of the compass card. This method of mounting eliminates the periodic motion or torsion pendulum effect which is always noticeable in the Sperry type with single rotor. The gyro is always

(Continued on Page 42)

Fig. 1
The Florida

Fig. 2
Torpedo Tubes of the Florida

Fig. 3
Aeroplane Catapults

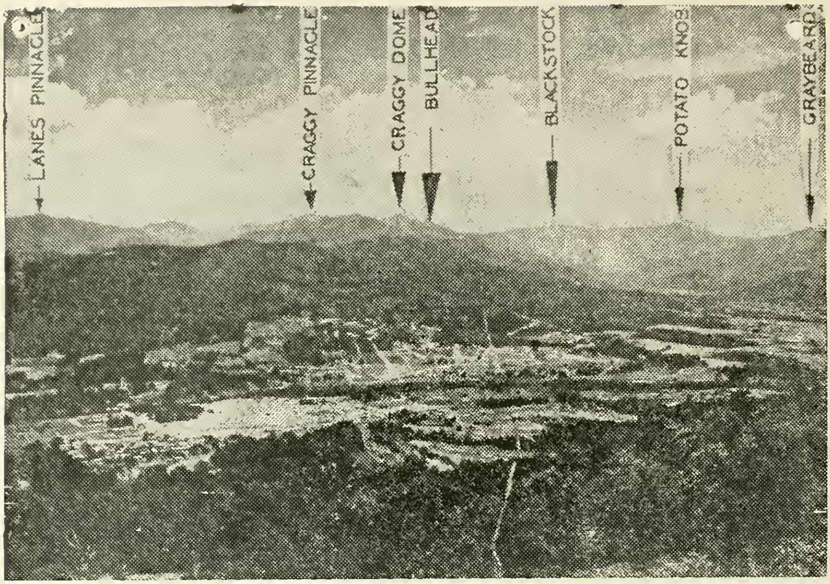

Fig. 1 View Showing Nature of the Country at Asheville, N. C.

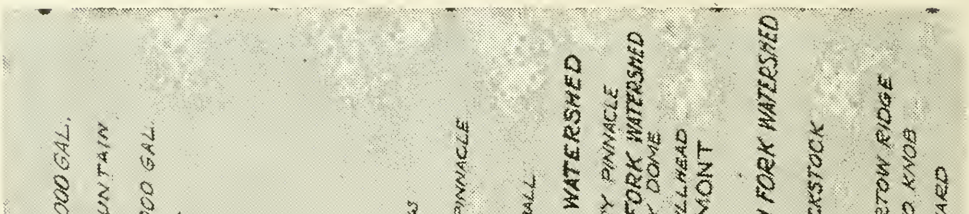

Fig. 2 Watershed with Conduits

Failure and Relief of a Water Supply

C. F. Hendrick, c.e., '26

The drought of the past summer, which caused a general loss of crops throughout the south and east, brought on a severe water shortage in Asheville, N. C., at a time when the city was host to thousands of summer visitors.

Conservation measures were taken early in the summer by prohibiting the use of water for sprinkling lawns or washing cars, while the municipal consumption was at the same time reduced to the minimum. The distributing mains and all plumbing fixtures were inspected and leaks were stopped wherever found. These measures helped, but the situation daily grew more serious. The initial action was followed immediately by restrictions which stopped all unnecessary use of water; shops manufacturing soda-pop were closed and all soda fountains were made to use paper cups and saucers in order to save the water used in washing; construction works were cut off the city mains; and the people were prohibited from indulging in either tub or shower baths.

The tragedy of the situation was that the city was not in the least prepared for an emergency of this sort. The supply had always been ample and of good quality, requiring neither filtration nor treatment. By the middle of August the normal daily supply of seven million gallons of clear, ice cold water had dwindled to little more than a million gallons of tepid, unpotable fluid.

The source of supply is a watershed high in the Blue Ridge Mountains of the Appalachian Range. A glance at Figures 1 and 2 will give some idea as to the nature of the country. The drainage area of seventeen square miles lies at the upper end of the valley in Figure 1. It is heavily timbered, fenced, thoroughly patrolled, and uninhabited. The streams come together at the intake, Figure 2, where at an elevation of 2700 ft. the supply enters a sixteen inch cast iron main that conducts it almost seventeen miles to a five million gallon concrete reservoir located on the mountainside above the city.

The annual runoff from this area is about thirty-three inches from a normal precipitation of between sixty-five and seventy inches. With impounding facilities able to take care of the seasonal variation this watershed would have a gross capacity of twenty-eight million gallons daily. In anticipation of the future demand the city began last year the construction of an impounding reservoir on a new watershed at Beetree, Figure 2, but it was not available in the present crisis.

It had been fully understood all along that a watershed, no matter how good, could not function properly without rain, and rain there was not. The weather bureau stated that it would probably rain eventually, but they couldn't say just when. Something had to be done quickly. The relief work which started about the middle of August progressed rapidly and proved quite effective. The plan was to install temporary pumping plants at four independent sources and force water into the distributing mains of the city. One plant was to be at Beetree, Figure 2, one at North Fork, Figure 2, pumping from a temporary dam below the watershed, and the remaining units were to be placed at artificial lakes a few miles to the west and north of the city. An emergency organization formed under the leadership of the city engineer, called into

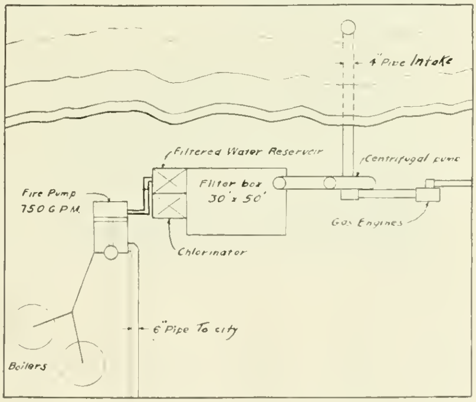

Fig. 3 Plan of a Typical Filtration Unit

service the necessary construction and supply men, and started work. The country for miles around was searched for pumps, boilers, and material of all kinds; chlorinators and other special equipment were ordered; and construction work was carried on night and day.

The arrangement of a typical pumping plant as installed here is shown in Figure 3. The unit consists of (1) feeder pump and suction line, (2) filter, (3) chlorinator, (4) line pump, (5) power plant. The feeder pump is a 4" centrifugal pump with a

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The Santa Barbara Earthquake

J. Russell Bennett, a.e., '28

On the morning of June 29th, I arose as usual, to prepare for my day's work. At 6:45, just as I was ready to wash, there was a peculiar quivering. As I looked out of the window to determine the cause, I was thrown violently against the wall. Recovering my balance, I stood with my legs out spread in order to brace myself, as the whole house shook with a terrific shock and appeared to move sideways a few feet. I stood thus, paralyzed for an instant and somewhat terrified and uncertain, while the house moved back and forth three or four times. Then, realizing that it was an earthquake of gigantic proportions, I tried to rush out of the house. This proved to be quite a difficult thing to do with the floor swaying back and forth. However, after a few bumps and knocks, I finally managed to get out of doors, and just in time to see a large chimney across the street fall away from the rest of the house, crumbling to the ground in the midst of a cloud of dust. The first quake then ceased, to be followed by a second in a few minutes, and many smaller ones in the succeeding hours.

Earthquakes of a varying degree of intensity have occured at one time or another in almost every section of the United States. They are much more common, however, in certain regions than in others. One of these regions is the West Coast and in particular, California, where the most recent quake occurred.

There seem to be a good deal of dispute as to the causes of the tremblings of the earth or the "earth quakes," and the exact cause may very likely vary with each case. Some say that they are caused by the shifting or settling of a portion of the earth's crust, the shifting being due to what is known as "faults" which are caused by volcanic actions within the center of the earth; and others have other opinions and theories. At any rate they are due to geological phenomena. The actions of the earthquakes vary and are often quite freakish, as was the case in this particular one.

The shaking of Santa Barbara in this recent quake, is said by geologists to have been much more severe than the one which shook San Francisco in 1906 when a large part of that city was destroyed. Santa Barbara was not damaged to as proportionate an extent as fire did not follow the quake. Unlimited commendation and credit should be given those individuals who, by their quick work in shutting off both the gas and electricity, undoubtedly prevented an otherwise great loss. Loss of life, fortunately was small, due to the time of the day at which the quake occurred, there being very few people in the business districts where the major amount of damage was done.

The motion of the earth varied with the different tremblers. The first shock, which was about the hardest of all, was mainly a motion sideways, apparently of several feet. It was of considerable duration and caused a large percentage of the damage done. The second shock was almost as hard and of as long a duration. In addition to the previous motions, this one also had a twisting motion. It brought down a great deal that had been loosened by the first shock but had remained in place. Practically all the damage done could be laid to these first two shocks. Innumerable lighter quakes followed and could be felt for several weeks. These gradually became less frequent and lighter as time went on and did little or no damage.

There are many stories as to the actions of the earth and ocean at the time of the big disturbance. The quake to on-lookers seemed to approach them with a motion of the ground like that of a wave. Several of the tremblers twisted violently, while others were an abrupt drop or dip. Some people say that the ocean acted peculiarly during the disturbance. Earthquakes sometimes cause tidal waves, but there was none at Santa Barbara. Early morning bathers say that they were able to touch bottom out where it usually is at a depth over their heads, then the ocean bed seemed to fall again giving the effect of a rising and falling wave-like motion. It is said by some that the tide went out after the first big shock and it is rumored that a large hole of great depth opened up in the ocean bed a mile or two off shore, the water rushing in to fill this, but the truth of this statement has not been established. Some fishermen reported roughness of the ocean and peculiar action.

In general, after the disturbance of the earth's crust, there was no noticeable change in the ground itself except in a few cases. At first there was some question as to the correctness of survey stakes after the earthquake. A check in different localities proved that in most cases there was not enough error to record, except along a section of the ocean front. Here there is an asphalt boulevard and in the preliminary survey there was found an error, I believe, as great as thirteen inches in places. The road was fairly well cracked and broken up. At places, sections of the road were offset several inches. The effect of ground shifting was best illustrated at a country bridge, a few miles out from the city, which was built on piles driven into a slightly jelly-like soil. The shock threw these piles out of line, zig-zagged them, and left them all disordered and of different heights. A reservoir, used for storage and for equalizing the flow of water to the city from the main water supply, was broken up by the earthquake, sending a large quantity of water down the canyon, tearing and cutting it way to the ocean. high off the foundation, without having sufficient bracing, toppled off their piers.

The greatest destruction was in the business district where the quake left things looking more desolate, and laid to waste, than in any other part of the city. It was only the down-town, or business section that showed signs of destruction, at the first glance. The types of construction in which the greatest damage occurred were brick and masonry structures. The failure of those types of construction was in the loosening of the brick and stone, the crumbling of walls and chimneys, the falling away

Views of Destruction Caused by Santa Barbara Earthquake

The main water supply, a large dam across a river in the mountains back of the city, was undamaged by the shock.

The residential district of the city, as a whole, was only slightly harmed; the greatest ruin being in the business district. The principle damage done to homes consisted mainly of chimneys breaking up, in most cases breaking off at the roof line. Chimneys on the outside of houses which were not well tied to the structure, fell away and crumbled to the ground. In some instances where there was poor plaster or else the house was shaken very hard, the plaster was torn loose. In the residential district the homes which suffered the most damage, were those which were poorly built, in most cases due to poor foundations and underpining. Quite a number of old fashioned houses which were built quite of brick and stone walls, and the breaking and falling of fire-walls and cornices. The amount of masonry damage was quite large, several buildings of this construction, (Fig. 5), being practically completely wrecked. Numerous fire-walls broke off and went crashing down, and in the case of higher buildings, caused a great deal of damage by falling through the roof of the buildings next to them which were not as tall. The fire-walls and cornices on the fronts of the buildings failed quite generally, even more than the sides of the walls, crashing to the sidewalk below. This would have caused a great loss of life if it had happened at a time when there were many people on the streets.

The chief cause of the great destruction of brick structures was the failure of the mortar. Trying to save by using cheap mortar cost many dollars. The mortar crumbled and the bricks fell as though they had been laid on top of each other with sand between. Lime had been used with the sand, but not the proper amount. If cement had been used in the mortar as is now being done, there would not have been nearly as great destruction as there was. The next greatest cause of damage to this type of

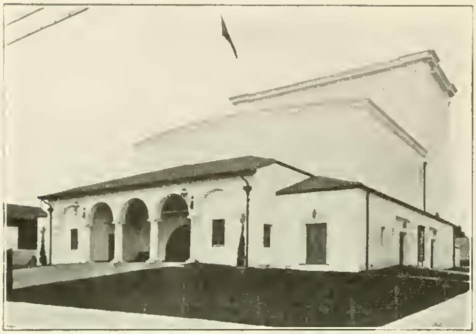

Fig. 6 Theatre Building of Spanish Style

construction was the lack of proper tie between members of the structure.

Where the walls and the inside structure were not anchored together well, the walls fell away from the rest of the structure as though they had been merely set upright with nothing holding them. Fig. 4, a picture of the California Hotel after the quake, shows very well the result of poor wall anchorage. The walls on the two sides of the building not visible in the picture both fell away from the structure. The front wall later fell away, leaving the building looking like a child's doll house, having all sides open, with the partitions holding up the remaining structure. The illustration of the Arlington Hotel in Fig. 3 also shows the failure of brick masonry. Concrete columns and floor slabs were also in this building. A tower once stood as a part of the building where all the wreckage is shown in the picture. The force of the shock was greater on the tower than on the rest of the building, causing it to collapse completely. Fig. 2 shows the damage done to brick-faced structures. All these failures show that better mortar and better tieing together of the members of the structure must be used for safe construction.

Structures of reinforced concrete skeleton and tile or brick filling, failed to some extent, but not to as high a degree as did those of masonry. In some cases, the concrete columns were cracked, but the greatest damage of this type was to the tile or brick filling which was broken up and crumbled to various degrees. One five story building of this type of construction was damaged only on the first floor, the filling being wrecked here, while the upper floors were only slightly harmed. In some buildings the entire filling had to be removed as it was too badly broken up to warrant any attempt at repair. The failure of the filling was again due to poor quality of materials used in the construction and to improper bond.

A four story reinforced concrete store and office building was almost completely wrecked as shown in Fig. 1. The building as "L" shaped. The corner of it was leveled to the ground leaving the two ends of the structure still standing. The greatest reinforced concrete failure to be found occurred in this building. In other cases buildings of this type were not demolished to ruins, but were cracked to such an extent that they will have to be torn down. On the whole, reinforced concrete buildings held up better than other types of heavy construction.

So far, this article may give the impression that nearly all the buildings and structures were wrecked by the earthquake. This is not so, as I have merely attempted to describe and illustrate a few of those that were wrecked to try to show the faults and causes of the failure of different structures which were brought out by the quake. The greater share of the residential district suffered only minor damages, as has been mentioned before. In the business district, there were a number of buildings of semi-frame and masonry construction which were well built and well tied together and withstood the shock with only slight damage. Masonry construction which was well constructed and in which good mortar had been used, withstood the effects of the shock quite well. Other types of buildings that had been more recently built, with proper materials and with proper workmanship, also stood up well. Next to frame structures, reinforced concrete buildings were found to be the most quake proof. There were several examples of this type. On was the Cottage Hospital, which was the only one of the three hospitals in Santa Barbara to escape without serious damage. Another example is the Daily News building which is a two-story reinforced concrete structure built on a foundation to accommodate a four-story building in the future. An excellent example of this kind of structure which withstood the severe quake without a crack, is a theatre building of Spanish style architecture, shown in Fig. 6. It proves conclusively that in a region at all subject to earthquakes, it is best to build of the best materials and to put the best possible workmanship into the job.

Although a good many buildings were ruined, totally or partially, these are rapidly being torn

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Golf Course Engineering

Norman Elsy, c.e., '29

A new field has been opened for men entering the engineering profession in the last few years. Country clubs and municipal golf courses are being laid out in increasing number all over the country.

Large salaries are being paid to men who can do this work, and at present the supply of trained men is far short of the demand.

The young man or student who is planning his life work at this time, if he has any of the requisites for a golf engineer, will do well to look into this profession for it offers a pleasant and profitable field of work.

A student with golf engineering in view can register in either the agricultural or engineering college and by the proper arrangement of his courses cover the ground necessary to fit him for the work. Of course the prime requisite for a golf engineer is a liking for the game, and the ability to play fairly well. Aside from experience pertaining directly to golf, a good deal of civil engineering knowledge is needed to do the work in an efficient manner, but no set rules can be laid down as to procedure. The work is really more like land surveying and the student should always remember what has been said so many times about surveying, "it is an art, not a science," and that good judgment and common sense are of more value than text book formulas and iron bound rules.

I think the best way to show just what the golf engineer has to do in laying out a course is to describe the construction of the St. Andrews Golf club that was started last summer near West Chicago, Illinois. This course was layed out by Fred Deary of Chicago and the surveying and engineering was done by the Geo. G. Nelson Engineering Company of Elgin.

St. Andrews is advertised as the golf club with a practical plan. The club owns two hundred forty acres of land and when the building program is finished there will be two complete eighteen hole courses. One course will be for yearly or daily "fee" players, a charge being made to cover playing rights only. The other eighteen holes and the club house will be for the use of full members. The plan is to have the revenue from the fee course maintain the fairways and greens in both playing areas. The club is located very advantageously—a special station has been provided by the Chicago, Aurora and Elgin Railroad and it is just a short distance from two paved highways.

J. P. Tuthill '17 was in charge of the field work and ran the instrument for the stadia party. Another man ran the transit and laid out the traverse that was used in making the topographical map. Alden Fork, now of the class of '27, William Fenzel and Charlie Mackenberg handled the rod and did the chaining.

To get an idea of the lay of the land and also be able to plan the location of the greens and fairways a topographical map, drawn to one foot, con-

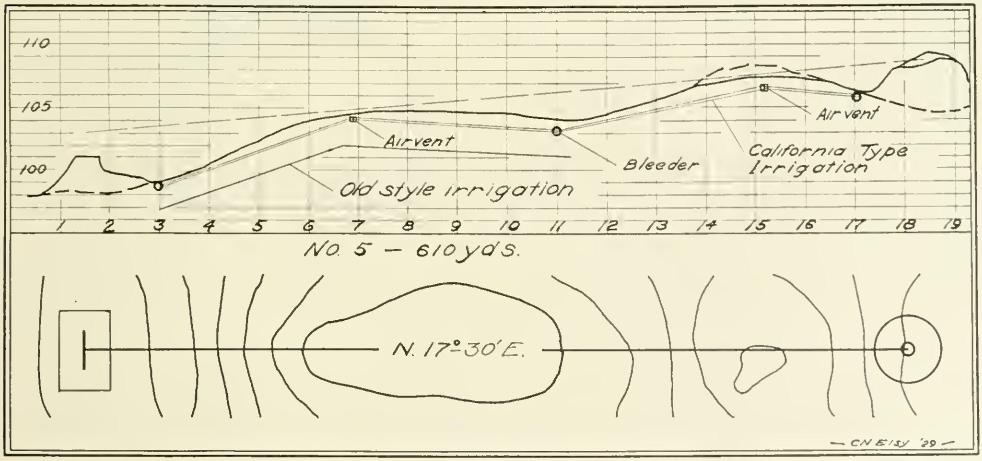


Fig. 1 Profile and Contour Map of Hole No. 5—610 Yards

tours was made. The elevations and distances were obtained by the stadia method.

First a traverse was run around the outside of the tract, the acreage was checked and an outline map prepared. To obtain vertical control and later locate points on the ground, from the map, a traverse of sixty-three stations was established. These stations were wooden two by two's, three feet long, driven in the ground about two feet. The distance between stations was chained and the angle read at all intersections.

A railroad spike driven in a tree at the highest corner was used for a bench mark and given an elevation of 100. A bench circuit was next run to every station and the elevation established was marked on one side of the stake. The number of the station was also marked on the stake to avoid mistakes when the stadia work was being done.

As soon as a few stations were set in the northwest corner the stadia party started in to "shoot" topography. Each station was occupied, the H. I. measured up from the stake, and the angular control established by back sighting on the last station or the station ahead. The rodmen took turns writing down the readings, called by the transit man, and running the rod. In this way each man got a chance to rest and could step along when it was his turn on the rod.

Two 80 page field books were completely filled with stadia notes alone. From these notes the stations were located. About 2000 points were located, and as each point represented three rod readings and an angle reading it meant that about 8000 notations were involved. Most of the calculating and drafting was done by Marvin Fierke now of the class of '29. The finished map was six by eight feet. It can be easily seen from these figures that a topographical map, plated to one foot contours, of two hundred and forty acres is not a small job. By hard work and good management the field work was finished in about one week of working time.

The tees and greens were laid out on the map and then staked on the ground. A traverse was run and the points tied in to some of the primary stations. These points were plotted accurately on the map and profiles of the tee to green line were scaled. The proposed elevations of the tees were marked on the profile, and with the aid of a straight edge the greens were checked for visibility all along the fairway. In this way the designer can see whether it will be better to cut down a hill or raise the tee or green without doing a lot of digging in the field. Figure 1 shows how this is done.

After the holes had been laid out and the final stakes set, the grade stakes for the greens were driven. The outline of the greens were staked with laths, the highest point was marked and a two by four driven to grade at that point. The feature of the green is then worked up, the high point being used as a control.

The drainage of the surface has to be carefully worked out to avoid water pockets, or a fast fall that will wash out the grass. The water is usually drained off the sides of the greens in to traps and then carried away by the drainage system.

As soon as the greens were started the traps and bunkers were laid out. The hazards were staked out with laths in the same manner as the greens. The tees were marked with a single four by four, the top of which was set at the proposed elevation.

The entire area included in the course was plowed and disced and in some places irregularities were ironed out with drags. The discing was kept up all summer so that the hot sun could kill the quack grass. Two Fordsons were used for this work and they performed very well. Teams with Fresnos and slips handled the earth needed to build up the greens and tees also to cut out the traps.

It is very important that a golf course shall be well drained. If water stands in puddles or the ground is soggy after a rain the course will look sloppy and the grass will be torn out by the players. At St. Andrews the surface water was drained in to a pond on the west side of the grounds. A main line was run, following a gully, from the third

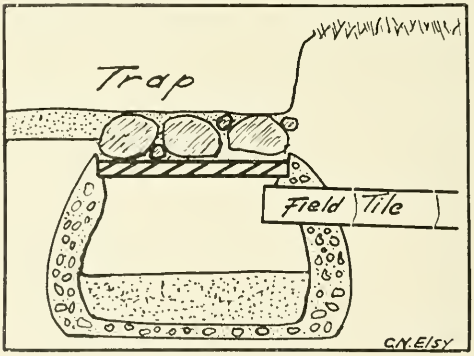


Fig. 2 Catch Basin

green to the north side of the pond. Laterals were run to all the greens and some of the traps that were in low spots. Field tile was placed throughout and laid with open joints.

As sand is used for the bottoms of all traps catch basins have to be built at the inlet of the drains. These basins have to be constructed in the right way, and kept clean or sand will get in the

(Continued on Page 48)

responsibility. Whether the TECHNOGRAPH can count 1925-26 a banner year depends on those who are called engineers. All may not write, all may not work on the staff, but all can be boosters. If you want to see our magazine maintain its position among the engineering college magazines, get behind and push. It is up to you of the "gang north of Green Street."

Smoking on the Campus

Fellows, let's quit smoking on the campus. The University rule against smoking isn't merely a regulation, it's a fine old tradition that loyal Illini have instituted and upheld for thirty-five years. North of Green street the regulation exists in the area bounded by Mathews avenue and Wright street, Green street and Springfield avenue.

No smoking on the campus adds dignity to our institution and commands respect from our visitors. No smoking is also a business matter that is vital to every one of us, for this rule is the only insurance the University has against fire. No fires mean more instructors, more courses, and bigger and better buildings for us. It is for us and the responsibility of making this insurance policy good or bad lies in our hands. Let's make it a good one, fellows, and while we are taking our smoking off the campus, let's deposit fewer "ducks" on the edge. In the present condition of the campus one might truly describe it as being a large and beautiful lawn entirely surrounded by cigarette "ducks".

The Shaefer Prize

For the fifth consecutive time Mr. John V. Shaefer me., '89 is offering prizes for competitive engineering papers. This contest, known as the Shaefer Prize Competition, was instituted by Mr. Shaefer to promote efficiency on the part of engineering students in accurate observation, logical thinking, and the use of good English.

It is generally admitted that we are devoting too little time to the study of good English in our engineering courses at Illinois. When the final examination papers in Rhetoric II are turned in at the end of the freshman year, the popular habit seems to be to forget as much of the work learned as quickly as possible. The results of these tactics have been altogether unsatisfactory.

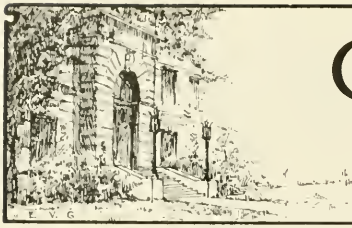
The Shaefer prize should be an inducement to renew acquaintance with the accurate use of good English. So it has proved for a few in the past, but only for a very few. More students should take advantage of this opportunity to test their observation, sense of logical thinking, and use of good English.

There ought to be many inquiring about this competition at the Dean's office in the College of Engineering. Let's try out!

Shaefer prize winners: 1922, Paul F. Witte m.e. '23; 1923, C. E. Parmelee cer.e. '25; 1924, H. E. Wessman c.e. '25; 1925, A. J. Shute m.e. '26.

Welcome

With this issue of the TECHNOGRAPH we "take under our wing" the Chemistry department of the University of Illinois as far as journalistic work is concerned. We are very glad to welcome them to our ranks. It seems as though the situation at Illinois is a little bit unique with respect to the Department of Chemistry. The writer will admit of a not very general acquaintance with all the other universities in the country. At the same time to our knowledge it is by far the usual custom to include the Department of Chemistry in the College of Engineering as one of its departments. At any rate, as its work is strictly scientific and technical, we feel as though there was considerable in common between us. We believe that the "Chemists" can bring to us another slant on scientific and technical life, through their articles and notes, and that certainly is desirable. H. G. Dawson, '27 has been appointed as their representative.



COLLEGE NOTES

Annual Senior Inspection Trip

Architecture

The seniors went on the annual inspection trip the week of October 27. Practically all of the time was spent in Chicago, where a tour of inspection was made of the more important new buildings under construction. The Furniture Mart was the scene of a study of period furniture. Among the buildings visited were the Tribune Tower, the Straus building, and the new Palmer House. A study was made of the layout of the Lake Front development under the direction of E. H. Bennett, chairman of the Chicago City Planning Commission. One of the most interesting features of the trip was the visit to the office studio of Benjamin H. Marshall, the well known Chicago architect. His office, which is the most unique and most costly in the country, is reputed to represent, including the elaborate furnishings, a cost of about $1,000,000. In Mr. Marshall's collection are many priceless antiques, many of which are the only ones of their kind in existence. Among the unique features of his office are a dining room for the office force, and an auditorium with a comfortable stage for productions.

The feature of the trip was a banquet given at the Chicago Architect's Club, where in addition to the elaborate dinner, entertainment and speeches were enjoyed. A chalk talk was given by Charles Morgan, '11, who is one of the best known renderers in this country. The inspection trip, besides being very enjoyable, was highly instructive and beneficial.

Ceramic

The ceramic engineers assembled in Lincoln, Illinois, at eight o'clock Wednesday morning, October 28 to begin the annual tour of inspection. The Illinois China Company at Lincoln was the first plant visited, where the art of china making was shown by the company's guides.

The group left Lincoln at noon for Springfield. Rrepresentatives of the Poston Brick Company met the party at the train and entertained them at a luncheon given at the Abraham Lincoln Hotel. Cars were furnished by this company for the trip to their plant and also to the Springfield Clay Products Company which was the next plant visited. The members of the party were entertained that night at a dinner given by the Springfield Clay Products Company, after which they left for St. Louis.

The Evans and Howard Fire Brick Company was visited Thursday morning, after which the party proceeded to the clay mine operated by the same company. After lunch the sewer pipe plant of the same company was visited where the various problems arising in sewer pipe manufacture were explained. The Quick Meal Stone Company was the next factory visited, where the group was shown the various processes used in enameling sheet metal.

Friday morning the Hydraulic Press Brick Company's plant was inspected, followed by that of the St. Louis Terra Cotta Company. Due to a lack of time, the party was unable to see the newest plant of the St. Louis Terra Cotta Company, which is under construction at present and is one of the most modern plants in the terra cotta industry. Friday afternoon was spent at the LaClede plant and the Christy plant of the LaClede-Christy Fire Brick Company, where the manufacture of all sorts of refractory goods was explained by the guides. The Mound City Roofing Tile Company was the last to be visited Friday. All kinds of tile and all colors used in the industry were shown and the process of manufacture explained to the party.

Saturday morning the group assembled at the Illinois Glass Company at Alton, Illinois. Guides were provided by the company and the party was broken up into small groups of three or four students and one guide. The processes used in making and testing the ware were explained and many interesting features were shown by the guides. The party dispersed at noon in Alton, the students to return to Champaign, and Prof. Hursh of the Ceramics department, who was in charge of the trip, to return to St. Louis, where he attended the Brick convention starting November 2, in that city.

Civil

The civil engineering class of '26 enjoyed this year one of the most successful inspection trips it has had since the annual tour was first taken. We started from Champaign Tuesday afternoon, Oct. 27, with fifty-eight men. After the assembly at 6:30 Wednesday morning in the lobby of the Fort Dearborn Hotel, Chicago, we set forth for Gary, Ind., where we went through the plant of the Illinois Steel Company. The process of steel manufacture was seen from the blast and open-hearth furnaces to the rolling of finished shapes. Having lunched at the Gary Y.M.C.A. where cheers were exchanged with the Lion's Club, civic luncheon club of the city, we proceeded to inspect the fabricating plant of the American Bridge Company at Curtis, wherein the shapes which we had seen rolled at Gary were being made into bridges and buildings. We dined in Chicago as guests of the Illinois Public Utilities Associations. After dinner Prof. Paine of the E.E. Department acted as toastmaster and talks were made by several public utility engineers. These speakers talked on the past, present, and future of Public Utilities in a powerful and illuminating manner.

Early Thursday morning we took a bus ride along the line of the Lake Front improvements of the South Park Commission. Our guides on this trip were R. A. Black, H. E. Wessman, and G. M. Keranen, all Illini. After finishing this trip, we spent the time until lunch inspecting the Lake View pumping station. In the afternoon we went to Evanston, where we saw their pumping and filtration plant ,and then to the Chicago North Side sewage treatment plant, a 13 million dollar improvement now being constructed. After supper we heard a lecture by Mr. Taylor in the rooms of the Western Society of Engineers on the Chicago Plan Commission and its work.

We employed the forenoon of Friday inspecting building construction in the loop and the Wacker Drive street improvement. Through the kindness of Lieberman & Hein, structural engineers, we saw the construction work on the New Masonic Temple and the Eitel Block, after which Mr. Evans and Mr. Jeppeson, of the Chicago Board of Local Improvements, conducted us over the Wacker Drive double-deck street development. In the afternoon we took a ride over the new I. C. yards at Markham, where north and south-bound receiving, classification, and departure yards are under construction. The train was stopped at points of interest and the details of the proposed electrification were explained to us by Mr. Grear, Mr. Mottier, and other officials of the Illinois Central Railroad.

Wacker Drive

The program ended Saturday morning with a ride up the Chicago River to inspect the bridges. The expedition started by launch from the Michigan Boulevard bridge and, after going to the outer breakwater of Chicago harbor, turned up the river as far as the South Halstead Street lift, where we took a ride on the bridge. We were fortunate in having as a guide on this trip Mr. Avery who is in charge of the maintenance work on the Chicago bridges.

The inspection trip officially ended Saturday noon. Everyone was tired by this time, but all agreed that the trip had been pleasant and instructive, thanks to the kindness and patience of the instructors in charge and the friends of Illinois who were our hosts.

Electrical

The Lockport hydro-electric station of the Sanitary District, the Crawford Avenue station of the Commonwealth Edison Company, and the Hawthorne plant of the Western Electric Company were visited on Wednesday. The electricals were the guests of Western Electric for lunch.

That evening, together with the civil, general, mechanical, and railway engineers, they were guests at a dinner given by the Illinois Public Utilities Association at the Edison Building. Prof. Paine was master of ceremonies.

Thursday and Friday were spent in Milwaukee visiting the Westinghouse lamp works, an automatic transformer sub station of the Milwaukee Railway and Light Company, the Lakeside power plant, and the Allis Chalmers Manufacturing Company. Through the courtesy of the Milwaukee Railway and Light Company a special street car was placed at their disposal. The Allis Chalmers Club entertained the electricals at lunch Friday.

Returning to Chicago Friday evening, the Central avenue (Evanston) automatic synchronous convertor substation of the Chicago, North Shore and Milwaukee Railroad was visited.

Saturday morning was spent at the Illinois Steel Company's plant in South Chicago.

Mechanical

Forty-eight M. E.'s, in the charge of Professors Benedict, Polson, and Leutwiler, made visits to various engineering works in Chicago and Milwaukee.

On Wednesday morning the Corwith plant of the Crane Company was inspected. This plant, located in Chicago, has one of the most modernly equipped foundries in the world. Everything is done on the move: moulds are weighted, poured, and broken apart while in motion. A red stream of molten metal is continuously spurting from the cupola into a huge supply ladle, and empty pouring ladles are filled from this perpetual reservoir of liquid iron with scarcely an interruption in their journeys to and from the traveling moulds.

During the afternoon the class inspected the South works of the Illinois Steel Company. Here they were treated to a little of the spectacular; they heard the boom and roar of giant rollings; and they saw the myriads of shooting sparks and the blinding flares of Bessemer convertors.

Thursday and part of Friday were spent in Milwaukee visiting industrial plants there. The Allis-Chalmers plant was the first to be inspected. Here the chief attraction was the immense size of the machinery. Plainly it said, "Big things must be done in a big way." Later, the plant of the Falk Corporation, the makers of the famous herring-bone gears, was inspected. Several unique gear generating machines here attracted much attention. Another object of interest was a huge gear reduction constructed especially for a large Argentine battlship.

The last plant visited in Milwaukee was that of the A. O. Smith Corporation, probably the most singular plant of its kind in the world. Automobile frames are stamped out of plain sheet steel and assembled by perfectly synchronized automatic machinery with practically no aid from human hands.

On the way back to Chicago, a stop was made at Kenosha in order to inspect the plant of the Nash Motors Company. Unfortunately parts of the plant were closed on account of an inventory which was being taken, but in spite of this the M. E.'s were given a good idea of automobile production.

The last place explored was the Crawford Avenue station of the Commonwealth Edison Company; the class disbanded after going through this gigantic power plant.

Railway

Wednesday morning this department, represented by fifteen seniors and accompanied by Professors King and Tuthill, visited the plant of the Illinois Steel Company at Gary. In the afternoon the civil and mechanical men inspected the plant of the American Bridge Company at Curtis, the electrical men returning to Chicago and going through the Crawford Avenue generating station of the Commonwealth Edison Company. On Thursday the railway freight and passenger terminal yards along Roosevelt Road from State Street to Canal Street were inspected, also the Union Station and the Baltimore and Ohio Railroad freight station at Polk Street. The Railway Electrical seniors spent this day in Milwaukee visiting the works of the Westinghouse Electric Railway and Light Company. On Friday the Mechanical and Civils inspected the Burnside Shops of the Illinois Central and the Terminal Improvement between Burnside and Homewood. The Electrical men on Friday went through the works of the Allis-Chalmers Manufacturing Company in Milwaukee, afterwards taking a special North Shore Train to Chicago stopping enroute at Kenosha to inspect an automatic substation. On Saturday morning all three groups went through the Pullman Car Works at Pullman, thereafter disbanding.

Physics Colloquium

The Physics Colloquium is an informal gathering, open to all interested, for the discussion of recent developments in physics and allied branches of science. Most of the contributions are in the form of original research by members of the faculty and advanced students. It is well that there be such an agency for it is valuable not only as a means of disseminating new facts, fresh from the laboratories of the investigator, but also as a source of inspiration to those who are themselves engaged in such work. The Physics Colloquium meets Thursday evenings from seven until eight.

Some of the speakers and their topics of past and future colloquiums are:

October 1—Dr. C. T. Knipp, "Experience in the Nela Laboratory."

October 8—Dr. W. F. Schulz, "Experience in an English University."

October 15—Mr. W. D. Lansing, "Electrolytic Conductivity of Solids."

October 22—Dr. J. Kunz, "Theory of Solutions."

October 29—Mr. E. M. Little, "Ionization Efficiency of Uultra-Violet Light in Caesium Vapor."

November 5—Dr. F. R. Watson, "Optimum Reverberation in Auditoriums."

November 12—Mr. C. N. Wall, "Measurement of Air Velocities with the Raleigh Disk."

November 19—Dr. E. H. Williams, "The Role of Magnetism in Valence."

December 4—Report on Thanksgiving Meeting of American Physical Society.

Experiment Station

Bulletin 148, "Radio Telephone Modulation," by Hugh A. Brown and C. A. Keener.

The purpose of this bulletin is to present and interpret the results of an experimental investigation of the degree of modulation obtained with the systems now in use, and also some modifications of these systems made by Messrs. Brown and Keener. The first part of the bulletin is devoted to a discussion of the characteristics desired in an ideal modulation system, and to an explanation of the methods used in measuring the degree of modulation obtained. In the balance of the report the different systems now in use are discussed, and the results obtained with each system presented in the form of oscillograms and performance curves. The performance curves show the performance of the circuit under different conditions, and, the writers think, should enable the radio engineer to make an intelligent choice of the equipment suited to his particular needs.

Bulletin No. 149, "An Investigation of the Efficiency and Durability of Spur Gears," by C. W. Ham and J. W. Huckert.

The object of this bulletin is to obtain (1) reliable information on the efficiency of spur gearing (2) data on the change in the profiles of spur gear teeth subjected to wear.

A Lewis Gear Testing Machine was used for the experiments and a detailed description is given of the range and control of both load and speed together with information on the gears used and their lubrication.

The tests were divided into two classes—efficiency tests and durability tests. Efficiency and tooth friction curves are given for the various tests performed and also the data and diagramatic changes in tooth profile for the durability tests.

Under "Results of Efficiency Tests" the effects of lubrication, speed, load transmitted, tooth proportion, and irregular spacing of teeth on the efficiency are commented on, and under "Results of Durability Tests," factors which affect durability, characteristics of wear phenomena, effect of wear on the shape of tooth profiles, and theory of failure of gear teeth are studied.

A general summary of "Conclusions on Efficiency and Durability" precedes the three appendices: A. Formulas for Computing Efficiency, B. Historical Review of the Principal Investigations on the Efficiency, Durability, and Strength of Toothed Gears, C. Bibliography on Efficiency, Durability, and Strength of Gear Teeth.

Bulletin 150, "A Thermodynamic Analysis of Gas Engine Tests," by Crandall Z. Rosecrans and George T. Felbeck.

This bulletin has for its purpose the analysis of the constant volume, or Otto, cycle and from the results obtained from an engine operating on such a cycle to get a comparison between theory and experiment in such a way as to reveal the factors which prevent the actual engine from attaining the ideal performance.

The first part of the bulletin takes up the thermodynamics of the ideal Otto cycle. The definition, requirements, efficiency, and sources of loss of the cycle are each taken up in detail together with calculations of the temperatures in the initial and final states.

Part two takes up the thermodynamics of the actual cycle in very much the same as the theoretical cycle. Tabulated forms are given showing the actual data obtained during the tests. The description of the testing plant, giving the accuracy and precision of the indicators and measuring instruments, is complete in every way.

A discussion of the results concludes the report and the authors find that the difference between the actual and Otto cycle may be accounted for by the various engine losses.

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Contemporary Engineering News

Cold Weather Hints.

Motorists are beginning to discover interesting possibilities in the use of glycerine in anti-freeze solutions. It does not evaporate as does alcohol, so that its greater first cost is compensated for by the fact that one filling is enough for a whole winter. Besides, an economically minded person could pour the whole solution into a can when spring came, store it away, and have it to use the next winter, and the next, ad infinitum. The kind of glycerine to use is the yellow distilled variety. Proctor and Gamble Company has placed on the market a correct glycerine solution called Ivo, which is suitable for use in all cars.

The advantages of this solution are many. It has no odor, there is no injury to metal or rubber hose connections, no fire hazard, and the first cost is the only one. Need we say more?

Dream of One Hundred Years to Be Realized.

Louisville, Kentucky, has completed plans for a new hydro-electric plant, to be one of the six largest in the United States. The initial capacity will be 108,000 H.P. with provision for an ultimate of 135,000 H.P. The hydroelectric plant will be located at the site of the dam for raising the level of the river for the canal and will be supplemented by an adjacent steam plant having a capacity of 250,000 H. P. The dam and waterpower plant have been started at the present time, but the steam plant will not be begun until 1928, as the installed power plants are sufficient to take care of the present demand.

The Corps of Engineers of the U. S. Army is in charge of the construction of the dam, which will be 9,000 feet long, will require 80,000 yards of concrete, and cost $3,250,000. The power plant will require 125,000 yards of concrete, and with the generators and switching equipment will cost $7,500,000.

This project is the culmination of a series of endeavors, dating back over 100 years, to use the Ohio for power. The consideration that kept the plans from being executed before this time, however, was the fact that the installed steam plants were sufficient to take care of the demand, would be required as auxiliaries even if there were a hydro electric plant, and represented a large investment that would be idle whenever there was sufficient water to run the turbines in the water power plant. The necessity of rebuilding the canal dam, however, offered an opportunity to install a hydroelectric plant without an excessive amount of extra labor, and as the steam plants would need consolidation and enlargement in a few years at any rate, in order to take care of increased loads, it was decided that a waterpower plant would be a paying proposition. It has been calculated that the investment of seven and one-half million dollars would be justified by 1930; that is, power may be generated at that time at about the cost of that generated by steam.

Rah! Rah! Rah!

There is a real reason why college yells so frequently contain the word "Rah". According to studies made by Dr. Irving B. Crandall and Mr. C. F. Sacia of the Bell Telephone Laboratories, men ordinarily speak this sound louder than any other vowel. If the value 50 be assigned to the amount of energy delivered by a man's voice to the air for this particular sound, then its nearest rival, the sound of "a" as in "tap", comes next at 44, and as in "talk" at 37.

Women's voices present quite a contrast to men's in that there are four vowel sounds of practically the same loudness. These are the vowels in "tone," "talk," "ah," and "rah,". "Ah" is the easiest sound to produce because fewest mouth and throat muscles are tensed; hence it is the basic vowel sound in most languages.

"The Mule of the Farm is More Deadly than the Plane"

Despite newspaper reports to the contrary, airplane accidents are less in number and fatality than those due to other causes. Speaking before a conference of aeronautical and business officials at the Ford Airport, Dearborn, Michigan, Major R. W. Schroeder, A. S., U. S. A., former chief test pilot of the Army Air Service at McCook Field, recently said: "A man in a plane engaged in ordinary straightaway flying is safer than on the ground. I have noted that during a recent year eight persons lost their lives in the entire United States while engaged in civilian flying, while during that same year, in the State of Missouri alone, eighty persons—just ten times as many—were kicked to death by mules."

"I's a Comin'"

(The Technograph will not vouch for the truth of this. However, it appeared in Power, *and has that magazine to back it. It is presented because it may bring to someone the realization of what kind of men these engineers be.)*

At a recent meeting of one of the engineering societies, a group of men were discussing the difficulties of "bringing in" an oil well. One of them told of a well that came in with the liberation of a large volume of gas. A small gasolene engine running near the well found the atmosphere sufficiently rich to propel it, and promptly ran away, notwithstanding its governor had shut off its legitimate source of fuel. In an effort to stop it, the man in charge pulled the ignition switch, drew a spark, and ignited the atmosphere. When those present came to and called the roll, they found everyone accounted for but one negro. Some few minutes later he appeared; when asked where he had been, he replied, "I been comin' back."

The Future of National Electric Service.

The conceptions of the imagination, scientific or speculative, are always interesting. Jules Verne foresaw the submarine, H. G. Wells the aeroplane, and Kipling the dirigible air service long before these things became realities. Bellamy, in his famous book, "Looking Backward," described a system of bringing music and education into the home which closely resembles radio broadcasting. Following the lead of these eminent writers, I, too, am going to risk mentioning one or two future possibilities in the electric field and I shall indulge in nothing more extravagant than the examples I have just cited were thought to be in their time.

The widest known electrical appli-

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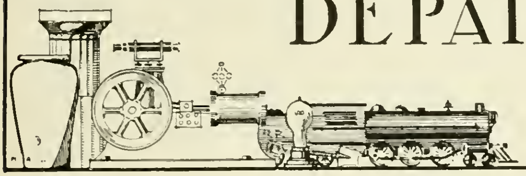

DEPARTMENTAL NOTES

Architecture

Each new year sees new members on the faculty of the architectural department. This year the new additions to the staff are O. M. Olsen, Phillmore Jacobson, Keith G. Reeves, and Clayton I. Meirs. Mr. Olsen is in charge of the junior design class. Before coming to the University of Illinois, he was in the office of Henry Hornbostel, the well known Pittsburgh architect. Mr. Olsen, who is a graduate of Carnegie Institute of Technology, was the winner of the much coveted Stewardson Prize, which gives the winner a year's study in Europe. Mr. Jacobson, Mr. Reeves and Mr. Meiss, have charge of the freshman architectural design, and the sophomore architectural engineers.

On October 8th, the Architectural Society held its first meeting of the year in the Union Building. Short talks were given by the new members of the faculty and by Professors Provine and Dillenbach. The new students were welcomed into the department, and made acquainted with the activities of the department. The meeting concluded with the serving of refreshments.

In the first Beaux Arts design problem of the year, "A Dam," the seniors were highly successful. Clayton Meirs was awarded a Second Medal, while First Mention was given to J. H. Chance, J. W. Gregg, L. R. Berner, L. T. Hedrick, K. W. Helms, Wm. Kramer, H. J. McKee, H. Sobel, and Mary Worthen. This is an unusually good showing since the competition in the Beaux Arts work is very keen and of a very high standard.

Ceramics

The first meeting of the student branch, American Ceramic Society, was held at the Union Building at 7 o'clock, Thursday evening, October 17. President Jack Baer '26, presided. Several talks were given by members of the faculty. Professor Parmelee addressed the Society and welcomed the freshman students.

G. Roeshe '26 was appointed chairman of the committee to take charge of the Annual Pig Roast to be held in the Kiln House in the early part of December.

Dr. A. I. Andrews, formerly a member of the faculty of New York School of Clay Working and Ceramics, Alfred, N. Y., has joined the department here as an instructor. Dr. Andrews takes the position occupied by Mr. Ray Watkins last year. Mr. Watkins resigned to take a position with a jewelry enameling company in Ohio.

Dr. Andrews, who is a Wisconsin graduate, was formerly with the Bureau of Mines.

Civil

Faculty

The Civil Eng.neering Department is fortunate in having for this semester the same staff as of last year with two promotions, Mr. G. W. Pickels, assistant professor drainage engineering, now being associate professor, and Mr. T. C. Shedd, associate in structural engineering, promoted to assistant professor.

Members of the staff have been quite active the past year in technical writing. At this time mimeographed notes for C. E. 95, Plain Concrete, by Mr. Bauer, are being used as a text; a book on Drainage Engineering by Prof. Pickels is with the publishers; and Prof. Rayner's work on Surveying is rapidly nearing completion.

Prof. Wilson is now running a series of tests on Concrete and Reinforced Concrete Arches as committee work for the A. S. C. E. with the assistance of F. T. Mavis, c.e. '22, and R. G. Sturm, graduate students.

Students

The Civil Engineering Department has enrolled for this semester fifteen graduate students, three of whom, L. E. Grinter, J. M. Hardesty, and L. G. Straub, are preparing for their doctor's degree. A. H. Finlay and J. E. Keranen, graduate assistants, are beginning a two year research on earth, gravel, and macadam roads in conjunction with Vermillion County, the Austin Manufacturing Company, and others; while W. K. Brown, University of Texas '24, and E. C. Hartmann, c.e. '23, graduate assistants, are engaged in experiment station work with Prof. Wilson.

The total undergraduate enrollment of the C. E. Department for the current semester is 284, distributed as follows: seniors 65, juniors, 72; sophomores, 70; freshmen, 77. It is interesting to note that the senior class represents almost one fourth of the total.

A. S. C. E.

The student chapter of the A. S. C. E. in its first business meeting of the school year elected the following officers: President, E. C. Bray; vice president, J. D. Voorhees; secretary, S. C. Bean; treasurer, R. E. Hiles.

Open meetings are to be held on the first and third Thursdays of each month at four o'clock in Room 221, Engineering Hall. The first of these, Oct. 15, was well attended and short talks by graduate students, Findley and Mavis, were enjoyed by all. These meetings, while primarily for students of Civil Engineering, are open to all, and a cordial invitation is extended to those interested in hearing a good talk on a vital topic.

Chemical

The American Chemical Society

On Tuesday, October 20, Dr. T. B. Hine of the Western Electric Company of Chicago, spoke on "Smokes; The Colloids of the Air" before the first meeting of the American Chemical Society this year. The first scientific study of smokes was made during the war when it was employed as a camouflage and a toxic agent. Like many other scientific studies, the study of smokes flourished during the war, but practically ceased after the signing of the armistice. The chief work in this field is being done at present by the Chemical Warfare Service at Edgewood Arsenal of which Dr. Hine was the head previous to his acceptance of his present position with the Western Electric Company.

Smokes are suspensions of solids or liquids in the air. The size of smoke particles varies from 10^{-3} to 10^{-6} centimeters in diameter, but the average is from 10^{-4} to 10^{-5} centimeters in diameter. These particles do not settle rapidly and are easily carried by air currents. Many attempts were made to spray smokes from airplanes, but these failed because the rush of air from the propellor atomized and dispersed the particles too rapidly. After some experimentation. Dr. Hine hit upon the idea of shooting the smoke to the rear of the airplane with the same velocity as that of the airplane, which would give the smoke particle a zero velocity. Today it is possible to lay down opaque curtains a thousand feet high and several miles long in a few minutes.

It is generally considered that a smoke which will obscure an object at a distance of twenty meters from the observer is a dense smoke. We have often heard the expression that a smoke was so dense that you could cut it with a knife. yet if the particles of a smoke so dense that we could not see our hand at arm's length were magnified to the size of a football, they would be 154 feet apart. An obscuring smoke, to be most economical, should utilize some constituent of the air. Phosphorus takes oxygen out of the air to form phosphorous pentoxide which reacts with the water vapor in the air to form tiny white droplets of phosphoric acid. Concentrated sulphuric acid is an excellent fog producer as it readily absorbs moisture from the air. During the war, concentrated sulphuric acid was sprayed down the funnel of a battleship and the draft from the boilers carried it out into the atmosphere to form a dense curtain of smoke. Dr. Hine suggested that someone invent a cheap method, which could be carried out on a small scale, of manufacturing sulphuric acid from sulphur on the scene of action as sulphur is very cheap and not as dangerous as the acid to handle.

Very few people know of the organization or importance of the American Chemical Society. The American Chemical Society was organized in 1876, and today it is three times as large as any other organization of chemists in the world having 14,500 members. "Chemical knowledge and industry are fostered in every possible way, and the members are offered every opportunity to keep abreast of the advancement of chemical science." To this end the Society publishes two monthly journals, a semi-monthly abstract journal and a semi-monthly news edition. The first serious attempt to build up a chemical literature in English, without primary regard to commercial considerations, has begun in a series of scientific and technological monographs now being issued by this Society. The members in various sections of the country are organized into local sections of which there are sixty-seven located in thirty-nine states.

The next meeting of the Society will be held on November 23. James F. Norris, president of the American Chemical Society, has accepted an invitation to speak at this meeting although he did not state the subject of his talk. An election of officers for the coming year will also be held at this meeting.

Department Notes

The registration in elementary courses of chemistry this year is the largest since 1918-1919 when chemistry had a boom according to Prof. Hopkins, head of the Inorganic Division. At present there are ninety-seven graduate students majoring in chemistry. Last year ninety-six degrees in chemistry were conferred with the following distribution: bachelors, 45; masters, 33; doctors, 18.

Have you purchased a "Chemrule"? These rulers are sold by the American Chemical Society as a part of a campaign to introduce metric units as a standard in this country. They are 40 centimeters in length and have a very compact and accurate atomic table on the back of the rule. They can be purchased at the general office of the chemistry laboratory for ten cents.

"The metric system is legal in all of the nations of the world and compulsory in all but the United States and Great Britain. It is used here in foreign trade, in electricity, chemistry, physics, biology, medicine and to a growing extent, in domestic trade and industry.

"Chemists use the metric system by preference, even carrying it over into manufacturing to great advantage in certain instances. By buying chemicals and apparatus according to metric specifications and dispensing them similarly to students and publishing all experimental results in metric equivalents, it is believed that there is offered to the general public a demonstration that the metric system is thoroughly practical and that its adoption will be attended by no hardships whatever."—Eugene C. Bingham, *Journal of Chemical Education* (Jan. 1925).

General

Department Notes

The enrollment in the General Engineering Department is greater than that of last year.

There have been two changes in the curriculum. Sophomores find Ec. 2 substituted for Ec. 1 in order that their schedules will not be overloaded by the new four year Physical Education system. Geology and Ec. 41 are now required in the fourth year, thereby decreasing electives.

G. E. Society

The G. E. Society held its first meeting September 29 at which the following officers were elected: President, H. C. Stearns, '26; vice president, J. J. Brownlee, '26; secretary, J. L. Pertl, '27; treasurer, G. E. Beverly, '26; chairman of program committees, H. P. Arkema, '26.

Plans were laid for a smoker and for a general get-together of faculty and undergraduates in the near future.

Mechanical

New Instructors

Three new instructors have been added to the department this semester.

G. A. Gafvert from Wooster Polytechnic Institute, where he taught engineering subjects for two years after graduating there in 1922 with a B. S. in mechanical engineering. Last year he received his M. S. degree. Mr. Gafvert is an assistant here in machine design.

C. H. Caughery is also teaching in the machine design department. He graduated from the University of Colorado, and for several years afterward he was an instructor there under Prof. F. S. Bauer, a U. of I graduate of the class of 1911. Mr. Caughery received his M. S. degree last year.

Paul E. Mohn is the third addition to the M. E. faculty. He is a graduate of Penn State. During the last three years, he taught mechanical engineering subjects at Renssalaer Polytechnic Institute, Troy, New York.

NEW EQUIPMENT

A recording controller has been recently installed in the Forge Laboratory. It keeps a dot and dash record of two thermo-couples having a temperature range of from 200° F. to 1800° F. Besides, the device is used for the automatic temperature control of a Westinghouse electric furnace. Leeds & Northrup are the manufacturers.

The Forge Laboratory also boasts a new type FH crucible heat treating furnace, together with an electric transformer. This equipment was purchased from the Hoskins Manufacturing Company. The furnace is one of the modern electric pot type. It will be used for instructional purposes.

Several new appliances have been lately bought for the foundry. One of these is a Universal sand riddle. Another is a Tycos Thermopyre. This is a pyrometer for controlling temperatures of molten metals. It was purchased from the Taylor Instrument Company.

A number of non-reversible plug and adjustible templet thread gauges have been added to the equipment of the Machine Shop inspection department.

Other recently purchased equipment includes two B & L metallurgical microscopes, two convertible lamps, and two No. 1848 resistances.

DEPARTMENTAL NOTES

An investigation concerning the measurement of air flow through orifices is being conducted by Mr. B. G. Wilson. Mr. Wilson has been just recently employed by the department as a special research man. He holds a degree of M. S. which he secured at Bushnell University. In his present investigation he is endeavoring to find a simpler way than the old weighing method of accurately measuring air.

Mr. Whitten, an instructor in machine design here last year, resigned in June, and is now engaged in engineering sales work for the Brown Instrument Company. His headquarters are in Pittsburgh, Pennsylvania.

Prof. C. W. Ham gave an address on October 2 before a general session of the A. G. M. A. on "Recent Developments in Gear Research." The meeting was held at West Baden Springs in the beautiful resort town, West Baden, Indiana. Men of national prominence were on the program. Among these was Brigadier General J. F. Fechet, assistant chief of the air service.

Prof. Ham has been prominently engaged in gear research work for a number of years. In conjunction with Mr. J. W. Huckert he got out a bulletin this summer entitled, "An Investigation of the Efficiency and Durability of Spur Gears." The men were two and a half years in collecting the data for it. Prof. Ham directed all the research work, while Mr. Huckert performed the necessary experiments.

Prof. Goodenough spent a month this summer with the General Electric Company at Schenectady, New York. He also made an extensive automobile tour during the vacation period of Northeastern United States and Southeastern Canada, visiting places of interest in Maine, Vermont, New Hampshire, and Quebec.

The twist drill investigation being directed by Prof. Benedict has not yet been completed.

F. E. H.

Mining

The Mining School opened its new year of activities with a smoker given on September 9 at the Union Building. All members of the Mining Faculty spoke on subjects concerning the Mining Society of the University, in which they urged all of the students to join that organization. Professor A. C. Callen, head of the Mining school also urged the members to join the American Institute of Mining and Metallurgical Engineers.

A meeting of the Mining Society was held two weeks later in the Union Building, showing a very large attendance. In fact, a greater percentage of mining students had joined the society than was expected. Professor Callen gave a very interesting talk on "The Relation of Education to the Practical Life," in which he emphasized the advantage of cultural studies as an aid to the engineers in their work. Mr. C. Borror, President of the Mining Society has planned a meeting for every two weeks during the following year, when some member of the faculty will speak on a subject pertaining to Mining and to add more spice to the meetings, the student members of the society will tell of their personal experiences in mining camps during the summer months.

During the summer months, Prof. A. C. Callen, head of the Mining school, spent most of his time organizing and preparing for the new school year. This fall he attended the International First Aid and Mine Rescue contest which was held at Springfield, Illinois, on September 10 to 12.

Prof. A. E. Drucker spent the summer in research for a suitable process for treatment of Ceylon and Madagascar graphites for the Chicago Crucible Company. A means of refining was successfully developed, enabling this company to put a better grade of graphite crucible on the market.

Professors A. J. Hoskins and C. M. Smith spent two months this summer conducting experiments in mine ventilation at two of the largest mines in the southern part of the state. A University of Illinois Bulletin No. 151, "A Study of Skip Hoisting at Illinois Coal Mines," by Prof. A. J. Hoskins has been published, and is now ready for distribution.

Prof. I. M. Marshall spent last summer in exploration work for a well known mining company in Canada. Much of his time was spent in visiting the large, new gold districts of Gowgonda, Lake Loida, and Rouyn.

Railway

INSPECTION OF TEST CAR

The staff of the department of railway engineering and the students in the mechanical division this week inspected a test car now ready for delivery to the Kansas City Southern Railway. The car was designed and equipped by the Burr Company of Champaign, the sole makers of this class of apparatus in the country. This firm has made many of these dynamometer cars for American and South American railways. The present car is the most elaborate of any that have been buil there, including not only the regular installation of instruments for determining the performance of locomotives and trains, but also a complete track inspection equipment.

The car will be used for the purpose of determining the most efficient make up of trains for different divisions of the railway company as well as to test the effect of special equipment now available for improving locomotive performance. The track inspection equipment will enable the company to test out the guage and alignment of the track itself merely by running the car over it. Automatic devices paint signals at spots where the track needs repair.

Since the pioneer work in railway dynamometer design in the jointly owned car of the Illinois Central Railroad and the University, the railway dynamometer car has found wider and wider uses and is recognized as the one scientific instrument available for a method of determining economical means of train operation.

The Kansas City Southern car is fifty-two feet long inside, is equipped with an ample office and shop, with berths for eight operators, a complete kitchen, and separate berth and wash room for a porter. The car is built of steel, representing an investment of over $70,000.

New Equipment

The department of railway engineering has just added a new air compressor to its demonstration air-brake rack which was finished last spring. The compressor was furnished by courtesy of the Peoria & Eastern (Big Four) Railroad, through the office of Mr. A. M. Armer, master mechanic, in Indianapolis. It is a Westinghouse machine, eleven inch, single stage, replacing a No. 1 New York compressor.

The air-brake rack has been in the process of design and erection for some time, including an assembling of parts from a variety of makers of this equipment. It is intended primarily for demonstration purposes, with special duplicates of many valves showing the operation of their internal mechanism. With it the department can demonstrate to its students different braking arrangements as used in practice. It was put up in conformity with the demands of practice, inasmuch as its has appeared that mastering the intricacies of the air-brake presents a serious practical difficulty to the railway graduate lacking special instruction. It is possible to operate the cylinders, analagous to those on freight trains of some length, by various parallel types of controls in the Westinghouse and New York makes.

The equipment was designed by Prof. E. C. Schmidt and Mr. H N. Parkinson, and is now in charge of Mr. H. J. Schrader, successor to the latter. It is located in the brake shoe laboratory which has recently been improved by the installation of a concrete floor.

Department Notes

The railway department welcomes a new man on its staff this year. He is Mr. H. J. Schrader, a graduate of Purdue University in the class of 1923 from the department of railway mechanical engineering. Since his graduation and before coming here, Mr. Schrader was working in the mechanical engineer's office of the Chicago Indiana and Louisville Railroad (Monon Route) at Lafayette, Indiana. He will teach here locomotive and car design. Mr. Schrader will fill the vacancy left by Mr. H. N. Parkinson, who is returning to the mechanical department of the Chicago, Milwaukee and St. Paul Railway at Milwaukee. Mr. Parkinson will have charge of a group working on the design of cars and locomotives. It will be remembered that he came from that office in 1921 to teach here.

News from some of the alumni indicate their present vocations: LeRoy Tucker '23 is working on the construction of a new bridge across the Mississippi River at Fort Madison, Iowa, for the Santa Fe Railroad; F. B. Matterhawsen '21 is with the Cuban Railway Company at Camaguay, Cuba; F. B. Shaw '11 has resigned from his position as chief engineer of the Cuban Railway Company and has returned to the United States; L. R. Lamport '23 is on a Missouri Pacific Railroad locating party; H. Groth '20 is in the office of the American Bridge Company at Gary, Indiana; S. Forsythe '24 is in the operating department of the Chicago Surface Lines; M. H. Genena '25 is with a Rock Island locating party in Oklahoma.

The Railway Club held its regular meeting Nov. 3 in Room 117 Transportation Building. Officers for this year are: president, J. H. Smith '26; vice president, W. L. Hunt '26; secretary-treasurer, H. G .Mason '26.

The enrollment in this department has dropped to 43 students this term against 46 last year and 53 the year before. Fifteen of these are taking railway civil engineering, 21 railway electrical engineering and 7 railway mechanical engineering.

Prof. J. M. Snodgrass, of the department of railway mechanical engineeding, spent the past summer in doing special research work for the Commonwealth Edison Company of Chicago in regard to the operation of several subsidiary railroads controlled by the Insull Interests. What will come of his results is not publicly known.

G. Buchanan, Jr., min.e., '22, is employed by the Old Ben Coal Corporation in its experimental coke plant at Waukegan, Illinois.

Earnest Martinson, c.e., '24, is in the Engineering Department of the city of Gary, Indiana.

L. W. Huber, min.e., '21, is employed by the B. F. Sturtevant Company of Chicago as an expert in their Mine Ventilation Equipment Department.

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ance is, perhaps, the incandescent lamp, but it is a most wasteful and extravagant form of the conversion of electricity into light. Only about five per cent of the force which is expended in an incandescent lamp is converted into light. Therefore, there is practically a clear field for research in this service alone, concerning which J. B. S. Haldane—the great English scientist of the University of Cambridge—says, "To light a lamp as a source of light is about as wasteful of energy as to burn down one's house to roast one's pork. It is a fairly safe prophecy that in 50 years light will cost about a fiftieth of its present price, and there will be no more night in our cities. The alternation of day and night is a check on the freedom of human activity which must go the way of other spatial and temporal checks."

The most modern and efficient steam turbine engine turns out about sixteen per cent of the theoretical power contained in the heat units of coal. Here is eighty-four per cent of a field in which science may work, and who can say that sometime, even in the near future, electricity may not be produced direct from heat, thus doing away with the use of the steam for that purpose. Even tomorrow there may be discovered a cheap foolproof and durable storage battery which would revolutionize the electric light and power industry by enabling it to store electricity as gas is now stored in a gas-holder or oil in a barrel.

Concerning the wind as the chief source of power, Mr. Haldane says that he thinks the power question in England ultimately may be solved somewhat as follows: "The country will be covered with rows of metallic wind-mills working electric motors which in their turn supply current at a very high voltage to great electric mains. At suitable distances there will be great power stations where, during windy weather, the surplus power will be used for the electrolytic decomposition of water into oxygen and hydrogen. These gases will be liquefied, and stored in vats—vacuum jacketed reservoirs, probably sunk in the ground. If these reservoirs are sufficiently large, the loss of liquid due to leakage inwards of heat will not be great; thus the proportion

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Fraternity Activities

Tau Beta Pi

At the first business meeting held this year by Tau Beta Pi, the honorary scholastic fraternity, plans for the coming year were laid and a program outlined. This includes a banquet and a "get-together" in November. The latter affair is to be in the form of a freshman smoker. Its purpose is to acquaint the new student with Tau Beta Pi and its functions, the value of high scholarship, and especially the importance of the literary side of an engineer's education. This last meeting, held at the home of Mr. W. N. Espy, was concluded with pumpkin pie and coffee. R. E. Peterson, with his record-breaking appetite, upheld his former reputation.

The national convention of Tau Beta Pi, which met October 15, 16 and 17, was attended by delegates R. E. Peterson and W. E. Lynch of the local chapter. Officers of the present semester are: W. E. Lynch, president; P. E. Soneson, vice-president; L. D. Fetterolf, recording-secretary; N. J. Alleman, corresponding secretary; E. M. Sobota, associate editor of "The Bent"; and J. C. Vorhees, treasurer.

Eta Kappa Nu

Eta Kappa Nu began the year's work with a business meeting held October 8. Activities for the coming year were discussed. A program committee was appointed for the semester and instructed to report at the second regular meeting of the year on October 22. The officers elected last June for the current semester are as follows: E. M. Sobota, president; R. O. Askey, vice president; P. W. Emley, recording secretary; W. S. Duncan, corresponding secretary; Wayne Hickman, treasurer; W. T. King, associate editor of "The Bridge"; F. B. Powers, master of initiation; and W. L. Branch, sergeant at arms.

Phi Alpha Lambda

Phi Alpha Lambda, honorary general engineering fraternity, was officially installed at a banquet given May 19 at the Southern Tea Room. The main speaker was Prof. R. A. Hall, who in his talk traced the development of engineering from ancient times. The graduating seniors also gave short talks.

Since all the juniors of last year have come back, prospects for an active year are very bright. A class will be initiated both first and second semesters. Plans have been made for keeping graduates in touch with the active chapter by means of circulating letters.

Delta Mu Epsilon

Delta Mu Epsilon, honorary mining fraternity, has pledged three juniors this fall, B. H. Melvin, R. E. Lager, and L. S. Voltz. Professors A. C. Callen and I. M. Marshall were pledged honorary members. Officers for the year are: E. R. Martin, president; C. R. Nelson, vice president; C. Borror, secretary; and C. G. Stevens, treasurer.

Theta Tau

Theta Tau started out the new school year by having a smoker at the Ilus house. As a result eighteen men were pledged, all departments being represented. Arrangements are being made for a chapter dance on December 11. This dance is to be in the nature of a Christmas party.

Several prominent men have been obtained to speak at some of the meetings to be held this fall. The officers for the ensuing semester are as follows; E. H. Taze, president; W. E. Lynch, vice-president; T. J. Hynds, secretary; E. D. Ponzer, treasurer; M. M. Cooledge, corresponding secretary.

Gargoyle

The officers of Gargoyle for this semester are: P. E. Soneson, president; J. W. Gregg, vice-president; W. Edholm, corresponding secretary; J. S. Berner, recording secretary; J. E. Sill, treasurer.

Among the main incidents of the coming year will be the award to the freshman student of architecture or architectural engineering who has made the best record during the last year, the freshman smoker, and the bi-weekly meetings at which interesting papers are presented.

Mu San

Mu San, professional municipal and sanitary engineering fraternity, has elected the following officers for this year; H. A. Vagtborg '26, president; J. C. Sager '26, vice-president and treasurer; H. E. Schlenz '27, secretary; and E. L. Hopper '27, historian. A smoker was held in the early part of November followed by a meeting at which plans were made for the year.

Chi Epsilon

Chi Epsilon, honorary civil engineering fraternity, resumed activity this fall under the able leadership of president E. C. Bray, and a very successful year is predicted. Eight men have been pledged to active membership this fall: C. F. Hendrick '26, V. E. Gunlock '27, D. H. Pletta '27, W. S. Cook '27, H. W. McCoy, '27, E. D. McKeague '27, R. A. Niles, '27, J. D. Cavanagh '27; and to honorary membership; Prof. F. B. Seely, and Prof. T. C. Shedd.

Sigma Epsilon

Sigma Epsilon, professional railway engineering fraternity, has elected the following officers for this year: H. G. Mason, president; T. C. Stressor, vice president; J. H. Smith, secretary; and W. L. Hunt, treasurer. At a recent meeting plans were definitely made for the year's work.

E. C. Hartman, c.e., '24, is employed with the Mississippi Bridge and Iron Works at Decatur, Illinois.

G. O. Bates, c.e., '24, is working as transitman for the Illinois Traction System.

Walter B. Worsham, e.e., ('11), is with the Illinois State Division of Highways in the Department of Public Works and Buildings.

E. H. Allison, min.e., '22, has opened a consulting engineering office at 105 W. Monroe, Chicago, Illinois.

C. C. Hubbart, min.e., '15, is chief engineer for the Superior Coal Company at Gillespie, Illinois.

H. L. Hildenbrand, e.e. '25, will enter the Industrial Department of the Westinghouse Electric and Manufacturing Company at his completion of that company's student course.

ALUMNI NOTES

(Courtesy Illinois Alumni News)

THIS IS WENSEL MORAVA, C.E., '78, STANDING BESIDE THE RIVER JORDAN. HE'S A GREAT TRAVELLER SINCE HE RETIRED FROM ACTIVE BUSINESS. NO SOONER DOES HE RETURN FROM ONE TRIP THAN HE'S OFF ON ANOTHER.

E. E. Orr, arch. '96 has retired and is taking care of his estate at Quincy.

A. C. Hobart, c.e. '97 is a construction engineer in Boston.

M. V. Stewart, e.e. '01 has been appointed commercial engineer for the General Electric Company, at Schenectady, New York. He recently returned from Mexico where he has been for 12 years.

A. C. Martin, c.e. '02, in his capacity as member of a committee of Los Angeles engineers, is making a survey of the effect of the recent earthquake on the buildings in Santa Barbara, California.

J. A. Dailey, m. & s.e. '07 is assistant engineer for the Sanitary District of Chicago.

E. J. Wheeler, c.e. '11 is in baltimore, Maryland, where he is building a plant for Montgomery Ward & Company. He expects to finish soon and return to the home office of his firm, The Wells Brothers Construction Company.

G. Gloyd, arch. '12 is practicing in Kansas City, Missouri.

H. O. Dany, m.e. '14 is chief draftsman for the American Blower Company of Detroit, Michigan.

W. L. Parish, c.e. '16 is structural engineer for Clausen, Kruse, and Klein of Davenport, Iowa.

C. L. Pitts, arch. '16 has taken over the office of the late G. H. Washburn at Burlington, Iowa. He came to Burlington as supervising engineer on some high school and stadium work for Temple and Burrows of Davenort.

C. E. Sargent, ry.e. '86 is vice-president in charge of the operating department of the Illinois Central Railroad. He began as a track apprentice for that company.

A. C. Martin, a.e. '02 is an architect in Los Angeles.

L. B. King, c.e. '03 is a partner in the firm of King and Petry, contractors and structural engineers, Champaign.

C. A. Petry, c.e. '11 is the other member of the firm of King and Petry.

C. P. Turner, e.e. '04 is with the General Electric Co.

J. Matonsek, c.e. '05 is engaged in general contracting at La Grange, Illinois.

M. B. Case, c.e. '06 is a bridge engineer in Philadelphia.

A. C. Brancher, c.e. '84 is a civil engineer and surveyor in Lincoln, Illinois.

W. L. Abbot, m.e. '84, chief operating engineer of the Commonwealth Edison company, Chicago, has been nominated for the presidency of the American Society of Mechanical Engineers. The election will be held in December.

H. J. Blanchard, a.e. '87 is practicing in St. Louis.

J. H. Eno, m. & s.e. '91, is professor of municipal engineering at Ohio State University.

C. A. Grenn, arch. '92 recently returned from the Philippines, South China, and Hawaii where he was a mission architect. He started east by auto from Los Angeles, but wrecked the car by a blowout in Arizona. He proceeded by train to Champaign and Chicago where he bought another car and continued his journey.

H. R. Linn, m.e. '96 is an engineer for the American Radiator Company of Chicago.

B. H. Prater, ry. '03 has recently been promoted to assistant chief engineer of the Union Pacific Railroad and chief engineer of the Oregon Short Line Company with headquarters at Salt Lake City, Utah. He began his career as an instructor in surveying and masonry laboratory and assistant in bridge design at the University in 1903 and 1904. He left the University to become a transitman on the Panama Canal. Later he became division manager for the Chester Shipbuilding Company of Chester, Pennsylvania, and just previous to his promotion, was chief of maintenance of way for the Oregon Short Line.

Gilbert Smith, min.e. '24, is mining engineer for the American Smelting and Refining Co.'s coal mines at Rosita in Coahuila, Mexico, where the company has completed a million dollar coking plant. Gilbert has a staff of laborers, draftsmen, and assistant surveyors to aid him in his work.

N. Tolch, min.e. '24 is doing mill work for the Utah Consolidated Company at Bingham Canyon, Utah.

A. G. Cadaval, min.e '24. is in Mexico City with his father in charge of his father's mining interests.

R. Fleming min.e. '24, is full instructor with the Maryland Mining Bureau.

E. F. Carpenter, min.e. '23, is assistant-superintendent and H. Gjssing, min.e. '23, is chief assayer of the Tomboy Gold Company, Ltd. at Telluride, Colorado.

C. Butters, min.e. '23, is taking the one year training course given at the Sullivan Machinery Company, manufacturers of mining machinery, which will enable him to sell the products of the company.

Albert Koenan, min.e. '23, is acquiring mining experience at McGill, Nevada with the Nevada Consolidated Company.

J. Blair and George Morris, both min.e. '23, are working in Great Falls, Montana, for the Electrolytic Zinc plant of the Anaconda Company. Morris has been promoted to a plant foreman's position.

A. Coltu, min.e. '23, is a mining engineer in Oklahoma, doing development and prospecting work for the Mining and Petroleum Company of Oklahoma.

W. E. Bull, e.e. '18, is supervisor and telephone equipment engineer at the Western Electric Company's Hawthorne station, Chicago.

E. J. Guardia, c.e. '21, is designer of bridges for the highway department of Panama City, Panama.

R. E. Spangler, arch. '21, who was formerly an architectural draftsman in the supervising architect's office, is now teaching in the architectural department of the University.

D. A. Branigan, c.e. '22, is connected with the state highway engineering department at Amboy, Illinois.

R. W. Morton, m.e. '23, is instructing in the mechanical engineering department of the Colorado School of Mines at Golden, Colorado.

M. S. Angier, e.e. '24, Olympic javelin thrower, is doing electrical engineering work in Edgewood, Pennsylvania.

C. H. Dodge, min. '24, received the degree of Master of Arts from Carnegie Institute of Technology and is now assisting superintendent of the Palmer mine of the H. C. Frick Coke Company, Antram, Pennsylvania.

W. H. Pfeiffer, cer.e., '24, is an assistant in research at the Ceramics Department at the University.

R. H. Louden, cer.e., '24, is with the National Tile Company. He is married to Frances Kurtz, '24.

J. Grout, cer.e., '25, is assistant to the general manager at the Acme Brick Company.

F. W. Mueller, m.e., '24, is in Springfield as a mechanical engineer for the Central Illinois Public Service Company.

C. G. Fels is at Perth Amboy, New Jersey, with th eAtlantic Terra Cotta Company.

W. B. Whitney, cer.e., '25, is with the Lancaster Brick Company, at Lancaster, Pennsylvania.

Arthur B. Durham, m.e., '23, is with the department of industrial engineering of the Joseph T. Ryerson & Son Co., at Kenilworth, Illinois. He is engaged in standardization of piece work.

John K. Holmes, m.e., '23, is maintaining the Illinois reputation against the assaults of Michigan, Rose and Purdue men at Marion Crane Co., of Marion, Ohio. He is in the engineering department and states that his work varies from electrical engineering to heating and ventilating.

C. E. Ksiazek, m.e., '23, has changed his name to "Kazek." He is assistant superintendent of the gas, water and light plants for the Southern Illinois Gas Co. He states that he will visit the campus the latter part of February.

John H. Anderson, c.e., '14, superintendent of construction for the H. F. Culbertson Co., Cleveland, Ohio, visited the campus recently. He is in charge of a four million dollar track elevation job at Cleveland.

Ira W. Fisk, e.e., '09, has resigned as instructor at the University of West Virginia and is now with John Biehler, Consulting Engineer, of New York. He is engaged in special investigation of street railway problems.

R. E. Lawrence, cer.e., '22, recently announced his marriage. He is with the Beaver Falls Art Tile Co., at Beaver Falls, Pa., together with V. K. Haldemen, cer.e., '23, and G. E. Sladek, cer.e., '17.

R. S. Bradley, cer.e., ('23), is now at Mexico, Mo., with a Fire Brick Co. He was at the University for the second week of the Ceramics Short Course.

M. Nakayama, e.e., '17, and S. Taketa, e.e., '15, are candidates for the professional degree of Electrical Engineer. They are engaged in hydro-electric development near Tokyo, Japan. They both were in the affected region at the time of the recent catastrophe.

G. W. Larson, c.e., '23, is with E. C. L. Wagner, Consulting Engineers, at Kansas City, Mo.

C. A. Hughes, c.e., '06, is assistant engineer of the Missouri Pacific R. R. at Kansas City, Mo.

Alfred P. Poorman, c.e., '07, Professor of Mechanics at Purdue, has recently revised his book "Applied Mechanics." The sale of the first edition was remarkable and the new edition promises even more.

E. J. Mehren, c.e., '06, has resigned as editor of the *Engineering News Record* to devote his full time to his duties as vice-president of the McGraw-Hill Publishing Company.

T. D. Owens, e.e., '20, is an instructor of electrical engineering at the Case Sschool of Applied Science of Cleveland.

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evaporating daily from a reservoir 100 yards square by 60 feet deep would not be 1 1000 of that lost from a tank measuring two feet each way. In times of calm, the gases will be recombined in explosion motors working dynamos which produce electrical energy once more, or more probably in oxidation cells."

Up to this point I have mentioned only the possibilities which are now being hopefully sought by researchers and scientists, but these possibilities are by no means the ultimate. The imagination can conceive a cold light obtained by activating certain substances by electrical influence; as, for example, activating the paint on the walls of a room by radio waves. Possibly the air may be so treated that it might take the place of present conductors of electricity and magnetism.

As the population increases and presses upon the means of subsistence, electrical processes of producing food from the nitrogen in the air or from other substances may rescue future civilization from sinking to the economic level of certain Asiatic countries.

The production of electricity direct from the heat of the sun or the interior of the earth may, by the elimination of wasteful steam engines, solve the heating problem of the future. And to go the limit, light, heat and energy may, in the distant future, be stored in some form and electricity not used at all. Phosphorescence, the glow worm and radium are indications of these possibilities.

Another on Commerce

Headline: "Billboard scored by Commerce head."

Yes, this confirms our opinions about the Commerce school.

Brother: "What are you taking the mirror out of your car for?"

Soph: "Oh, just to be on the safe side."

Brother: "How so?"

Soph: "My girl is going to drive the car today."

On Those Field Trips

A Frosh on his first field trip had caught a butterfly in his net and had straightway ran to the Professor who was on his 106th field trip.

Frosh (excitedly): "What do I do now?"

Prof. (sarcastically): "Climb up the pole and stab it."

Landlady: "I think you had better board elsewhere."

Student: "Yes, I'll admit I frequently have."

Landlady: "Have what?"

Student: "Had better board elsewhere."

Here's Elsie Again

Little Elsie says that she is strong for Engineer dates—she has to be.

Judge: "I'm going to fine you five dollars."

Facetious Fred: "Judge, if you find five dollars on me I'll split it with you."

Judge: "Well, if I don't find it on you you'll split rails and stone here for the next thirty days."

Oh Harold

Dad: "Who sat on that newly painted bench in the garden?"

Sweet young thing: "Harold and I."

Dad: "Well, you must have ruined your clothes—both of you."

S. Y. T.: "Not both—only Harold's."

"What have you in the shape of automobile tires?"

Salesman Sam: "Funeral wreaths, life preservers, invalids cushions, and doughnuts."

Doctor: "The best thing for you to do is to give up late hours, wine, women, and ———"

Stude: "What's the next best thing?"—*California Engineer.*

"I hear you have an addition to your family, Mrs. Cat; was it a boy or girl?"

"Oh, just six of one, and half a dozen of the other, Mrs. Tabby."—*Burr.*

Joke Editor of the Technograph: "I can't think of a joke to save me."

Helpful chorus from the rest of the staff: "That's easy. Call in one of the university firemen."

L. A. & S. student: "I suppose you play Mah Jongg?"

Engineering student: "Say do I look like a guy that would play with blocks?"

Sometimes when two people think of the same thing at the same time it is either mental telepathy or a coincidence. At other times it is quite embarassing.—*Cougar's Paw.*

Foaming Youth

He: "Please come out in the garden with me."

She: "Oh, no. I mustn't go out without a chaperone."

He: "But we won't need one."

She: "Then I don't want to go."—*Columbia Jester.*

"Yes," said the Theta, "We call our dog Coffee because he keeps us awake at nights."

Grad: "What salary do you think I'm getting now?"

Undergrad: "Oh, about half."

Grad: "Half of what?"

Undergrad: "What you say."—*Cougar's Paw.*

He: "We're coming to a tunnel, are you afraid?"

She: "No, not if you take that cigar out of your mouth."—*Buffalo Bison.*

"The dirty crook," muttered the Frosh, when he got up one morning and found that a burglar had stolen everything from his room except a cake of soap.

Missus: "Has the Professor had his breakfast?"

Maid: "I don't know, mum."

Missus: "Well, ask him!"

Maid: "I did, mum, and he don't know either."—*Sanford Chaparral.*

"Sure, I like talkative co-eds," said the junior. "What other kinds are there?"

Waiter: "Where is that paper plate, I gave you with your pie?"

Frosh: "Plate? I thought that was the lower crust."

Ohio Public Service

(Continued from Page 23)

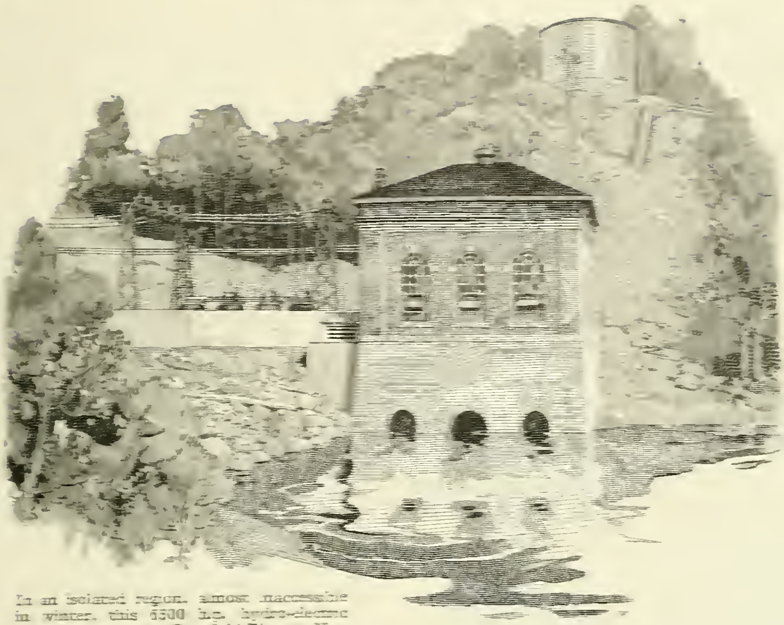
Warren was off, the voltage on the distribution circuits in Alliance ran high enough to be dangerous to lamp filaments. With the load entirely off, and being carried by the local power plant, the static charge on the lines was so great that opening the disconnects drew an eight inch arc. The snapping among the conductors was very noticeable and at night it made one feel as though the air were alive.

A continuation of this transmission line ran from Alliance to Canton and there it tied in with the Ohio Power Company's lines. The "Sunnyside" sub-station at that place is one of the largest in the country, interconnecting sources of power that have a total capacity of nearly 200,000 k.v.a. Five 132,000 volt lines here connect Canton, Ohio with Windsor, West Virginia, Akron, Alliance, Philo, and Ashland, Ohio. From these cities interconnection is made with other large utilities for an interchange of power and eventually these systems will be a part of a great super-power system. Already this interconnection has had a great effect on continuous service since Alliance, for example, draws power from either Warren, 36 miles away, or Canton, 18 miles away; and the turbine units can be operated at their most economical load.

With this super-power development, numerous problems have come up dealing with the prevention of lightning "knockouts," and sudden surges of current. The charging current of a transmission line with the receiving end on an open circuit is sometimes as large as one half the full load normal current. One stormy night a lightning charge came in on one of the secondary 22,000 volt lines and completely blew up a transformer, scattering oil in all directions. To help maintain steady voltage condition, two large synchronous motors were installed in the substation switch house. Oxide film lightning arresters were installed at all substations on both the secondary and primary sides.

Every station along the lines was in direct communication with the others through a system of carrier-current telephoning. At each station an aerial was run for a short distance parallel with one of the line wires. This had not yet been installed at Alliance, but Canton had direct connection with Windsor, West Virginia, 75 miles away.

Chem Stude—"Notice my golf shirt?"
Other Stude—"Golf shirt?"
Chem Stude—"Yep, eighteen holes."
—*Kansas Engineer.*



In an isolated region, almost inaccessible in winter, this 6500 h.p. hydro-electric plant located on the Deerfield River in New England, starts, protects, and stops itself.

A Self-Starting Power Plant

Dawn—the slumbering city awakens and calls for electric current. Many miles away the call is answered. A penstock opens automatically, releasing impounded waters, a water turbine goes to work, driving a generator; and electric current is soon flowing through wires over the many miles to the city. This plant starts and runs itself.

Power plants with automatic control are now installed on isolated mountain streams. Starting and stopping, generating to a set capacity, shutting down for hot bearings and windings, gauging available water supply, they run themselves with uncanny precision.

Thus another milestone has been reached in the generation of electric power. And with present-day achievements in power transmission, electricity generated anywhere may be applied everywhere.

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The General Electric Company has developed generating and transmitting equipment step by step with the demand for electric power. Already electricity at 220,000 volts is transmitted over a distance of 170 miles. And G-E engineers, ever looking forward, are now experimenting with voltages exceeding a million.

A new series of G-E advertisements showing what electricity is doing in many fields will be sent on request. Ask for booklet GEK-1.

GENERAL ELECTRIC

GENERAL ELECTRIC COMPANY, SCHENECTADY, NEW YORK

The Navy Cruise for Engineers

(Continued from Page 15)

mounted at the center of bouyancy of the ship, which is the point of least disturbance from the heavy seas. Dumb compasses or followers are located at convenient points about the ship as well as on the bridge at the wheel. These compasses are electrically synchronized with the main gyro.

The fire control stations were located far below decks, one amidships, and one astern. There are many complicated instruments for allowing a myriad of variables in range determination. The American gunners are the best marksmen in the world, which is no wonder when one considers the pains they take in letting go of one of the projectiles. No doubt you have noticed in the movies a sort of clock that hangs high up on the cage mast of a battleship. This instrument is a range indicator used in battle formation. The figures read in thousands of yards. Before learning about this, I once wondered why a clock was put in such an unusual place.

I was assigned to the destroyer Brainbridge and lived with the officers in their quarters. Besides the captain who was a two and one-half striper (lieutenant-commander by commission), there were a doctor, two lieutenants, and three ensigns, fellows about my own age. I do not know the specifications of a destroyer. That too is to be found more accurately in a handbook. They are however, over two hundred and fifty feet long, oil burning and will make thirty-three knots at which speed the turbines develop five thousand horse-power. The turbines are of the Westinghouse-Curtis type. Four triple, twenty-one inch torpedo tubes, Figure 2, and two four inch guns make up the armament. The steering apparatus has a steam-hydraulic control.

The Brainbridge burnt out a fan motor armature just before I came aboard. This gave me a chance to take it over to the tender ship Vestal and do some practical work in one of the most unique repair shops. The U. S. S. Vestal is a floating foundry and machine shop, in fact a complete factory. Imagine a foundry half as large as ours at Illinois, a forge with a steam hammer that would make Mr. Lanham's look like a toy and other shops of all kinds carried out on the same scale. The men were all busy; so much more interested than civilian workers seem to be. Perhaps I only imagined that.

During the cruise there were inspection trips to the government torpedo plant, and to the Patoka, the tender of the ill-fated Shenandoah. There was a trip in a bombing plane, during which the planes shot at each other with camera guns. We had an opportunity to inspect the scout cruisers Raleigh and Milwaukee with their areoplane catapults, Figure 3, which threw the planes from the deck. These planes took the air after one bounce upon the water. All these things were fascinating though I haven't the space for a suitable description.

You will agree I think after reading even so crude an account as this that the cruise is an opportunity that comes but once in a life time. If I have been rather vague, please remember that it is more than a year since the cruise and that I have attempted to arouse curiosity rather than to instruct.

WHAT HE THOUGHT SHE THOUGHT

"My, isn't he wonderful. I simply can't drag my eyes away from him, especially his tie."

WHAT SHE THOUGHT HE THOUGHT

"The cute thing, and what a lovely silk sweater."

WHAT EVERYBODY ELSE THOUGHT

"The simp with the pimply necktie has fallen for the dumbell with the stringy blouse."

In the parlor there were three,
She, the parlor lamp and he.
Two is a company there's no doubt,
So the little lamp went out.
—*Kansas Engineer*

Lake Front Development

(Continued from Page 11)

tend back into the approaches, is 510 feet. The end spans are 114′ 3″ long and the center span is 138 feet long. The bridges will be encased in concrete and when complete will appear to be arches. True arches were eliminated from consideration, because of the depth to which foundations have to be carried, bed rock being approximately at 85.0 feet.

There are several features of interest in the design of these bridges. Suspended plate girders 12′ 0″ long in the end spans and 44′ 0″ in the center span necessitated extreme care in the design of expansion and encasing details that would function without detracting from the beauty of the structure. The girder section in the cantilever arms, varies from 4′ 3″ to the extreme depth of 18′ 6″ at the supports. This required horizontal as well as vertical web splices, and also necessitated the use of diagonal stiffeners to reinforce the web against the extremely high diagonal compressive stresses.

Figure 1 indicates the locations of seven continuous arch bridges spanning the lagoon. These will be 3-span bridges approximately 350 feet in over-all length. It is proposed to carry the piers and abutments to bed rock which varies from elevation —35.0 feet to —50.0 feet at the different sites, rather than use pile foundation. This may require a continuous arch analysis to determine the effect of deflection of the top of the piers under unequal loadings. There are several methods of analyzing continuous arches, but in all probability the one developed by Professor Hardy Cross of the University of Illinois will be used in this particular work. However, these bridges are in the tentative state as yet, and further investigation may warrant entirely different types.

To-date, contracts have been let on the 31st Street viaduct, Oakwood Boulevard viaduct, and five of the bridges north of 12th Street. It is estimated that five years will be required for the completion of all of the continuous bridges crossing the Illinois Central Railroad and that ten years will see the completion of the entire program.

The total cost of the completed Lake Front improvement and Grant Park improvement is estimated at $80,000,000. The work is being carried on by the South Park Commissioners, a municipal corporation, authorized by the state of Illinois. The governing body consists of a board of five commissioners appointed by the judges of the circuit court of Cook County, for terms of five years. This board elects its own president, the present incumbent being Edward J. Kelly, who is also chief engineer of the Sanitary District. Work is financed by bond issues retired by tax levies on the property within the South Park district. The chief engineer for the South Park Commissioners is Linn White. The structural department is headed by C. R. Hoyt, structural engineer.

Radio Station WOK

(Continued from Page 14)

ten hours. It is necessary to have these large batteries because each five kilowatt tube requires twenty-five amperes for filament heating; this discharge rate requires that the cells be put on charge for about ten hours once a week.

A motor generator set, located in a separate building, supplies the charging current. Its rating is fifteen kilowatts at 125 volts. The cells, both "A" and "B", are connected in series parallel for charging, so that the charging voltage of the bank is about 80 volts.

The whole station was designed so that most efficient operation would be had at the assigned wave length of 217.3 meters; there is no provision for a change of wave length, and it seems unlikely that any will be required for some time, as any new wave allocations made in the future will probably take this wave length into the broadcasting band.

To sum up, the voice currents are picked up by the studio microphone, amplified, and sent to the station, where they are further amplified, impressed on the high frequency wave, and sent on the air, for anyone to pick up.

A PANTOMIME IN MATH

Let X=?

Her series extended from O to B.

His path was $X^2 + KX - 4$.

They intersected at a point in common.

He then changed his base to function of Loge.

Interpolating, she assumed an irrational number.

"You are variable," he determined, trying Horner's method.

She immediately solved for his coefficients and real roots.

She deduced them to be imaginary values that he had assumed.—*The Transit.*

Mary: "Is John courting you?"

Marie: "Not exactly, but he is getting there step by step. When he first called on me he sat all evening with the album on his lap. Next time he sat with my dog in his lap. Then he took my little brother in his lap. And next Saturday night is my turn."—*Kansas Engineer.*

ONE BETTER

He: I think I'll have this car equipped with Steer-Straights, something to keep it in the center of the road without any attention on my part."

She. Wouldn't it be a lot better to use the brake?

WHAT DO YOU THINK?

Prof. (*in government class*): "What is a silent majority?"

Stude: "Er—I guess it's two men when there's one woman present."

College Notes

(Continued from Page 29)

Bulletin No. 151, "A Study of Skip Hoisting at Illinois Coal Mines," by Arthur J. Hoskin.

This bulletin first enumerates the advantages and disadvantages as claimed by followers and opponents of this type of hoisting.

Every skip hoisting mine in the state was studied—among them being such famous ones as the "Valier," "Zeigler No. 1," and "New Orient." Physical features and their bearing on the problem (such as the shaft bottom plans) are given for each mine and in addition general considerations are taken up such as the handling of men and supplies, coal dust on the bottom, and sump cleaning.

Other influencing factors including the preparation and inspection of the coal in addition to the cost of plants, labor, and power were summed up in a resumé of the advantages and disadvantages of skip hoisting in general.

Failure and Relief of a Water Supply

(Continued from Page 17)

suction line entering the water of the lake forty or fifty feet from shore and a discharge into the filter, the static head being about fifteen feet. Wooden filter boxes 50'x30'x10' deep were used with tile drains placed on the bottom. A twelve inch bed of gravel was placed on the tiles and above this a thirty inch bed of sand. The filters are of the rapid filter type which have a capacity of 125,000 gallons per acre per day. A manual chlorinator was placed on the intake side of a fire pump. These pumps have a capacity of 750 gallons per minute. The power plant consists merely of boilers with the necessary firing facilities.

Within one week from the commencement of relief work the situation was better, and in two weeks there were four pumping plants supplying water to the mains. At this writing the supply is almost normal again in quantity if not in quality. The watershed is slowly recovering and the emergency installations are operating effectively. Asheville is out of danger for this season and in another year there will be a new impounding reservoir and watershed to augment the water supply.

Old Man: "How is it, sir, that I find you kissing my daughter? How is it, I ask you?"

The Sheik: "Oh, it's great, sir!"

Teacher: "Johnny, give me a sentence using the word 'diadem.'"

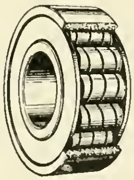
Johnny: "People who drink moonshine diadem sight quicker than those who don't."

Columbus was a man of vision

BUT not even he could have foreseen the great industrial development of this country which would come about through improved methods of manufacture and transportation, and the important part that would be played by Hyatt roller bearings.

Modern industry requires and far sighted engineers demand that rotating parts be mounted on bearings that will roll instead of rub.

Raw silk, wool and cotton are transformed into the fruit of the loom; deeply hidden coal and metal ores are brought to the light; ribs of steel are fabricated for the backbone of modern construction. In fact every phase of industry is speeded up and assured uninterrupted output by the use of Hyatt roller bearings which, with their rugged durability and unfailing dependability are serving the needs of the nation faithfully and well.



When designing or purchasing mechanical equipment, remember that the combined experience of the Hyatt Roller Bearing Company's engineers and specialists is always at your disposal to help you solve your bearing problems.

HYATT
Roller Bearings

An actual Hyatt bearing, nickel plated for use as a paper weight or pocket piece, is yours for the asking. This bearing, the smallest we manufacture, clearly demonstrates the anti-friction principle which has made Hyatt bearings leaders in the commercial world.

HYATT ROLLER BEARING COMPANY, NEWARK, N. J.

Golf Course Engineering

(Continued from Page 22)

tile lines and cause trouble in a short time. Some times cast iron gratings are used for covers but stones make a more natural top and are usually used. Figure 2 shows the construction used; the stones have to be removed and the basin cleaned about once a year.

The water problem on a golf course has two sides. Not only has the excess water to be cared for but some provision must be made to irrigate the greens during a period of drought. The system at St. Andrews is almost universally used for watering golf courses. A well was sunk on the edge of the pond, that was used as a dump for the storm water. The water is pumped from the well into the pond during the morning. At night, as soon as the playing is over, the pumps are shifted and the water is pumped from the pond to the sprinklers. The water has been in the sun all day and is warmed and is much better for the grass than cold well water.

There are two systems used on golf courses to prevent the water that is standing in the pipes in the fall from freezing and splitting the pipes. The old way is to sink the pipes below the frost line as is done in city water works. But digging miles of five-foot ditch is a costly process and the California system of irrigation has been adopted on all the new courses. We didn't know that California was bothered with frost and were under the impression that neither frost, rain nor wind blighted the peaceful existence of the golfers of the Golden State.

In the California system the pipes are laid to a set grade as near the surface as possible.

At every break in the line a bleeder valve is fitted in the pipe. When these are opened the water is drained out at the low points, air to relieve the vacuum going in through the air vents at the peaks. Figure 1 shows a profile of a line fitted in this way. A profile of the sunken system is also shown for comparison.

With the course thus far along the engineer has usually finished his part of the work. All courses will not present the same problems to the engineer. In either a hilly or extremely flat country a great deal of excavating may be necessary to form the features of the course. Also in flat country it is sometimes a problem to locate an outlet for the drainage system. This is usually done by digging out some low spot in the fairway which is used as a drainage dump, to warm the irrigation water and some times serves as a hazard.

Mr. James Allan was in charge of the construc-

(Continued on Page 52)

Golf Course Engineering

(Continued from Page 48)

tion at St. Andrews, and the writer feels that he would be glad to show any one the second course, which will be under construction next summer near West Chicago. The writer would also be glad to go into further details with any one that might be interested in this kind of work.

Santa Barbara Earthquake

(Continued from Page 20)

down, removed and replaced with better built and more beautiful looking buildings and the quake will soon be only a memory, while a much more beautiful city will appear. The Spanish style of architecture is being carried out almost entirely in this reconstruction. Santa Barbara is an old Spanish town and, incidentally, it has one of the oldest and best preserved of the Old Missions, built by the Franciscan Padres in the early Spanish days. Spanish architecture already predominated and after the rebuilding is finished, the city will have even a greater Spanish atmosphere. And so, out of the havoc and ruin caused by the earthquake, there will rise a better, more permanent and more beautiful city of Santa Barbara.

He: "Sweetheart, I'd go through anything for you."

She: "Let's start on your bank account."

There may be thousands of nutmegs but there is always one grater.

With some people it isn't so much that they wouldn't, but that they hate for you to think they would.

It was the end of the scene—the heroine was starving. "Bread," she cried, "Give me bread!"

—and then the curtain came down with a roll.

NO MOAH NOAH

A bad little boy was Noah,
He drank one night till foah.
A car in the night
Hit him just right,
And now he can drink no moah.

—*The Transit*

THE TECHNOGRAPH

PUBLISHED QUARTERLY BY THE STUDENTS OF THE COLLEGE OF ENGINEERING UNIVERSITY of ILLINOIS

January

1926

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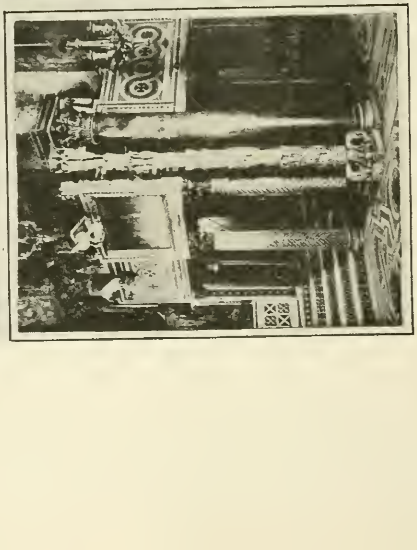

Fig.10

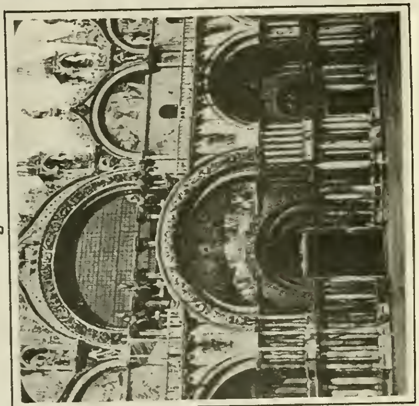

Fig.6

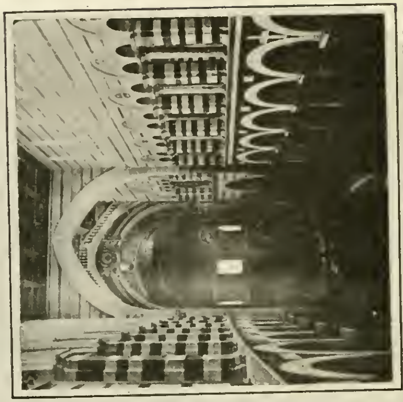

Fig.5

PHOTOS FROM RICKER LIBRARY SLIDE COLLECTION.

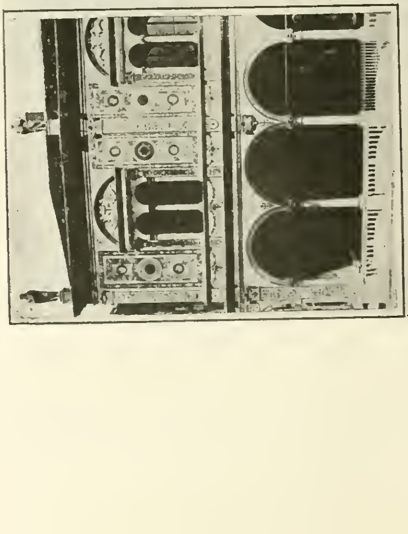

Fig.1

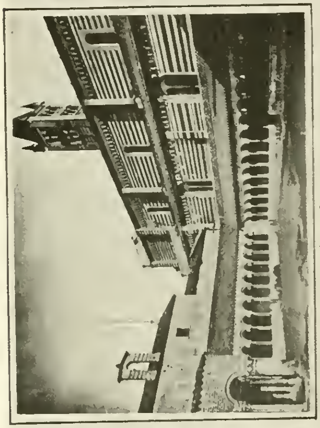

Fig.2

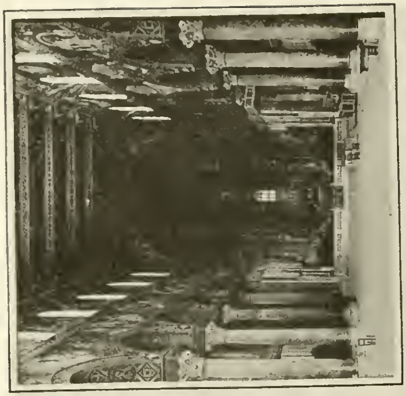

Fig.4

THE TECHNOGRAPH

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VOL. XXXVIII JANUARY, 1926 NUMBER II

Color in Italian Romanesque Architecture

J. D. PROUTY, a.e., '26

First Prize, 1925 Ricker Paper

Color Plates by the Author

There is a deplorable coldness in our architecture, as a whole, even when the chromatic interest occurring through the use of the natural colorful materials is granted. Every structure has a color scheme, but the prevalence of one or two colors causes a sense of familiarity and an observer dismisses a building as not indicative of any chromatic scheme when it is erected in one of the common building materials. What is needed is a combination of materials that will lend color to a building and give a change in texture of surfaces. The increasing tendency to introduce color into architecture gives rise to a problem of how to maintain a sincerity in the use of materials and still attain a definite and intriguing chromatic interest. The use of color in Italian Romanesque architecture is presented here to show how this has been accomplished. The Romanesque of Italy is a style well adapted to our climate and it is in the handling of colored materials of this style that we can find a source of inspiration which will enliven our architecture.

The application of color to an architecture conceived in flat tones at once produces a conflict of form and color. An intelligent use of color allows form to remain dominant and emphasizes and sustains this dominance. This follows from an adaptation of the color to the surface on which it is placed. Thus a mural decoration should be so subordinated as to preserve the wall surface and not make holes in it by indicating more than can take place on this two dimensional surface. The Italian Romanesque wall treatments in painting and mosaic are successful in maintaining the character of the surfaces because there was little knowledge of perspective to tempt the designers to digress from flat treatments.

In the terra cotta work which began in this period and attained its height in the Della Robbia work of the Italian renaissance the form and color ratio was nicely determined. Here the application of color to ornament introduced a conflict between delineation of form by it and by light and shadow. Form was here modified to receive the color, and reliefs were made lower in favor of it. Further, buildings designed for application of color show a distinct flattening of projections. This is exemplified in the Palazzo del Consiglio which will be discussed later.

There are two orders of architectural use of color. The first order includes those buildings in which the colored materials were part of the substance and were necessary for the stability of the whole fabric. The second order includes those structures in which the walls were covered with decorations such as mosaic, tiles or veneers which had nothing whatever to do with the structural requirements.

The great variety of uses of color in the Romanesque is included in both orders. San Ambrogio at Milan, in brick and San Abbondio at Como, in stone are undoubtedly of the first order. The monastery of Certosa near Pavia and the Palazzo del Consiglio, Figure 1, are of the second order. San Zenone at Verona, Figure 2, with its striped walls splits the classification. In general the most colorful of the buildings are included in both classes; the usual combination being exteriors of the first order and interiors of the second order. The Palatine Chapel of Palermo, although an incorporated building, and the Cathedral of Monreale are of this two ordered type. The interiors of these structures are shown in Figures 10 and 4.

L. V. Solon in his "Architectural Polychromy" gives the general rules for color treatment of structures. To afford a means of criticism of the Italian Romanesque architecture the rules will be repeated:

a. The presence of color in a weight sustaining feature depreciates its apparent capacity to fulfill its function.

b. Application of color to a supported item is advantageous for the reason that the apparent substantiality is reduced; this diminishes the apparent gravitational thrust, with the result that the sense of structural strength is inversely benefitted.

c. In polychromy those items which admit such treatment, decorative elaboration may augment as structural significance diminishes.

The Italian use of color carries out the second rule. Delicacy, lightness and elegance are written into the structure by use of color on arches, their spandrels, the walls they carry and the ceilings and domes above. The third rule is adhered to by a tendency everywhere to increase the color as it goes upward, the nal burst of glory occurring in ceilings and domes. This ascending order gives an aspiration which in religious structures is exceedingly desirable.

In the case of the first rule there is a violation almost everywhere. The supporting elements of the Italian Romanesque architecture were columns, groups of columns, and less frequently piers. Where piers were of one material and hence one color the violation is not so noticeable. It is when striped masonry is used that the rule is flagrantly broken. The piers in the choir of the Cathedral of Pisa which can be seen in the distance at the left of Figure 5, and the piers of the triforium gallery in the same photograph show how the feeling of support is lost by this use of color.

The columns used everywhere were of colored marbles or granites. The color occurring here was, however, not so flagrant a violation of the rule as it at first might seem. The relative chromatic values of the column and the highly elaborated work above is such that the supported members are lightened, according to rule two, enough to give a structural weight-bearing sense to the column. In this way rule one is modified.

The materials in which the charming chromatic schemes of the Italian Romanesque architecture were achieved are numerous. Brick was plentiful on the plains of Lombardy. Fine limestones and marbles were found near, Como, Pavia, Pisa, etc. Clay of good quality was plentiful for tiles and terra cotta. Wood was used for timber roofs, bronze and iron for doors and accessories, gold for backing up glass in mosaic work. Colored marbles and semi-precious stones, local and imported, were used for mosaics and intarzia.

The influence of preceding styles is, as everywhere else, important. Early Christian structures, among them the Tomb of Galla Placida, near Ravenna, carry the style into the immediate neighborhood of the Romanesque examples. The Byzantine styles had a powerful influence through the Cathedral of St. Marks in Venice, and through an infiltering, along with elements of the Saracenic, by means of commercial intercourse between the Italian centers and the countries in which the styles flourished.

No structures exerted greater influence on the Italian use of color than did two early Christian examples: The Church of St. Marks in Venice, and the Tomb of Galla Placida at Ravenna. The Church of St. Marks is noted for the most elaborate mosaics in the world. The south transept of the church is paneled in marble slabs of red, orange, green, and gray chosen for their markings. The south doorway has a tympanum of green marble with inserts in red and dark red. The archivolts are of green and red marbles. The columns are gray and white variegated, cream, red, and green. Panels of mosaic insert in walls have incrustations of lapis lazuli, agate and cornelian. The west facade, Figure 6, is completely incrusted with mosaics. All tympani are filled with mosaics on gold grounds. The central gable has a panel with the gold lion of St. Marks on a blue ground with gold stars. The great central doorway is flanked by columns and has a mosaic incrusted tympanum. The marbles of grey, green, red and orange are singularly harmonious due to the weathering of the surfaces.

Mosaics are everywhere on the interior. The colors, blue, blue green, yellow, red, purple, cerise, and gold, are very brilliant but the use of only small bits gives a blending that is very satisfactory. The hemidome over the apse is incrusted with brilliant mosaics, depicting the virgin and child flanked by two angels. Bits of the mosaic of the pavement are shown in Figures 15 and 16.

On the exterior the gilded bronze horses above the entrance portal and the lead gray domes add a further glory to the chromatic scheme of this church of Byzantine influence.

The tomb of Galla Placida near Ravenna dating from 430-50 A. D. had a powerful influence on the structures of the environs. This tomb of the Italian school of early Christian architecture is unimposing and even ugly on the exterior which is of red brick with wide mortar joints. The interior is resplendent with color. An orange marble wainscoting with grey veining lines the walls. The barrel vaults above are encrusted with mosaics in dark blue, green and gold, the dark blue in predominance. Figure 12 shows the pattern and coloring of one of those vaults as recorded by Dolmetsch. The mosaic work is of glass. The low dome is also incrusted with mosaics and the narrow windows piercing it are filled with thin translucent slabs of orange marble. A very inspiring interior which was undoubtedly the source of inspiration of many of the fine examples of the use of color which occurs nearby.

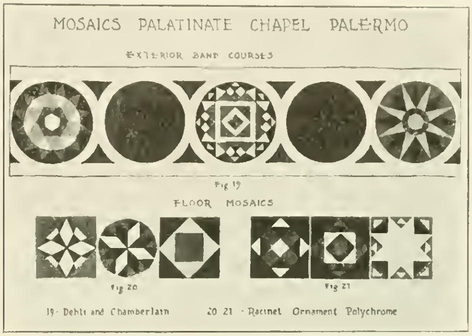
Of the Lombardic examples the first is the old church of San Satiro at Milan which dates from 873 A. D. The exterior combines cream and pink by use of brick, stucco, and terra cotta. The interior is in tan, blue, and gold, giving a structure with a very stunning color combination both inside and out.

Near Pavia is found the old Carthusian monastery of Certosa, the church of which is the most highly decorated and colorful of all Europe. The interior is of white marble. The side altars are of colored marbles elaborated with inlays of precious and semi-precious stones: lapis lazuli, agate, ruby, garnet, and cornelian. The exterior is of brick, terra cotta and stucco on the flanks. The facade is of Carrara marble inlaid with rich colored marble mosaics in dark gray, green, red, pink, and cream. The statuary and the busts of Roman emperors in medallions are executed in white marble with cerise markings.

In the court yard white marble columns carry terra cotta arches in pink. The font in the court is green with water moss. The whole composition blends into a ruddy glow in the Italian sunshine. In the old sacristy there is a marble mosaic pavement, a dado of marble with panels of mosaic insert in a guilloche pattern. This structure combines the two orders of color use in a very successful way. A wealth of rich materials skillfully combined give a structure of chromatic appeal that will well serve as a text for the modern use of intrinsic and applied color.

At Bologna we find an example of a church group entirely of brick. Among the buildings and courts about the church of San Stephano there is a cloister, south of the atrium. The spandrels of the arches and wall above are decorated with patterns of colored brick. The octagonal baptistry on the west end of the interior court is of brick. The walls have mosaics of stone and marble and patterns in the brick work of great variety of patterns. Sometimes the patterns occur in bands enclosed between courses of brick zigzags and sometimes in isolated circles or in lozenges. There is no system or attempt at a symmetrical arrangement. The designs are applied at random with a delightful informality and the character of the work is such as to be admirably suited to work of today. This use of color falls within the second order.

The church of Paolo and Pietro is another of this group at Bologna. The walls are of brick and in them we find the best examples of polychromy of openings that the style affords. The door is of stone set into the brick wall. Wine colored marble inserts, square set on the diagonal, flank the opening. Green, wine, and gray marble inserts frame in the round arched open tympanum. A band of marble



inserts in the wall carries the color on at the height of the opening. The whole door forms a subdued and rich composition in a good refinement of line, form and color.

The "cross window" of this same church is another opening of rare beauty and workmanship. A wall of alternate bands of brick and stone frames an opening under an arch ring of wine and dark green marbles. A cross of orange marble thinly lined with white reaches across the opening and separates a series of square panel lights of pierced white marble. The carving is lace like, the colored surfaces plain, and with the varied surface textures of stone, brick and marble we have an outstanding example of good form and color composition of the second order.

The church of San Zenone at Verona, dating from 1139, is a typical example of Romanesque color use. The walls of this church are striped, yellow sandstone and red brick courses alternating, with occasional orange marble insets, Figure 2. On the interior the columns and piers are of orange Verona marble. The ceiling is a wood vault, paneled and painted. The colors used to high light the woodwork are brown, yellow, and blue green with the latter in predominance. The walls of apse choir and nave are painted with figures.

The entrance porch is a round arched tunnel vault under a canopy, carried on orange marble columns. The columns have the characteristic griffins or lions for bases. The steps are of red sand stone. The door is of bronze weathered green. The tympanum is carved in a low relief and is high lighted by red, blue, green, yellow, and gold. The facade is of yellow sand stone. The cloister, Figure

2, has coupled columns of red marble carrying a plain wall. The tile roof is red. This church is of both orders of color use, intrinsic color and applied color occurring both inside and out. The whole effect is magnificent and inspiring through the elegance and the harmony of the color scheme.

Of the Tuscan examples, the Cathedral of Pisa, 1063-1118, is standard and will represent this school of the Romanesque. The interior has polished granite and marble columns with corinthian capitals. The arches of the nave arcade are white marble, the spandrels of black marble, Figure 5. The piers of the triforium gallery are striped, black and white marble courses alternating. The spandrels of the arches have inserts of various medallion patterns. The clerestory wall is of white marble banded with narrow black marble courses. The ceiling is a flat wooden paneled covering elaborately carved, with color and gilt high lights. The hemidome of the apse has a gold ground mosaic. The transept wings have stained glass windows.

The exterior is a remarkably delicate and consistent design. The walls are banded black and white marble. The arch heads of the first story have marble inlays, round and lozenge shapes alternating. Within three of the arches are bronze doors. The four upper stages are arcaded and the spandrels of the arches and the walls they carry are decorated with beautiful and delicate inlays of colored marbles. This entire structure is an essay in the use of tiny bits of color to brighten and enhance a pure white building. Where the formality and attendant dignity of a white structure is desirable the cold harshness can be relieved without lessening the dignity by following the example of color relief set for us in the Cathedral of Pisa.

The Palatinate Chapel in the Royal Palace of Palermo is one of the most splendid examples of the interior use of color. The exterior of the chapel has little exterior expression. The marble mosaic inserts in the band courses of what exterior there is on this incorporated structure, Figure 19, indicate that this chapel would have been as marvelously incrusted upon the outside as on the interior had it been free standing.

The entrance is through a portico of six columns of Egyptian granite. The interior which is a three aisled basilica is alive with color. The ceiling is a Saracenic stalactite covering high lighted with bits of color. The walls are flat surfaces with no mouldings. The arches of the nave are painted on soffit and spandrel with geometrical designs enclosing occasional portrait medallions. The wall above is also painted. The columns of the nave are antique, some plain, some fluted, in various colors of marble and granite. The wall has a marble dado with mosaics on a gold ground above picturing saints and apostles. The reveals of the windows are elaborately encrusted with mosaics. The mosaics of the floors are intricate in design and of splendid color combinations.

The choir steps, the pulpit, the choir rail, and the altar are lavishly wrought in Cosmati work, Fgure 10. The Figures 20, 21, and 24-29 are from Racinets' Ornament Polychrome. They bear the title "Mosaics émaillés en pieces de rapport." Further than this they are not located as to their appearance in the Chapel. Their beauty is unquestionable and as inspiration for floor patterns, band courses, and inserts for door and window jambs they are of great value. Throughout the Chapel there are evidences of Byzantine, Saracenic and Norman influences.

The interior of the Cathedral of Monreale is by far the most interesting part of this structure which dates from 1171. Antique granite columns carry arches the broad archivolts of which are inlaid and painted as are the spandrels and the clerestory wall. The roof is an open timber truss carved, inlaid, and painted, Figure 4. The walls of the nave have a marble dado with a mosaic encrustation above. Geometrical designs and pictures of saints occur on gold grounds. The choir screne, altar and pulpit are of perforated marble with mosaics and inlay. Figure 11 and 15 from Jones' "Grammar of Ornament" plate XXX show the intricate patterns of the mosaics. The similarity of the scrolls and coloring of the floor mosaic, Figure 13, and that of the inlaid window reveals in the Palatinate Chapel is great enough to say without further argument that the mosaic of the Palatinate Chapel furnished the motif for the floor pattern in the Cathedral of Monreale.

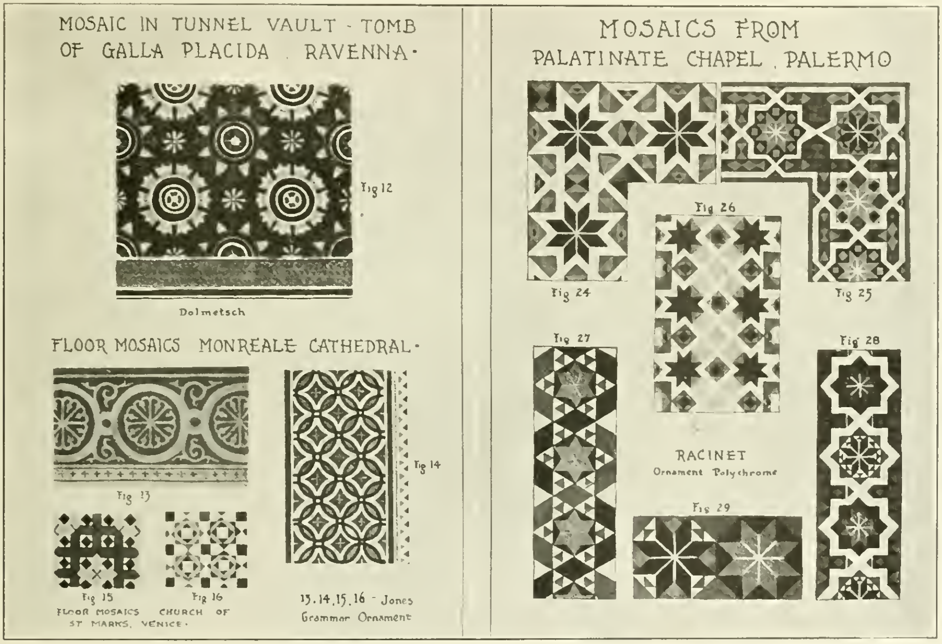
On the exterior of the cathedral the greatest interest is on the east end and in the cloister. The three apses on the east end are in three stories of interlaced arches. Bands of marble mosaics and bituminous stones, rosettes, and marble columns furnish the decoration.

In the cloister we find interesting violations of Solons' rule for the application of color to supporting members. The columns are of infinite variety, carved, twisted, coupled, and inlaid. The inlaid columns have plain and zigzag bands of mosaic which run vertically or ascend spirally. In some cases the zigzag motif is used horizontally but here the vertical character of the motif is strong enough to overcome any tendency to break the vertical feeling of the support. The bands are made up of a six pointed star motif in a variety of color patterns. The character of the cloister is such that it does not suffer appreciably from the lightening of the members by this use of color. Except for cloisters and arcades of this same lightness this use of color is not advisable.

In concluding the discussion of the examples the Palazzo del Consiglio at Verona is mentioned as a good example of a structure of the second order. It was built for an all over application of color and the surfaces and projections are so adapted as to allow the applied ornament full play. This council hall, Figure 1, is a study in white, orange, gold, and green-gray. The pilasters of the second stage are decorated with arabesques in low relief, picked out in color and gilt. The cornice is painted. The walls of stuccoed brick are frescoed, orange and gold in predominance with occasional inserts of a green-gray marble. The wood ceiling is of natural brown wood relieved by small bits of patterning in gold and blue. This civil example can well inspire us toward the use of chromatic schemes on our store fronts and will furnish many motifs for such a treatment.

In general the Italian use of color in the Romanesque style was contributive to architectural effect. This was attained by introducing a decorative interest and by accentuating the qualities of delicacy and elegance in the members which have this architectural characteristic. A change in quality of surface through a variation of materials was used to lend interest and to relieve the monotony of large areas. Structural sincerity was not lost to decoration during this period. And as this style was a transitional style there is a naive expression and a multiplicity of motifs from which to choose the foundations for a modern application of color to our architecture.

The use of mosaics in the framing of openings both interior and exterior is to be encouraged. Where structural truth demands an indication of floor levels would not a simple band of occasional bits of color, as in the exterior band courses of the Palatinate Chapel, do the work much better and with less interference of the vertical aspirations than the clumsy, unstructural, and misplaced friezes, cornices, and bracketed mouldings so often resorted to? Mosaics have been used with fidelity and success on the interiors of such buildings as the Chicago Public Library. Now bring those mosaics out of doors and use them on our every day architecture.



Terra cotta, not alone but in combination with other materials of a different surface texture and tonal quality offers great possibility for an individual chromatic expression. Tiles can be used in place of the more expensive marbles for inserts. W. G. Raffé in his lecture on "Color in Architecture" says, "It is likely that future color in architecture

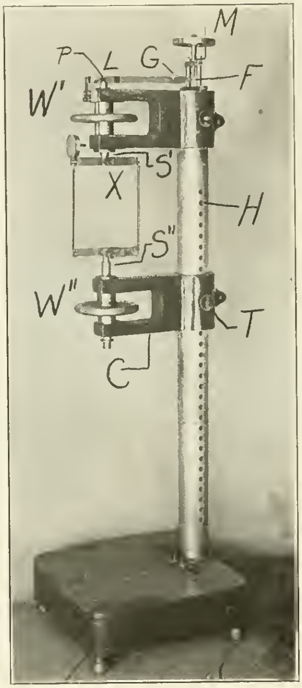
(Continued on Page 95)

Apparatus for Standardizing Extensometers

H. F. Moore

Research Professor of Engineering Materials, University of Illinois

During the past summer there has been put into use in the Laboratory of Applied Mechanics, an apparatus for standardizing the readings of extensometers, micrometers, and dial gages. The apparatus has a sensitiveness of 1/100,000 of an inch, and is itself standardized by Johannson gage blocks. Fig. 1 is a photograph of the apparatus showing an extensometer in place to be calibrated, and Fig. 2 shows the apparatus in diagram with the rig in place for standardizing the apparatus itself by means of Johannson blocks. The extensometer X is clamped to the ends of the screws S′ S″. The screw S′ has a total motion of 1/10 of an inch and is used to move the upper clamp of the extensometer which is being standardized. Screw S″ and clamp C are used to adjust the apparatus for extensometers of varying gage lengths.



With the extensometer X in place as in Fig. 1, a slight motion is given to the extensometer by turning the wheel W′ and the extensometer dial is read. This moves the point P and the 10:1 lever L. On the end of the 10:1 is a "last word" dial gauge G. The standard micrometer M is brought down until contact is made with the point F of the "last word" dial gage and the gage G is brought up to a definite reading. The micrometer M is then read. When this reading is taken the micrometer M is backed off the screw W′ moved slightly, and a second reading of the extensometer X and the micrometer M is taken. The micrometer M is graduated directly to 1/10,000 of an inch and the lever has a ratio of 10:1, hence one division on the micrometer M means 1/100,000 of an inch motion of the extensometer. By taking a series of readings of extensometer X and micrometer M, the extensometer may be calibrated over its entire range.

The apparatus itself is standardized by means of Johannson gage blocks and the method of standardizing it is shown in diagram by Fig. 2. To the screw S′ is attached a Federal dial gage D on whose dial one division indicates 1/10,000 of an inch motion. Between the nose of the dial D and the upper end of screw S″, are placed one or more Johannson blocks J. The wheel W′ is adjusted until the lever L is at the lower limit of its travel, and then the wheel W″ is turned until the dial D indicates some definite reading, usually zero. As one division on dial D represents 1/10,000 inch, it is possible to reproduce a zero reading to 1/100,000 of an inch. The micrometer M is then adjusted to standard contact with F and a reading taken. After this reading has been taken the Johannson blocks are changed for another set having a different known thickness and a reading of the micrometer screw is taken for this second set of blocks. The difference in thickness between the first set of blocks and the second set of blocks gives the actual motion of the screw S′. The difference between micrometer readings for the two sets of blocks gives the instrument reading for this known distance. By using a number of blocks, it is possible to calibrate the instrument itself throughout its range.

With the instrument, there are used a set of 11 Johannson blocks varying in thickness from 0.1000 inch to 0.1100 inch. These blocks have been certified by the U. S. Bureau of Standards and the largest error found on any part of any block was six one-millionths of an inch. Tests made with the apparatus indicate that it is self contained and easy to handle and that it can be used with an accuracy of 1/100,000 of an inch. This apparatus is expected to be of service in keeping the extensometers in the Materials Testing Laboratory in good calibration, and in calibrating extensometers from other laboratories. The apparatus was designed by the writer of this article and was built by the J. B. Hayes Machine Company.

Thoughts on the Education of a Civil Engineer

Hardy Cross
Professor of Structural Engineering, University of Illinois

At one time engineers were classified as civil and military. Today most engineers may better be grouped as civil engineers, who deal largely with forces imposed by nature, and as mechanical engineers, who deal with machines largely of their own creation and with forces at least partly within their control. While the classification is by no means complete and is based on a distinction not very fundamental, it gives rise to certain minor differences in view point and training which justify the limitation of the title above.

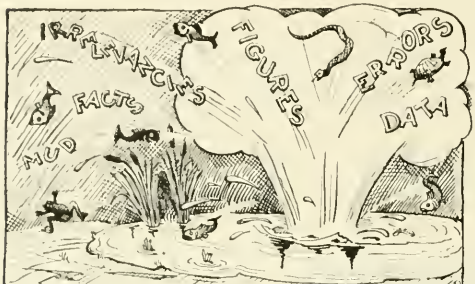
Professor Hardy Cross

From several distinct sources the civil engineer derives his education: from his own observation of the action of natural forces and from records of such observations: from experiments on the properties of materials as made by himself and by others; from training in weighing, interpreting, correlating and using his information. Of these the last is the rarest, the most valuable, the most difficult. This training cannot be got from books, though books may guide one in its attainment, no teacher can guarantee it though he may hasten its development, it will not automatically come with any length of variety of schooling or of experience. A man must give it to himself and if he gets it it will bear the mark of his own individuality. The insistent and constant need which a civil engineer feels for any scrap of fact from which he may predict natural phenomena, tends to develop in him an insistent hunger for anything that looks like a fact and may lead to a wolfish and gluttonous attitude of mind, a gobbling up of every statement or opinion, figure or formula indiscriminately and incessantly. The result is often intellectual autointoxication from "hunks and gobs" of unselected, undigested and undigestible material.

Rather the civil engineer needs to select very discriminatingly his mental diet and when he goes a-fishing after facts, he wants a fish-fry and not a chowder. His fishing trips are often long and arduous and it is important that he take along only the simplest and most valuable equipment; complicated toys, however beautiful are to be avoided on his mental journeys. Definition of terms are like the names of towns along the way, mathematical relations make a sturdy canoe to bear him, and desire for engineering facts drives him on. At last he finds his country, a land of lakes and rivers teeming with fish—facts of nature borne on by the unceasing current of natural phenomena, all sorts of facts, some useful and some useless to him. And he spreads his net and catches them and selects what he wants and uses them. And later he often tells about it after the manner of all fishermen.

The net which catches mental fish is made of questions bearing on the subject studied. Hence a trained man in collecting information begins first by collectiong questions rather than by collecting data. Indeed a man's knowledge of a subject can be gauged better by the questions which he asks than by the answers that he gives, and there is no surer mark of ignorance than assurance of complete knowledge. When a subject is first studied, the number of questions is few, the mesh of the net is large and many very important facts slip through unobserved, but if the student is wide awake each new fact adds new questions, and as the data are reviewed new facts are perceived and are held fast in the mesh. At first the net is not very well made and at this stage too many facts may be bad, for the net cannot hold a large number of fish even if it catches them. But if the threads are made stronger, if the questions become more clear and definite as the study proceeds, the net will eventually hang each little fact by its gills and all the trout or perch or catfish can be strung on separate strings and eventually put in the frying pan of design. If the net is not allowed to rot but is turned over in the sun occasionally it's all ready for another fish-fry some other day.

Of course there are other ways to have fish frys.



DYNAMITING THE POOL OF KNOWLEDGE!

You can dynamite a pond; that's "messy" and ruins the technique of the fisherman. Or you can buy several barrels of assorted fish and see how you like them; they may be spoiled if you don't know the man who sold them. And you can, if you like, go to a restaurant; but we were talking about how to be an engineer, not how to use handbooks.

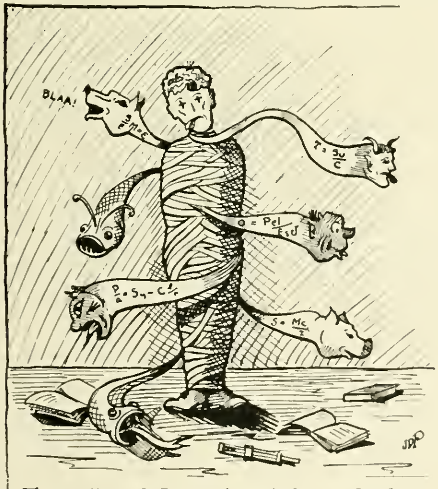
To drop this metaphor, these last three ways of having a fishfry corresponding in reverse order to three definite tendencies of our minds, all based on the same motive. They may lead—and often do lead—to definite mental ailments, the pathology of which is characteristic and important. Most of us will go to any amount of trouble, effort and inconvenience to avoid the supreme agony of concentrated thought; and yet we know that no trouble or effort or inconvenience can avoid the final need of it. And so from fear of mental exercise we become exposed to the maladies of formularitis, translatitis, and experimentalitis.

Formularitis appears at every age, in every clime, in every field of thought. It attempts to reduce cases to formulas; then we congratulate ourselves that we are all through with that group of cases and do not have to think about them any more. Now every one tries to get some general rules to go by and so avoid the need of thinking every think out from the beginning each time. In fact, such general rules supply excellent material from which to spin the skein of questions which make a mental fish net. And often it is convenient to state these general conclusions in symbols or catch phrases without adding a list of all the detailed limitations and exceptions. Everyone who ever propounded a formula which benefitted anyone except a manufacturer of print paper fully realized all this; but a sufferer from formularitis cannot understand it. A formula for bond in a reinforced concrete beam is to him a formula for bond in a reinforced concrete beam and if the faces of the beam are not parallel, he cannot help it. If someone stated broadly the truth that all men are born equal, he knows what equality is—like two plus two equals four. Formularitis, though extremely common and sometimes epidemic, is rarely incurable in civil engineers; vigorous mental exercises in the fresh air of natural phenomena is recommended.

Translatitis is imported. It consists in exaggerating the value, importance and credibility of facts because they came from a considerable distance and were imported into English with considerable effort. Of course it is very desirable that all facts bearing on our work should be at hand from the laboratories and literatures of all countries; it is not always possible, but it is very desirable. One can very readily realize the usefulness of such material when clearly and concisely arranged by referring to the reviews of foreign literature in the Proceedings of the Institution of Civil Engineers of Great Britain. But, quite unconsciously as a rule, we are inclined to measure the value of information by the distance from which it came and the effort devoted to its translation, as if engineering bore any similarity to postage stamps or tropical orchids. The writer recently tried to find the basis for an important rule formulated by a committee and at variance with usual practice but was able to learn only that one member had seen a statement in a certain foreign book that tests supported that rule, but could not find the tests.

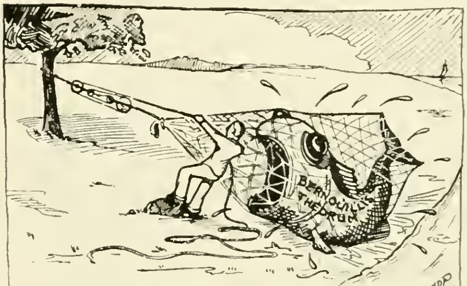
THE C.E. TAKES OUTDOORS INTO THE OFFICE

Perhaps the case just cited was complicated by experimentalitis. The director of the engineering work in a well known institution once told the writer that if he wanted to know all about reinforced concrete beams—he was a mechanical engineer—he would go down into his laboratory and test some. Now such experiments are very helpful, but no one at Illinois would ever maintain that a few or even many experiments on concrete beams would tell a man all there is to know about them—or even all he needs to know for design purposes. There is no field of study that requires more careful training or a rarer intellect than devising and interpreting experiments. But there exists at the present time a vague but prevalent idea that the shortest road to a fish-fry of engineering facts is promiscuous, indiscriminate experimentation — a process of dynamiting the pond of knowledge. But many tests may give few facts and unless well devised they give none that anyone can be sure of, and it is not desirable to eat fish "all messed up" with mud and drift-wood. Except for the work of a few men of peculiar genius in the interpretation of test data, it is true that the least valuable part of any report of tests is the conclusions. To safely use those data each man should draw his own conclusions. A more general tendency to do so would discourage the amateurish idea that this is an easy way to acquire knowledge and would further discourage the very objectionable custom of merely stating that tests indicate thus-and-so without explaining how the tests were made or how they showed it. The writer often finds students prone to refer to tests when they cannot either describe



FORMULARITIS GOT HIM

them or even imagine a test capable of proving the alleged fact. What they really mean is that they have seen or heard it stated that tests prove it and that they know nothing else about the matter. The statistical method is recognized by scientists as an extremely powerful tool which it is very dangerous to use carelessly, but its dangers are often forgotten and its misuse has led to many errors. Those who

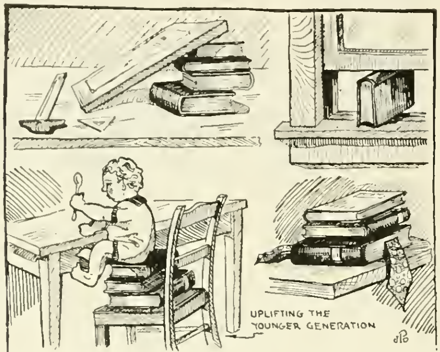


THE CIVIL ENGINEER CATCHES A FISH

have gone astray, however, have done so not by drifting into Mark Twain's climactic group of liars, but by failing to remember how pointedly true in engineering is Josh Billings' advice that "It's better not to know so much than to know so many things that ain't so."

Much of an engineer's best work is the result of "hunches," vague analogies to other cases with which he has worked. It is undoubtedly true that good results come from hard work but it is also strangely true that they often come from hard work done at some other time on some other problem. Hard work has a surprising way of paying unexpected dividends through later inspirations. However, one must clearly realize that "hunches," because they are vague and formless and unreasoned, are dangerous and that an analogy is not a reason nor does similarity constitute identity. The idea suggested may prove true—or it may be nonsense; and yet the persistent "hunch" of a trained thinker should not be treated lightly. One does in time develop what has been called, with needless erudition, a power of unconscious ratiocination.

One hears much, at times especially from beginners, as to discrepancies between theory and practice. Of course there can be no discrepancy between correct theory and good practice, but theories are not, in general, entirely correct, because they are based on assumptions which limit their application ;and a theory which will not work is a wrong theory. Yet it is evident that all engineering is dependent on theory, for it is only by theory that we can profit by experience or interpret experiment; burning down a house every time you want a roast pig is too expensive. All theory is limited in application, but you cannot dispense with theory by the relation of cause and effect, by experience or experiment, by neglecting it, or even by common sense. For common sense, unless it is very common, is only the application of theories which have grown and been formulated unconsciously as a result of experience. He who assumes that the first thing to be done with an engineering problem is to begin industriously computing areas, moments, and stresses will appear as absurd as did the little jurors in "Alice in Wonderland" who began so busily to add up all the dates in the evidence and reduce the sum to pounds, shillings and pence.



COLLEGE TRAINING IN THE USE OF BOOKS

The reader, getting a little tired, will here complain that the writer has not yet said anything about engineering colleges. He was, however, writing of an engineer's education, and not chiefly of his schooling. However, the school has much to do with it. The function of the instructor is more important than the writer once thought. He cannot completely ruin a good man nor can he make a barrel out of a bung-hole, but he can accomplish much in either direction. Undoubtedly he can be invaluable in indicating those methods of thought and study which are commonly unprofitable or actually harmful to a civil engineer. He can help the man to grasp the idea that civil engineering is not a branch of mathematics, though mathematics is useful to the civil engineer; he can discourage purely speculative studies which have no purpose; he can get his men to realize that the engineer asks "What of it?" as quickly as "What is it?"

Perhaps the most valuable training that the college can give is in the use of books. Few students know how to use them. Few can realize how hesitatingly a discriminating author selects his material and that the author, last of all, would say that all this is to be swallowed and that's all to the subject. The information in books is second-hand to the student and second-hand information carries the same dangers of disease germs as second-hand clothes. Few students know that at best books can furnish only a perishable net of large mesh through which they may begin to strain their information and that every fibre of that net must be rewoven out of man's own thinking and many new strands added if it is to be permanent and reliable in holding the selected data of forty years of engineering practice.

The civil engineer needs character and culture and charm—and so does every man. Stevenson says "There is only one road to honesty and the name of that is thrift." Stevenson was Scotch but he no doubt included thrift of mental powers as well as of material things. There is probably no surer road to the development of character than straight hard courageous thinking. As for social charm, the colleges have no monoply: any student who will fairly compare himself or his classmates with men of equal mental endowments and social advantages who entered business from the high school will at once realize this fact—a matter of common knowledge in the business world. He who lives without culture, without a knowledge and appreciation of the beautiful in the past and in the present will only half live; but it is a very common error to assume that cultured men of eminence are great because of their culture, whereas they are cultured because of that cosmopolitan interest which helps to make them great.

In writing of his grandfather, Stevenson describes civil engineering as that calling which carries a man into God's out-of-doors and then finally takes him and shuts him up in an office. But he failed fully to understand that the engineer takes the out-of-doors into the office with him. Artist and scientist, experimenter, investigator, thinker and planner, sometimes a dreamer, often a driver, the civil engineer finds his precedents back to the pyramids and the possibilities of his art stretching to the millennium. The writer wonders that he ventured to write on so complex and important a subject as his education.

Success is one part Inspiration and nine parts Perspiration.

Some men are content to envy success in others; others achieve it for themselves.

Highway Signs

R. A. Culp, c.e., '25

The study of the proper method of marking the hard surface road system, now under construction in many of the states, is one of very great importance and deserves considerable thought and study for a proper solution. The era of automobile transportation is now upon us and in order to meet it successfully there must be adopted a standardized system of road markers, warning, and directional signs.

A few years ago the daily travel of the vehicle was short, the auto tourist was unkown, and the volume of traffic on our highways was comparatively small. There was, therefore, little necessity for any extensive scheme of directing or controlling traffic. At the present time, however, because the volume of traffic is so great, the distance traveled by individual vehicles so long, and because of the fact that many of the drivers are traversing the road for the first time, it is imperative that there be some adequate method of furnishing the drivers with information which will enable them to use the highways with maximum convenience, speed and safety.

This problem is not at all unlike the control or operation of trains on the railroad; but, of course, it does not involve, either by necessity or possibility, the extreme centralization and standardization demanded by railroad operation. The scheme employed for controlling movements of the highway traffic is that of a system of signs.

Highway signs must furnish the driver with two kinds of information. First, they should inform him as to the route to follow and as to certain important features and locations. Second, they should furnish him with information concerning the control of his vehicle. Signs for the first purpose may be divided into those which indicate the particular route and which are usually known as "route markers" and signs of local directional character which may be called "informational signs," the two together constituting "directional signs." Signs for the second purpose may be called "warning signs."

Owing to the fact that many vehicles are traversing long distances and not infrequently traveling the road for the first time, it is highly desirable that the entire system of marking signs be standardized. At present, every state which has attempted to mark its through routes has used a different system of marking and little attempt has been made to connect them with those of other states to get a through route marked in a uniform manner. It is almost impossible to mark all routes in the country as a unit, but the principal through routes can be marked as such and the secondary routes by a system adapted to the local conditions.

Route marking is not the only phase which should be standardized. Of even more importance for the safety of the travelling public is the standardization of the warning signs. There have been several codes proposed for warnings and each has its proponents who believe it to be the best. It is the writer's opinion that the particular code is not of much importance but that the adoption of some code is of great importance.

Code, as here used, may be defined as any set of shapes of signs or symbols imposed thereon, which emphasizes the particular information the sign is to convey. For example, one code which has gained considerable favor is the one recommended by the Mississippi Valley Highway Association. It is as follows:

Rectangular signs to give direction and information.

Square signs to indicate caution.

Diamond shaped signs to indicate danger.

Octagonal signs to designate points where traffic must stop.

Circular signs to indicate railroad grade crossings.

This system is simple and not expensive of installation, and has been found to be effective in the instances of its use.

However, to make any code of the most value, it will be necessary that it be adopted universally, and not only the code itself but also a standard location of the signs with respect to the point indicated and the roadway. The last point is one in which extreme care must be exercised as the misplacement of a few signs will be very detrimental to the effectiveness of the code and the marking system in general.

The purpose of this study is to endeavor to formulate the fundamental principles pertaining to an adequate system of highway signs including combinations of colors, sizes, shapes and locations of signs under normal conditions of illumination and background. The scheme of study was to review the literature of the subject first, then to secure information concerning present practice, and lastly to make such experimental investigations as might prove helpful.

In order to determine what, if any, investigation had been conducted by others, it was necessary to make a survey of all the literature at hand. After reading and classifying all of this material, it was found that, although the subject was a popular one, no actual research had been conducted and the results published. It was also found that there had been offered many solutions to the problem but all seemed to be based on the personal preference of the writer or on observation and study of existing systems. The latter solution is of some value in that the several states are gradually sifting out the good and bad points and improving their systems each year.

To obtain information concerning present practice, a letter of inquiry was sent out to each of the state highway departments asking for a description of the marking system in use in each state and any other information which could be furnished. The response to the letter was very satisfactory and a review of the material so collected furnished some interesting facts that are of considerable value and gave a basis on which to devise some experiments or tests. Some of the principle facts are as follows:

First: Some states do not have a standardized system of signs. They are Mississippi, Iowa, Oklahoma, Kentucky, Kansas, Arkansas, Massachusetts, California, New Mexico, Montaua, Utah and Idaho.

Second: Some states have no route markers but have a system of warning signs. They are Delaware, New York, Pennsylvania, Maryland and New Jersey. In some cases these states have incorporated a route marker with their warning sign, but the system cannot be called a standard complete system.

Third: Some states have a standard, complete system of route marking. They are Alabama, Florida, Georgia, Indiana, Illinois, Missouri, Michigan, Minnesota, Nebraska, Nevada, North Carolina, North Dakota, Ohio, Rhode Island, South Dakota, Tennessee, Texas, Virginia, Washington, West Virginia, Wisconsin, Wyoming and Oregon.

Fourth: Some states either did not reply or could not give the information requested. They are Louisiana, Colorado, South Carolina, Connecticut, Vermont, Maine, New Hampshire and Arizona.

Fifth: Nearly all states which have a system of signs have based them upon the recommendation of some other states or some society interested in the subject.

Sixth: In the cases where a code has been used, the one most generally adopted is that described above as the Mississippi Valley Highway Association code.

Seventh: The color combinations in most general use are black letters on a white background, black letters on a lemon yellow background and white letters on a black background. In some instances other colors have been used; but, as yet, only two states have ventured to use other than black on some light background.

Eighth: As regards location and size of signs and the letters used thereon, each state seems to have followed its own preference and only few have specified dentiitely the location of the sign with reference to the road. All of the states specified more or less generally the exact shape and size of the integral parts of the sign itself.

A tabulation of the standard route markers in use at the present time is shown in Fig. 1. and is here given as a representative outline of the various systems.

The necessity for experimental investigation concerning the principles of highway signs is very great

TABULATION OF STATE ROUTE MARKERS

NAME of STATE	SIZE HORZ. x VERT. INS	OUTSIDE SHAPE	COLOR OF BACK GROUND	COLOR OF LETTERS	SIZE OF LETTER INS	DESCRIPTION of DESIGN
ALABAMA	12 X 18	Rect	Black	White	6	Diamond with Route No in Center
FLORIDA	12 X 12	Diamond	Blue	White	3	Name of State above Route No Below
GEORGIA	14 X 22	Rect	White	Black	2½	Diamond with Route No in Center
INDIANA	14 X 27	Rect	White	Block	5	Route No Above Arrow Below
ILLINOIS	12 X 24	Rect	White	Black	6	State Outline with No in Center
MISSOURI	10 X 8	Oval	Lemon Yellow	Black	5	Name of State. Route No. in Center
MICHIGAN	14 X 24	Rect	White	Black	3	State Initial with Route No with Arrow Beneath
MINNESOTA	15 X 15	Square	Lemon Yellow	Black	3	Star on field and Route No in Center.
NEBRASKA	30 X 11	Rect	White	Black	8	State Outline with Route No in Center
NEVADA	18 X 24	Rect	Black White	White	2	State Outline with Route No in Center.
NORTH CAROLINA	14 X 22	Rect	White	Black	2½	Diamond with NC. and Route No in Center
NORTH DAKOTA	14 X 14	Square	White	Black	4	Indian head with Route No in Center
OHIO	10 X 10		Light Yellow	Black	4	State Outline with Ohio and Route No in Center
RHODE ISLAND	8 X 8	Square	Chrome	Black	4	Route No in Center
SOUTH DAKOTA	28 X 8	Arrow	White	Black	4	State Outline with Route No in Center
TENNESSEE	16 X 20	Rect	White	Black	6	Triangle with Route No in Center
TEXAS	10	Round	Block	White	2	Star with Route No in Center
VIRGINIA	10 X 14	State Shield	White	Black	2½	State Seal with Route No in Center
WASHINGTON	16 X 20	Rect	White	Black	3	Route Name and No in Center.
WEST VIRGINIA	12 X 24	Rect	White	Black		Red Band top and Bottom Route in Center
WISCONSIN	11 X 14	Triangle	White	Black	3	Route No Above WIS. Below
WYOMING	10 X 7	Rect	White	Black	2	Triangle with Route No in Center
OREGON	12 X 12	Diamond	White	Black	6	ORE Above Route No. Below

due to the fact that, as far as is known, there is very little accurate data on which to base definite conclusions. It was thought, therefore, that the material obtained from experiments would assist in forming some definite conclusion or indicate the lines of future investigation.

The question of location of signs was not touched upon in these experiments as the conditions are too variable. Some recommendations are offered, however, and it is thought that they represent the best practice of the present. All other conclusions are based on a certain amount of experimentation and should not be considered as definite as the actual number of experiments were comparatively small.

It is to be noted that in a study of this kind the conditions are so variable and the subject of such a character that the results will necessarily depend on the average of the opinions of the observers. In other words, no exact mathematical tests are possible in these particular phases under observation. It is for this reason that the conclusions cannot be exact, but have a very large "personal equation" factor in them. It is hoped, however, that by averaging the opinions of several observers, the personal equation factor will be reduced to a minimum.

From the tests described below, it is hoped that the following results may be obtained:

First: The most satisfactory color combination for highway signs under the conditions described.

Second: A code of shapes of signs.

Third: The proper sizes of background and letters for the signs under ordinary conditions.

Fourth: The desirable location of the sign as pertaining to the point of danger or interest.

TABLE NO. 1

Sign No.	% Observers Reading All Letters		Av. No. Letters Read		Aver Grade %	Order Letters	Color	
	1 Sec.	3 Sec.	1 Sec.	3 Sec.			Letters	Back-Ground
1	12.5	62.5	4.7	6.6	100.0	KDKAWRM	Black	White
2	9.4	62.5	3.8	5.6	67.8	ADRMKWK	Yellow	Red
3	0.0	40.5	3.2	5.8	47.0	MKRWAKD	Red	Blue
4	3.1	43.8	3.9	5.6	86.0	ADWKMKD	White	Black
5	6.2	43.8	5.1	5.9	80.4	WAKRDMK	Yellow	Black
6	6.9	31.0	4.5	6.1	71.3	KADRMWK	Red	Black
7	17.3	83.0	4.0	5.5	78.2	KWKMAD	Orange	Black
8	0.0	41.4	3.6	5.9	67.8	DKMKRA	Black	Red
9	5.9	41.0	3.7	5.7	62.1	WDKMKRA	White	Red
10	0.0	59.0	3.8	6.4	93.0	MWKAKDR	Black	Yel'w
11	1.0	65.0	3.9	6.4	72.4	KMRWDAK	Orange	L'v'dr
12	5.9	41.0	3.9	5.4	50.6	WKDAMRK	Yellow	Blue

NOTE: All observers read all letters in five seconds.
Observers: Junior Civil Engineering Students C. E. 54 Class.

The first group of tests were conducted under artificial conditions similar to those encountered in night driving. The apparatus for these tests consisted of a rectangular box four by six feet in size mounted on a pedestal so that the box could be swung in a complete horizontal circle. The interior of the box was painted a dead black so that the reflection of light would be the least possible, which is about the condition of the actual background of highway signs. A spotlight was arranged to throw a direct ray into the box and thus illuminate the signs placed therein. These artificial tests were conducted upon three sets of signs, and were twelve, twenty-five and ten in number. The signs were constructed of colored carboard ten inches wide by twenty inches long and had mounted on them the letters described below. The letters in the first two sets were seven in number and were chosen because

FIGURE 1.

they were representative and because it was almost impossible to form any common word or syllables by a combination of these. The letters used were K, D, K, A, W, R, M. The letters in the third set made up the word CAUTION and the combination of colors were selected from those of the second set.

All tests of this nature were conducted for the purpose of selecting from the many combinations possible a number which proved to be the best and to use these in road tests. The first test was conducted upon 12 signs which are listed in Table No. 1 together with the results of the test.

The observers were instructed to try to read as many of the letters as possible in the time the sign was illuminated. They were then to record this result and the sign was lighted for a longer period of time. This was repeated a third time and then each observer was to grade each sign as to their respective merit. All observations were taken with silence in the room so that the results of one man would not be influenced by those of his neighbor. The last test was conducted upon ten signs having the word CAUTION on them. This test was entirely an opinion test as the observers were given three views of each sign and asked to give three grades for each. The lengths of time that the signs were illuminated were one, three, and five seconds and were taken as an average time that an actual sign is illuminated by the headlights of an automobile while traveling at the speeds of 60, 30, and 15 miles per hour, respectively. This time can be only approximate as the variation in the quality and quantity of light obtained from automobile headlights is very great and this coupled with weather conditions is very effective in reducing or increasing the time a highway sign can be seen.

The second set of experiments in this investigation were conducted by constructing some signs and placing them along a paved road. Observers were then driven by the line of signs varying from 15 to 35 miles per hour. On each run the signs were given a grade so that the effect of the speed of the vehicle might be noted. The apparatus for this test consisted of lightweight standards to which the signs were attached. These were spaced about 400 feet apart on the roadway and were set about six feet from the edge of the pavement on the right of the driver. This set of experiments consisted of two tests on the same signs, one of which was conducted during the daylight hours and the other at night.

In the study and experimentation pertaining to the subject of highway signs, there have been brought to the writer's attention many points which are of interest. One of the most important of these points noticed in the first tests is the fact that the glare on the signs caused by the reflection of light from the headlights reduced the readibility of the sign to a very great extent. During the artificial light tests it was found that the observers complained of a constant glare which spoiled the effect of the sign. To overcome this, the box in which the signs had been placed was moved about its axis until the glare was removed. This position was found to be the same for all color combinations. An estimate of this angle placed it at 15 degrees. The angle referred to here is the one which the plane of the sign makes with a line perpendicular to the ray of light. This inclination of signs is partially accomplished by setting the signs to the side of the road, and in some cases has been increased by giving the plane of the sign a slight angle to the line perpendicular to the center line of the road.

An example of the photographic properties of the signs used in the tests is shown in Fig. 2 and this illustrates clearly the negative value of photographs in the study of color combinations because of the fact that black and white appear exactly to both the camera and the naked eye while other colors do not. This photograph shows another important point and that is the fact that black letters on a white background look smaller than white letters on a black background when in reality the letters are of the same size. This form of optical illusion is known as halation and is truly detrimental to the value of the sign. It may be said that in this respect dark colored letters on a light background have a decided advantage over other combinations.

From an analysis of the tabulated data obtained from the experiments, and from a review of all material presented in this paper, the following conclusions have been drawn.

First: The color combination best suited for highway signs under the conditions described is black letters on a white background, especially at night when signs are of greatest value.

Second: The code of shapes of signs best suited for highway signs is as follows:

A. Rectangular signs to give information and direction.

B. Square shaped signs to indicate caution.

C. Diamond shaped signs to indicate stop points.

D. Octagonal shaped signs to indicate points of danger.

E. Round signs to indicate railroad grade crossings.

It is to be noted that the diamond shaped sign which rated highest is to be used for the "Stop" sign. This in the author's opinion is the most important sign of the code and therefore the shape which received the highest grade should be used for that purpose.

The octagonal shaped sign is made the "Danger" sign because it received the second highest grade.

The rectangular signs are used to convey information and direction because it is possible to get more information on this shape, and because it received the lowest grade in the experiments.

Third: The proper sizes of background and letters best suited for highway signs are:

A. The background shall be large enough to be seen at a distance sufficient for the driver to get his car under control by the time he gets to the sign.

B. The letters shall be of such a size as to be visible for about three seconds, the length of time necessary to read the ordinary sign. To meet this requirement it is the writer's opinion that the letters be at least six inches high with the lines of the letters from one-half to three quarters of an inch wide.

C. Lines should be heavier with dark letters on a light background than for light letters on a dark background, but in no case should they be heavy enough to make the letters appear blurred.

Fourth: The location of highway signs cannot be laid down as a definite rule but requires some judgment in each particular case. However, it is believed that for most cases the signs should be set about four to six hundred feet in advance of the point of danger, information or direction, and should be set about four to six feet

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The Virginian Railway Electrification

R. L. Dugger, e. e., '26
R. E. Peterson, m. e., '25

One of the outstanding modern engineering achievements is the development of railway electrification. In 1895, the first real railway electrification was competed in the Baltimore and Ohio tunnel at Baltimore. The development has not been very rapid, but has been steady and progressive.

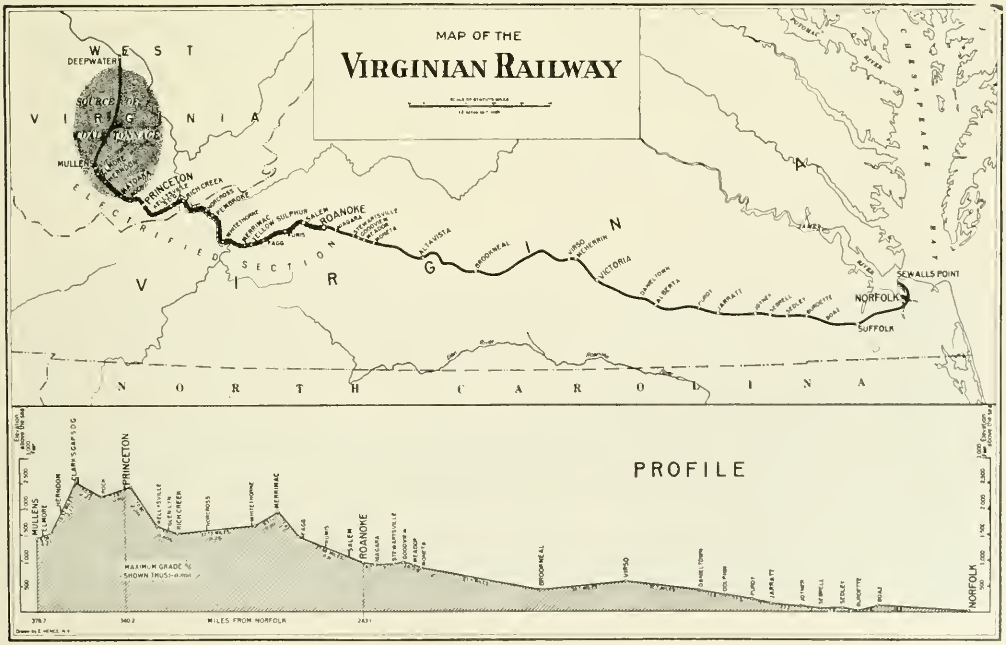
The heavy initial investment required has caused railway executives to be very cautious in considering electrification. The coal supply has been so plentiful, and its cost has been so low, relatively, that it has not been considered wise in most cases to overthrow existing conditions for the resulting gain in efficiency. On non-congested lines, branch lines, etc., aggregating some 175,000 miles of railroad, electrification would not be profitable at present. For light traffic, the internal combustion engine is postponing electrification.

The electric locomotive profitably supplants the steam locomotive where very heavy traffic is carried over a road involving severe topographical conditions. Electrification has in some instances been compulsory by legislation, as in the case of New York City, where, due to the Kaufman Law, all steam operation must be abandoned by 1926. Any increase in prosperity and favorable sentiment will result in increased electrification.

Among the recent electrifications are the Pennsylvania; the New York, New Haven, and Hartford; the Long Island; the Norfolk and Western; and the Virginian projects.

The Virginian Railway electrification, which is now being undertaken, is the largest of its kind in the world. It involves the electrification of one hundred and thirty four miles of the mountainous section of the coal carrying lines between the rich West Virginian coal fields and the Atlantic coast. Conditions are very severe, involving grades of as high as two percent, and curvatures of as much as twelve degrees.

To double the capacity of the railroad without electrification would mean a very large expense in additional trackage, bridges, and tunnels, or an increase in speed using more steam locomotives. With electric locomotives the capacity of the train



can be increased indefinitely, and the speed becomes chiefly a problem of mechanical parts.

The Virginian electrification is a $15,000,000 contract. This includes a turbo-generator plant, the transformer substations, transmission lines, and twelve electric locomotives of the type shown in Fig. 1, each locomotive being made up of three units.

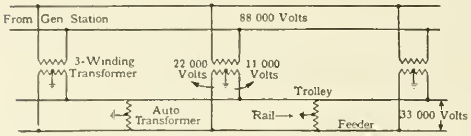


Fig. 2 Distribution System

The greater percentage of all the electrification work in recent years has been carried out by means of high voltage, single phase alternating current systems. Nearly forty percent of the world's railway electrification are using this method of power distribution and utilization.

It may be interesting to note that Switzerland, Sweden, Norway, Germany, and Austria, have definitely standardized on single phase alternating systems at 16,000 volts. At the present time one single phase system is being extended in England. In the United States three existing single phase systems are being extended, and one additional system is under construction.

The advantages of high voltages are numerous. In general the number of substations may be greatly reduced, and the distances between them extended. The size of the feeder wire is invariably reduced, and occasionally it may be dispensed with entirely.

The general plan of the Virginian transmission and distribution system is shown in Fig. 2. For the present the operating potential between trolley and the rails will be 11,000 volts, but this may be conveniently changed to 22,000 volts when traffic conditions warrant such measures.

The power demand necessary to start a 9,000 ton train on some of the grades of the railroad amounts to about 11,000 Kilowatts, or about five and one half times the entire power load of Urbana and Champaign combined.

To supply these enormous drafts of power a steam generating station has been installed at Narrows, Virginia, on the New River. This plant consists of four twenty-five cycle, three-phase 11,000 volt turbo-generators. These generators when operating on single phase service have a capacity of 15,000 KVA each. Three of the generators will be sufficient to carry the maximum load at the present time, and provision has been made for expansion when the load conditions of the railroad demand such measures. Pulverized coal equipment is used throughout in this generating station.

The locomotives to be used on the Virginian Railway are the largest and most powerful in the world. Each of these modern steel dinosaurs is 152 feet in length and can exert a pull of 277,000 pounds. The locomotives are symmetrical and may be run equally well in either direction.

Each locomotive is composed of three semi-permanently coupled units, every unit being a complete plant in itself. By means of a multiple-unit control apparatus, the three units are made to function as one complete locomotive.

The single phase power is received from the trolley wire thru the pantagraph. By means of a step-down transformer and a phase converter the high voltage single-phase power of the trolley is changed to low voltage three-phase power.

The traction motors are of the wound-rotor induction type. The wound rotor permits the insertion of resistance in the rotor circuit. This gives the motors a high starting torque, which is very

(Continued on Page 92)

Fig. 1 Three Unit Locomotive

Graduate Work in Engineering

L. E. Grinter
Third Year Graduate Student in Engineering

Graduate work is looked upon by the undergraduate student in engineering in much the same way as this student looked upon a four-year college course during his high school days. To him it is something rather vague and unknown, and therefore almost fearsome, besides offering only an increasing agony of study to his already saturated system. In addition, what information he actually has, probably causes him to consider it as a highly theoretical, high-brow training which may be all right for future instructors in engineering, but which has little place in the life of one who intends to become a practical engineer. His connection with the engineering profession through summer employment, and in some cases his contact with instructors and professors who are men with considerable practical experience, leads him to the conclusion that the thing to do in order to attain a high place in his profession is to rush blindly into the first position offered and hold it for a period of years so that he may some day walk into the office of the chief engineer of any organization he may select and say, "I am a practical engineer because I have a bachelor's degree and five years of engineering experience, and I want a good position."

The writer does not want to belittle in any measure the value of experience to the engineer. That is something he must have. On the other hand the young man who believes that age and experience are the only essentials is likely to soon become sadly disillusioned. A glance into the "Positions Wanted" section of any engineering periodical will show him an astounding list of men with five to twenty years of engineering practice who are anxious to get positions but little better than he can hold immediately after graduation. What is the logical conclusion? It is that there is another requirement besides a degree and the years of experience which an engineer must have before he becomes a highly valuable man to his profession. Call it a combination of personality, ability, resourcefullness, self-confidence, and any of the other much talked about desirable qualifications, one comes back to the plain fact that there is a quality which some men possess and others do not, and without which one is doomed to fill mediocre positions in the engineering field, or any other field.

The writer fears that an article like this may tend to give the impression that he wishes to hold up graduate work as the great institution for the development of these essential qualities, the perfect panacea for all engineering ills. Allow him to go on record then as having no such illusions. A great many men with the B. S. degree would be simply wasting their time in taking graduate work, while the same men might find themselves developing into broad minded, practical engineers who would some day fill highly influential positions through the channel of the designing room of an engineering organization. On the other hand, many men will find a great opportunity for growth and development in graduate work.

In order to clarify the undergraduate's ideas of graduate work the author will quote in rather random fashion from a paper under the same title as this article by Professor A. N. Talbot[1]: "I should characterize graduate study as distinguished from undergraduate study, by the nature of the larger part of the work, which should be deep rather than extensive, independent rather than minutely directed; the study going to the roots and foundations of the subject and involving an examination of the sources of our engineering knowledge rather than a mere study of current practice and of the methods of attack in special professional lines." "The field covered in four years is so large and the student is expected to know a little about many things that some of the instruction tends to become narrow and dogmatic. Graduate work should steer clear of this difficulty and give the student a broad outlook on the topics he covers." "The young man of ability will be greatly benefited by graduate study taken either immediately after his graduation or a little later."

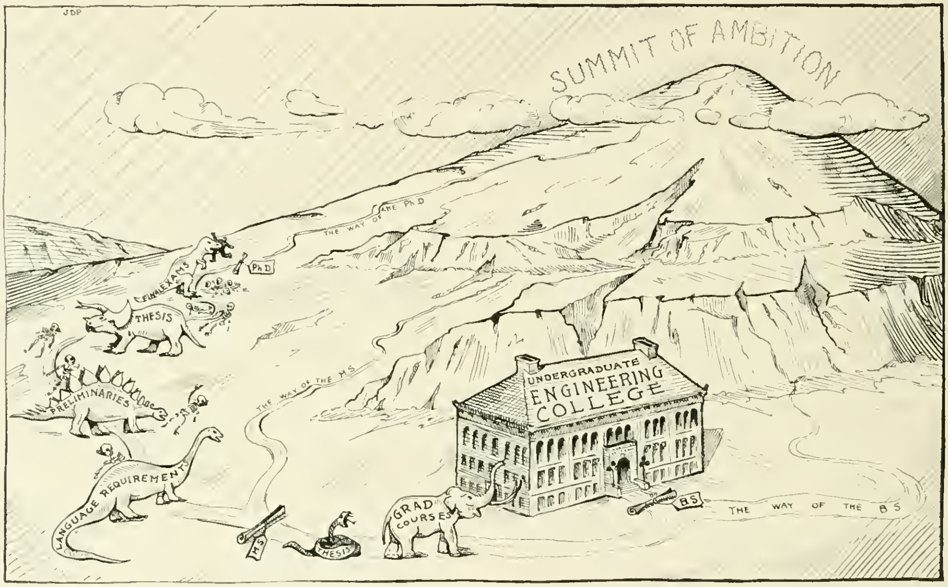
These quotations give a very clear statement of the character of graduate work. Its benefits result from delving into the underlying principles of engineering theory and practice, from shouldering the responsibility for carrying on this study, and in addition, from forming closer contacts with those men who are at present leaders in their profession, and with those younger men who will someday become leaders in their particular field.

The question then is: who are those men that will profit by one or more years of graduate study? Quite obviously anyone who has the ambition to

[1] "Graduate Work in Engineering," Arthur N. Talbot, *Proceedings of the Society for the Promotion of Engineering Education*, Vol. XXX 1922, p. 147

become an engineering teacher will find graduate work essential. Among the men who intend to enter the professional field a great opportunity is offered to those interested in research work. Mechanical engineering, electrical engineering, ceramics, chemistry, and materials testing offer direct openings for research work which may later lead to an enviable position.

The answer for the student in the other branches of engineering, including primarily the many subdivisions of civil engineering, is not so plain. In general he will expect to enter the professional field



in the capacity of draftsman, designer, or some similar position. In obtaining such a position he will not find the possession of a master's degree or the statement that has had one or more years of graduate study to carry any considerable weight. However, the writer believes that the additional training the graduate student has had in the fundamental principles of design, the responsibility he has shouldered in carrying out one piece of research work almost entirely under his own direction, the broader view of one who really understands the theories and methods which he puts into daily use, will combine to eventually bring him to one of the higher places in his profession.

The question of the standards by which an undergraduate should measure his capacity for graduate work is a very important one. As graduate work is more and more being looked upon as a period of training for those who are expected to become leaders in their profession, it is natural that there should be certain requirements. Grading standards are very strict in the graduate schools, so only those students with an undergraduate scholastic standing in the upper quarter of their class are usually encouraged to consider further study. In addition to good scholarship, a student should be a hard worker, should enjoy responsibility, and should have some definite aim in life which graduate work will help him accomplish. For instance the mere desire for a master's or doctor's degree simply because of the distinction it carries is not sufficient reason for even an exceptional student to go on into graduate work.

This outline of qualifications probably gives the impression that the graduate school demands that one already have the qualities which the writer suggested that graduate work would help develop. To some extent this is true because the tremendous expense of offering graduate courses makes it necessary for the men in charge of this work to demand that the student have a certain amount of natural ability which will allow him to readily develop under their direction. It is simply too expensive to train a student who lacks natural ability for graduate work.

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The Ceramic Industry of India

T. W. Talwalker, cer., '26

Heavy Clay Products

Clays are used more extensively in India than in any other country. Ninety percent or more of the houses are built of brick, and most of them set in clay and plastered with clay as well. The floors in most of the houses are of clay, and clay tiles are used almost exclusively for roofing. The kitchen stove in every household is an earthen homemade affair and the drinking water storage is usually a porous earthen vessel (so made because it keeps the water cool). Children's toys add considerably to the trade in clay ware also.

Although clay is so extensively used in India, the clay industries are not very well organized. Each village or town has a brick yard conducted by a family, probably a profession they own by heritage, and take care of the local demands. In and about the cities the situation is about the same, only that more families are employed in the trade. The cities usually buy some ware from surrounding villages in busy season, especially when the farmers are not so busy and their transportation system, the bullock carts, is available at reasonable rates.

Very little capital is invested in such enterprises. The "factory" is usually situated in the open, on the banks of a pool or river where yellow soft and grit-free clay is available. Such clays are obtainable almost anywhere. The overburden of black clay is removed or sometimes mixed with the yellow clay in small proportions. The clay is dug by man power and carried to a washing pit not far from it. The washing pit is simply a rectangular hole 20′ by 8′ by 4′ deep, made in the ground and lined with brick. Clay is dumped into these to about two-thirds the depth and its then filled to capacity with water. After a day or so the water will have percolated through the ground, taking with it some of the soluble salts as well. To this plastic mass some wood ashes and some pulverized charcoal are added, then the mass is pugged well and is ready to be molded. Molding is done by hand, wooden and usualy one brick mold being used for the purpose. The molding table is made of brick, about 3′ wide 7′ long and 30″ high, with a smooth stone on top of it, and is located at one end of the drying yard. Either wood ash or finely ground brick-dust is used to sand the mold. A lump of clay is thrown into the mold from a height and then the excess is removed with a scrapper. Then the mold is emptied on a steel plate and the brick on the mold is carried to the drying yard. The drying yard consist of an open plain piece of ground, about 100′ long and some 20′ wide per molding table. In its first stages of drying the brick are laid flat and then turned on the sides. The only control in such drying yards is the cutting off of draft. The rainy season being restricted to four or five months a year, the brickmaker is not taking very many chances at all in laying the brick in the open. As the drying proceeds the brick can be laid on top of one another and piled up in rows. The roofing tiles are made in a similar manner. The ware is then ready for burning.

The burning of brick and tile is a very simple matter. There is no kiln structure as such. Kiln site is chosen near the drying yards and if possible is so located that the wind will not blow on it except from the top. Wood or charcoal is used for fuel, coal being inaccessible to them. There are two ways of setting up the kiln. First, the brick is piled to make a rectangular shape kiln with arches running from side to side. The outside is plastered with mud and may be opened up for draft if need be. If a particular part of the kiln gets cooler some pulverized charcoal is thrown there to balance up the heat. The brick itself contains some carbon and if sufficient time be given for oxidation there should be no particular trouble. The second way, which is the more common one, is to lay a few courses of brick and then a course of fuel and then some brick and so on. In such kilns the fire is started at the center and spreads towards the sides and ends. The burning period is about two weeks, and the control is similar to that mentioned above. A good burner ought to get something like 60% class A brick, some 25% class B brick and the rest class C. Underburnt brick is usually used on the sides of the succeeding kiln wall.

Although this method of manufacture may appear rather crude, it has its own advantages. There are no overhead charges in the first place except for the capital in the stock. The material put out is of good quality and low enough in price so that everybody can afford it. There is no other building material that can compete with brick; for brick sells at four to eight dollars per thousand.

The clay worker who is called "Kumbhar" has also the charge of mining clay and delivering it to houses whenever needed for plastering, and of laying brick, or floor.

I must mention here that coal is beginning to be used in certain districts for fuel; also that some permanently constructed kilns are being used for making what is locally called "Mangaloree Kaul" which is similar to the interlocking tiles seen around here. They cost around twenty five dollars per thousand, which is about three times the cost of

GLASSWARE PRODUCED IN INDIA

the Spanish type made by simpler processes, but their repair cost being low, they are beginning to attain popularity.

Hollow tile and drain tile are almost unknown to the people, although some attempts were made to put on market a patented hollow tile, without any success. Probably these industries may have a great future to them if worked out properly. The sewer pipe manufacturer is in the hands of an English concern and undoubtedly that industry also has a great future.

During rainy season (June to September) the clay worker must work under the roof and during these days he turns out household utensils, toys, etc. Throwing method is used commonly and occasionally casting is resorted to.

The Glass Industry

The glass industry of the modern type has definitely passed the experimental stage and is winning steadily the confidence of both the capitalists and the public. The art of making glass bangles has been practiced by Hindoos for centuries. They gather their own materials, melt them and mold into bangles, and occasionally into other shapes. However glass has never been used as extensively as in other places. Of course all Hindoo women wear bangles and that alone makes some trade with a population of some 350 million people. The bangle-makers now buy their glass in lumps, and remelt it for their own use in small furnaces.

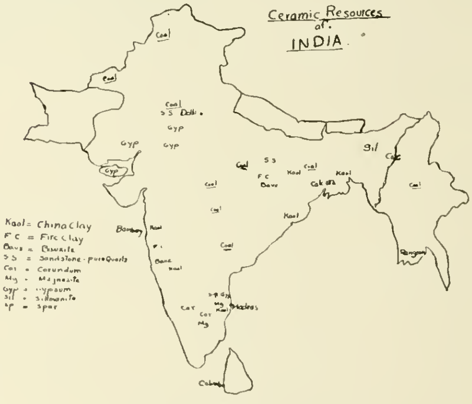
Our domestic manufacturers are working against odds. In the first place the government is not helping them by enforcing protective tariffs. Not only that no help is given them but their legitimate right, the cooperation of the Geological Survey and Institution of Research Bureaus is denied them. Undoubtedly there are a number of deposits of fire clay, sand stone, etc., that would be of interest to the glass maker but who is going to do the surveying? As it is the glass makers import the soda from England, get their sand from some 900 miles, coal from some 500 miles and their refractories from 700 miles. The transprtation system is working against the manufacturer in every way, and to add to his misfortunes he must contend with the poor banking system and the warm weather. In spite of all this we are proud to have amongst us such a genius as Mr. S. P. Ogale and others who have come out of all storms successfully, and steadily with firm determination are gaining ground.

There are some dozen glass factories now in the country all using direct fired pot furnaces, with bituminous coal for fuel. Hand blowing methods are employed throughout. The glass is of medium quality in general. The illustration shows some of the products.

There is plenty of scope for these factories for expansion if the resources of the country are better investigated.

Cement Lime and Gypsum Products

A considerable number of varieties of limestones are found all over the country. Amongst them the most important are marble deposits near Jabalpoor. These are said to be of a better quality than the



CERAMIC RESOURCES OF INDIA

Italian. The famous Taj Mahal is built of marble found in this region. A considerable amount of cheaper limestones are used as building stones, and certain railroads have even used them for fence posts. Lime mortars are used necessarily whenever the wall is in direct contact with water and optionally in other cases. Mortar is also used between brick and lime plaster. When limestone is used as a building stone the chips are saved and burnt as they collect, for lime.

The limestone quarrying practices vary, depending on hardness of the particular deposit. Most of the work is done manually. The stone is then crushed to 1½ inch cubes with a hammer. These are then burnt either in vertical shaft kilns or in open piles, charcoal or wood being the fuel used. The shaft kiln is about 10 to 15 feet high and about 6 to 8 feet in diameter with openings in bottom for discharge. Burning in open is also quite commonly practiced. Either charcoal or wood is mixed together with limestone and arranged in a conical heap or else in layers i.e., a layer of fuel and a layer of stone.

Strange as it may appear to some, a small quantity of high grade calcium oxide is sold for human consumption. It is used in connection with a "Pan Patti", a preparation which has no equivalent here, served after meals.

Magnesite deposits are known to occur in many parts but since the refractory industry is undeveloped, the market for magnesite is limited. Its value as a source for CO_2 for making pops is also limited and we cannot today expect to be able to sell magnesium oxide as a by-product.

There are no definite statistics as to the actual production.

Cement industry (portland cement) has been started some time ago and cement of excellent quality is made on the modern lines, i.e., with long rotary kilns, etc. The industry is at present overproducing. Cement is being used more and more but climatic conditions do not make it absolutely satisfactory to use in many cases. (The roads are made neither of brick nor cement but of crushed stones.

Gypsum of the highest quality is known to occur in many places. Alabaster is used by sculptors. Some gypsum is used for high grade plaster. There is undoubtedly a lot more room for advancement in this field.

Total production in 1923 was 39,297 tons.

The Refractories Industry

The market for refractories is somewhat limited because of the limited use of steel to which it is indirectly related.

Fire clays of good quality are known to occur in various places, however the survey in this respect is far from complete. Corundum, silmainte, bauxite are also obtainable. Corundum and silmanite are exported to other countries including the United States, to a certain extent.

The trade has been little built up and whatever little there is, is in the hands of an English concern and the people of the country do not share in the industry except as consumers.

Glass melting pots used to be imported from Germany and Japan. Attempts to produce these locally have had some success.

INTERIOR OF A POTTERY FACTORY

Pottery Industry

Unvitrified ware made of red burning clay is quite common. Such ware is not glazed but a coat of more fusible clay or decorations made by such clay mixtures are common. Sometimes the body is left unoxidized and has a black color.

Hard burnt or semi-vitrious pottery or stone ware has just been introduced into the country. It will be a long time before we will begin to use white ware for table use. Cups and saucers, china jars.

(Continued on Page 100)

The Atom as a Magnet

Professor Worth H. Rodebush
Head of the Division of Physical Chemistry

In spite of the fact that the atom is so small that nobody can hope ever to see it, it has become possible to count the number of electrons it contains. The methods by which the number is arrived at are indirect and we cannot discuss them here, but we may state with great confidence the number of electrons per atom of any element. Thus the elements may be arranged in a series beginning with hydrogen which has one electron per atom and ending with uranium which has 92. There are few gaps in the series, but eventually elements will be discovered to fill all these gaps.

It will be seen that about half of the elements have an odd number of electrons per atom while the remainder have an even number. These elements may be combined to form compounds in various ways, the molecules of the compound being aggregates of one or more atoms from each of two or more elements so that the number of possible combinations is practically unlimited. Actually, chemists have prepared in the laboratory several hundred thousand different combinations.

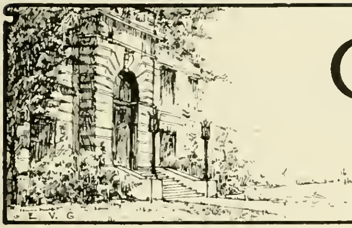
When we come to consider the way in which these compounds are made up, we find a very remarkable situation in regard to the number of electrons per molecule in the compounds. We should expect to find the number of electrons per molecule to be sometimes odd and sometimes even. In certain classes of compounds at least the probability is that there would be more compounds with an odd number of electrons per molecule than with an even number; but the fact is that out of the hundreds of thousands of different combinations of atoms which form the molecules of the different compounds, the number of compounds which contain an odd number of electrons per molecule may almost be counted upon the fingers of one hand. Furthermore these compounds which are made up of the odd numbered molecules are for the most part very reactive and even explosive substances.

Now one of the fundamental postulates of science is that there is no deviation from the general law of probability without cause. There must be some reason why an atom containing an odd number of electrons prefers to combine with another atom which has an odd number of electrons. Moreover, this tendecy toward even number goes even deeper. In discussing the number of electrons per atom we have had in mind the electrons external to the nucleus. In the nucleus, which is the minute center of the atom where most of the mass resides, there are electrons imbedded, and in all but a few atoms the number of electrons here is an even number. Apparently, the electrons go into the nucleus two by two as the animals went into the ark.

All this of course suggests the idea of the pairing of electrons. A stable atom is one which has its electrons paired. But why should electrons tend to form pairs? We are taught in elementary physics that electrons repel each other and pairing surely implies attraction. This question is indeed a poser. The only hypothesis which offers a reasonable explanation is that the attraction is of a magnetic nature. It is a fact familiar to most people that a loop of wire carrying an electric current will if suspended in such a manner that it can turn freely take up a position normal to the earth's magnetic field. A loop of wire carrying a current is then so far as its magnetic properties are concerned the equivalent of a bar magnet placed perpendicularly to the plane of the loop. Now an electron moving rapidly in a closed orbit will give a good imitation of a continuous loop of current. Two such electrons rotating in orbits might be expected to attract one another if properly oriented. Before we should attempt to carry such a hypothesis very far, however, we ought to have direct experimental proof that the electrons possess magnetic properties. This experimental proof we now have.

The first demonstration of the magnetic properties of the rotating electron was made about three years ago by two Germans, Gerlach and Stern. They first worked with silver atoms. They formed a narrow beam of silver atoms by evaporating molten silver and causing the vapor to pass through narrow slits. This beam of atoms was passed between the poles of a powerful electromagnet, and it was found that the atoms were deflected strongly by the magnetic field giving conclusive proof of their magnetic properties. They experimented upon several other metals and came to the general conclusion that the atom with an odd number of electrons is magnetic and the atom with an even number is not. Recently, Mr. J. B. Taylor, working in the Laboratory of Physical Chemistry here at the University of Illinois has demonstrated that the sodium atom is magnetic. The sodium atom has an odd number

(Continued on Page 104)



COLLEGE NOTES

Prof. A. N. Talbot Elected Honorary Member of A. S. C. E.

The American Society of Civil Engineers has honored Prof. Talbot, head of the department of theoretical and applied mechanics, by electing him to honorary membership in the society, a rank held by only 20 engineers of world-wide reputation.

The honor will be formally bestowed at a meeting of the society which will be held in New York City January 20.

While an active member of the organization, Prof. Talbot held the position of member of the board of directors for many years, and in 1918 he was its president. The society was founded in 1852 and now has a membership of 12,000. The membership of the local chapter is 35.

On the list of honorary members are included: Marshal Ferdinand Foch, France; Herbert C. Hoover, Secretary of Commerce; J. F. Stevens, chief engineer of the Panama Canal; Samuel Rea, president of the Pennsylvania railroad, retired; and William Crathorne, England.

The Ceramics Short Course

Fifty-three men and women from various parts of the United States enrolled in the ceramics short course which started January 11th. The course, which was under the direction of Prof. C. W. Parmelee, head of the department of ceramic engineering, dealt with the work and problems of superintendents, managers, foremen, burners and others interested in the manufacture of ceramic products. The course consisted of lectures, laboratory work, and informal discussions. The lectures given the first week of the course were given by men of the ceramic engineering department and other departments in the University. Three lectures of the second week of the course were given by men outside of the University. The visiting lecturers were: R. R. Danielson '14, of the A. J. Lindemann and Hoverson Company, Milwaukee, Wisconsin; M. C. Booze '15, Mellon Institute, Pittsburgh, Pa.; Prof. A. S. Watts of the department of ceramic engineering, Ohio State University.

Dean Milo S. Ketchum delivered the opening address of the short course. In his address of welcome, Dean Ketchum outlined the work of the engineering school and the Experiment station and also explained the research work which is now in progress. Some of the lectures delivered during the early part of the first week are: "Properties of Clay," by Prof. Parmelee; "Ceramic Chemistry," by Prof. A. I. Andrews, of the department of ceramics; "Prospecting and Sampling," by T. N. McVay of the ceramics department; and "Engines and Boilers," by Prof. A. P. Kratz also of the ceramics department.

Concrete and Re-enforced Concrete Arch Research

Professor W. M. Wilson of the department of civil engineering has been engaged for some time in doing research work on concrete and re-enforced concrete arches. Recently the American Society of Civil Engineers has provided two part time assistants for Professor Wilson to help him on tests on re-enforced concrete arches which he is making for the Committee on Concrete and Re-enforced Arches of the society. Mr. R. G. Sturm, University of Nerbaska '24, and Mr. F. T. Mavis '22 have been obtained for the positions.

Professor Wilson will continue the series of tests started last year to determine the effect of the slenderness ratio upon the strength of an arch. Last year he tested arches having spans of 19 feet 3 inches and widths of 16, 12, 9, and 4 inches respectively. This year he expects to test spans of 17 feet 6 inches and widths of 8, 6, and 4 inches respectively. The first arch of thel 926 series was poured January 5th and will be tested about the first of February.

Experiment Station

Bulletin 152, "An Investigation of the Fatigue of Metals," by H. F. Moore and T. M. Jasper. This bulletin is the fourth report of the progress of an investigation of the fatigue of metals carried on at the University of Illinois in co-operation with the National Research Council, the Engineering Foundation, and several manufacturing firms. Previous reports are given in Bulletins Nos. 124, 136, and 142.

This bulletin is a summary of the work done since the completion of that recorded in Bulletin No. 142. It deals with the following subjects: (1) Fatigue strength and the static strength of steel at elevated temperatures, (2) the effect on fatigue strength of stress intensification at a small hole, (3) magnetic analysis as a test for fatigue strength of steel, (4) fatigue strength of non-ferrous metals, (5) fatigue strength of case-carburized steel, (6) testing machines for repeated stress, and (7) miscellaneous test results for metals. The results of the numerous investigations are clearly shown by means of graphs or tables. The experiments are described in detail accompanied by drawings of the various machines used in making the tests.

Notes

At the last meeting of the American Society of Mechanical Engineers which was held recently in New York City, Prof. E. C. Schmidt, head of the department of railway engineering was elected chairman of the fuels division of the society.

The work of the fuels division of the society consists of research, and experimental work in the use of coal, and of the promotion of economy in consumption.

EDITORIAL

Inter-College Debating

On a campus composed of as many divisions as is ours, each vieing with the rest for honors along every line, we as engineers, can be justly proud of the things that we have accomplished in the past,—of the things that we are responsible for originating, pushing and causing to succeed. The immediate issue that caused the above points to come to mind, is that of the inter-college debates.

The start of this inter-college competition in debating came just two years ago, when the College of Engineering challenged the College of Commerce to a debate. That was the only debate held that year, but last year a further step was taken. A league composed of eight teams from five colleges, was organized and these teams competed in a series of elimination debates. Members of this college were largely responsible for the promotion and successful completion of the series. Our college was represented by both an affirmative and a negative team and while not winning out, they gave a good account of themselves.

Another series of debates will again be held this year under rules and regulations prescribed by a committee appointed by the President of the University, which rules are published from time to time in THE DAILY ILLINI. We believe that we have the best talent in the University and strongly urge every one to turn out for the tryouts. There is nothing to lose and certainly a very great deal to gain:—the honor of representing the college; cash prizes (which total $75.00 to the members of the winning team); the opportunity to bring to the college a large leather trophy and possibly a large silver loving cup, also; eligibility for membership in a forensic fraternity; and last but probably most important, the opportunity for attainment of a certain degree of efficiency in handling one's thoughts and words, in being at ease before a large group of people and in being able to convince your listeners of your point of view. All in all, it's mighty worth while. Let's all turn out.

Professor Hardy Cross

The TECHNOGRAPH is pleased to publish in this issue "Thoughts on the Education of a Civil Engineer" by Professor Cross. The staff has observed that many students are anxious to read this article and feels that it certainly has something worth while to offer these students and those who are not yet aware of the treat in store for them. All who have taken courses under Professor Cross know him to have a comprehensive grasp on the physical aspects of engineering problems which cuts cleanly to the root of the matter and through the all to frequent array of laborious mathematics which tend to obscure them. We all remember C.E. 60, and grasp the opportunity that this article offers to help us, shall we say, to cure "Formularitis"?

The Proctor System

To the Editor of The Technograph,
University of Illinois,
Dear Sir:

I have just learned that the proctor system, which has been heretofore more or less nominal in the Engineering School, is to be rigidly followed in the coming examinations. Cheating on examinations is undoubtedly detrimental both to the student who does it and to the institution as a whole. It goes without saying that some steps should be taken toward mitigating this evil. I do not believe, however, that the rigid enforcement of the proctor system will accomplish the result that is desired.

I have at hand no statistics with which to back up my remarks; neither have I been at Illinois long enough to have become acquainted with the local history of the honor system and the proctor system and their comparative results as practiced at this institution. I speak from five years experience as a student, a student in three universities one of which held examinations under a pledge of honor while the others used the proctor system. I say that there was less cheating under the honor system. I say that the attitude of the students toward their work, their examinations, and toward their school was more wholesome under the honor system. I say that and I believe that, and I think that I know why it was so.

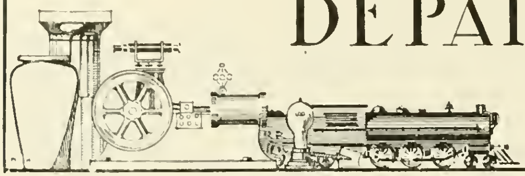
The reason for this difference is, I think, the fact that the proctor system ignores a factor which should be considered. Every student knows that there are two kinds of men who cheat on examinations. One kind is the man with the yellow streak who is just naturally afraid to stand up and meet his obligations fairly. You see him sometimes as a poor student trying to get by, and again as a good student trying to make an A. Possibly the proctor system, rigidly enforced, is the best medicine for him. He will cheat anyway, but with a vigilant proctor present his transgressions are apt to be less flagrant than when he is on his honor.

Then there is the other kind of man who cheats on examinations. He doesn't cheat because he is yellow. He doesn't cheat because he is crooked. He doesn't cheat under the honor system. He is the salt of the earth, the kind of man that helps to write constitutions and build democracies. Instead of a streak of yellow he has a streak of Irish. The school places over him a proctor saying, "Thou shalt not," and he answers, "Damn you, I will."

That is the kind of man who cheats on examinations that the proctor system fails to recognize. There are others, though, for whom the proctor system has no consideration. I speak now of the kind of men who will cheat under no condition. They are in the majority at Illinois and they despise the proctor system. There is nothing more distasteful to an honest man than espionage.

A nominal proctor system is virtually an honor system and, if you can ever become accustomed to the name, is almost as sweet, but I sincerely hope that the movement now on foot to enforce the proctor system will fall by the wayside.

Yours truly,
(Signed) CHAS. F. HENDRICK



DEPARTMENTAL NOTES

Mechanical

A. S. M. E.

The student branche of the A. S M. E. has been doing some exceedingly valuable work this semester. A good number of interesting and instructive programs have already been given; and J. A. Tomasek, president of the society, promises more equally entertaining and educational ones in the future.

Under the auspices of the society, two moving pictures were brought to the campus; both depicted a little of the spectacular in mechanical engineering. One of them, shown early in the fall, told, as no other medium can tell, "The Story of Petroleum." It omitted nothing. The glamor of the oil fields was there; also the wonders of the modern refinery. The other picture, "From Iron Ore to Steel Pipe," secured from the National Tube Company, had special appeal to mechanical engineers. Still, anything dealing with the making of steel is always somewhat sensational; and this picture was no exception. The showing of it was accompanied with sidelights and explanations given by Mr. R. W. Wire, a National Tube Company representative.

In one of the opening meetings of the society, a number of students spoke on "Summer Experiences." These are always interesting, if only for the simple reason that they afford an opportunity to compare notes and reactions on engineering work done during the summer. R. W. Shute gave an account of wire drawing as practiced at the Western Electric Company; J. H. Smith presented some of his experiences in regard to steel inspection; G. Zenner gave a short talk on die design, illustrating it with diagrams of some of the dies with which he had worked; and J. A. Tomasek outlined and illustrated the chief processes involved in the manufacture of Sheetrock wallboard.

Engineers are constantly giving more attention to liquid fuel consumption. According to scientists, the supply of such fuel is limited; therefore it is advisable to use what there is as economically as possible. Everything having to do with developments in liquid tuel apparatus is as a result interesting to the mechanical engineer. At a recent meeting of the society E. F. Bicknell, junior in M. E., gave a valuable lecture on "Oil Burners." Other talks on fuel apparatus are planned for the future.

Several weeks ago Dr. Newkirk, prominent investigator and engineer of the General Electric Company, gave a highly instructive and entertaining lecture on "Shaft Behavior," accompanying it with demonstrations on a model shaft.

According to Dr. Newkirk, it is possible to balance a shaft so that it can be run at its critical speed without noticeable vibration. Yet, despite the fact that a great many machines are being operated at and above their critical speeds, people are still skeptical that such things can be safely done. They must see to believe.

Not long ago it was commonly supposed that the radius of distortion of a shaft at the critical speed was infinite; Dr. Newkirk, by means of several simple mathematical equations, convincingly proved that it is not.

Unfortunately, large machines do not behave as models or as present theories would have them perform. For one thing, lubrication has a big effect on models; and for another, theory assumes a weightless shaft. Generally vibrations occur away below calculated speeds. These vibrations, however, according to Dr. Newkirk, should be thought of only as being resonant A very small stimulus is all that is necessary to set a shaft in motion.

DEPARTMENTAL NOTES

According to latest information, there are 226 mechanical engineers enrolled in the University. Seventy-one of these are freshmen, 65 are are sophomores, 38 are juniors, 51 are seniors, and one is unclassified.

Mining

MINING SOCIETY

The Mining Society held a meeting in the Union Building on Nov. 24, during which Prof. A. E. Drucker gave an interesting illustrated talk on mining operations in South America. Mr. Drucker, together with other members of the London Mining Company, landed on the northern shore of Colombia, S. A., at Santa Marta, one of the oldest Spanish cities in the Americas. From Baranquilla, for seven days they sailed south on the Magdelina River in a wood-burning steamer, crossed the Andes on pack horse, and finally reached their destination near Bogota.

Professor Drucker told of the beautifully colored birds, the animal life, and the jungles of the lowlands. He also described the living conditions on the plateau region. Archeological records of the ancient Aztec and Inca civilization, and the old Spanish cathedrals of Bogota were some of the points of interest mentioned. Many novel and interesting problems were encountered on this assignment. After completing the task of designing, constructing, and putting into operation a cyanide plant for the company, the party returned to London. A better idea of the various phases of the work of a mining engineer was given to the members.

NEW APPARATUS

The department has felt the need of small-scale machinery for use in the mining laboratory; consequently a set of coal and ore machinery has been designed and constructed for use, by the coal and metal mining students. By using small scale apparatus, smaller amounts of ore, power, etc., may be used to demonstrate the purpose and operation of the apparatus without sacrificing any of the instruction value.

The Plumb pneumatic jig for purifying graphite was installed to show the students the operation by which graphite is mechanically separated from unavoidable foreign material that is carried along with the graphite when mined. A disk vibrating 300 times a minute separates the material so that it will collect into separate compartments.

The two mechanical agitators for leaching copper-cyanide solutions are upright shafts with small paddles that are immersed into the solution and revolved by a belt and pulley method have also been added.

The Case Floation machine was installed for concentrating lead ores. The ore is fed into a hopper at the top of the machine. It passes into the floatation chamber, where four times its volume of water is added, together with the required amount of floatation oils. The "rich" ores adhere to the oil globules that float at the top while the gangue is carried off at the bottom. The concentrated ore is retained for refining. The new Ruth floatation machine is not as large as the Case, but operates on the same principle. It separates various grades of lead ore by floatation.

Apparatus for testing ores and cleaning coal, the Harz Jig, is also in operation. There are 2 2-compartment and 1 3-compartment machines, mechanically operated by electric motor, shaft, belt, and pulley complete the power transmission. The ore as mined contains considerable gangue which has to be separated from the purer ore before the ore can be worked. It is charged into the first compartment which has a copper-screened bottom and the top of which is located a little higher than the top of the second compartment. Eccentrically driven pistons force a large volume of water upward through the compartment, producing a heaving effect to the material. The ore being heavier than the gangue collects at the bottom and is washed out through an opening designed for that purpose. The gangue collects at the top and is carried over the top at the side into the next compartment for further concentration and finally is passes into the waste heap.

Two Wifley testing tables for concentrating ores have been installed. The machine has a water feed and an ore hopper at the upper right hand corner of the table. The table, which is slightly inclined, is covered with fine strips of wood placed about one inch apart parallel to the longer axis of the table. The table is vibrated rapidly in simple harmonic motion parallel to the direction of the longitudinal axis. The ore is fed to the table and washed down over the strips. Due to the vibration of the table and its specific gravity, the ore collects farthest to the left falling into a container at the lower left hand corner, while the middling drops into a container next to the ore vats. At the lower center of the table, the gangue passes into a compartment where it is disposed of. A Buchart Table is also in operation. It is similar to the Wilfley Table in construction, operation, and principle, namely, concentrating by specific gravity. Another and more complicated two compartment Harz Jig is ready for use. It operates on the same principle as the others described.

A three-compartment hydraulic classifier of the Spitzlutten type has been designed and constructed for sizing by water gravity methods. Three compartments are arranged, all on successively different levels. The compartments are arranged, all on successively different levels. The compartments are parabolic in shape with a small hopper set in the middle of each. The current of water passing through the compartments carries the lighter gangue with it while the concentrated ore is collected at the bottom of each compartment.

Chemistry

American Chemical Society

The following officers for the coming year were elected at the regular meeting of the American Chemical Society held on Nov. 23:

Prof. A. M. Buswell, chairman; Dr. S. A. Braley, vice-chairman; Dr. H. A. Neville, secretary; Dr. M. M. Austin, treasurer; Prof. B. S. Hopkins, Prof. S. W. Parr, councillors.

Prof. James F. Norris of the Massachusetts Institute of Technology and president of the American Chemical Society spoke before the meeting on "Chemistry and World Problems." Basing his illustrations and arguments on the assumption that the discontented man is the sources of our greatest problem in the present day, Prof. Norris explained how chemistry by relieving the press of population served to make more people happy. Every man has a right to food, shelter, labor, play, health, and other things essentialto his happiness. Chemistry has benefitted everyone by giving them many things which were formerly considered luxuries.

In solving our food problem, chemistry has played a leading role. The process perfected by Haber for the fixation of atmospheric nitrogen gives an unlimited supply of fertilizer. In olden times, man raised animals for their wool which was used to make clothing; today, we can manufacture artificial silk in large quantities with a speed that far surpasses that of the silk worm. Many people of Germany are clothed with materials made out of wood. In this way we may clothe more people on a given area of land.

Chemistry has helped to reduce the hours of labor by eliminating wastes. Wherever there is waste, chemistry can utilize it to manufacture something useful; chemistry is as essential to industry as accountancy. More loyal support of our chemical industries is needed in America at the present time.

Since this meeting Prof. Norris has been re-elected president of the American Chemical Society for the year 1926.

On December 21st an informal dinner for the Chemistry faculty and wives, in honor of Professor S. W. Parr was held at the Inman Hotel. Professor Roger Adams was toastmaster, and Professor W. A. Noyes and Mr. J. M. Lindgren were the principal speakers. Professor Parr received an honorary degree from Lehigh University recently and has gained recognition throughout the country for his research work on coals.

Anyone wishing to contribute articles of general interest on some phase of chemistry or to contribute to chemical notes please see the chem representative.

Civil

Open House

The Engineering Open House was well attended despite the inclement weather. It is estimated that between fifteen hundred and two thousand people visited the Civil Engineering exhibits in Engineering Hall and the Structural and Highway Laboratories. Mr. Wilson and Mr. Williams ran their experimental work on movable bridge rollers and vibratory stresses in masonry full time during the open house and their testing work was of great interest to the visitors. The Highway Laboratory held an exhibit consisting of equipment for making concrete and testing the materials used in streets and pavements, and in addition presented a display of the highway signs in use in the different states. The displays in Engineering Hall consisted of photographs and surveying instruments. There were photographs of construction work in every branch of civil engineering and the collection of surveying instruments was complete and up to date. Faculty members were there at all times to act as guides for the visitors.

A.S.C.E.

The Student Chapter of the A. S. C. E. has had good attendance at its open meetings this semester. Within the last two months they have heard Mr. Miller, of the American Institute of Steel Construction, Prof. King, on Railway Terminal Design, and Prof. Wilson in an illustrated lecture on movable bridges. A cordial invitation is again extended to all to come to the lectures given in room 221 Engineering Hall at four o'clock on the first and third Thursdays of the month. The program for the rest of this semester includes Mr. Loweth, vice president of the C. M. & St. P. R. R., and Dean Provine of the School of Architecture.

New Equipment

The equipment of the undergraduate concrete and highway laboratories has been considerably augmented since last year. The funds available were not as bountiful as they might have been, but the additions are of the best material and workmanship and represent the latest development in scientific equipment. Perhaps the most interesting pieces of the new equipment are the Constant Temperature Electric Oven and the Chainomatic Analytical Balance. In the Chainomatic balance the use of weights smaller than 10 mg. is obviated by means of a vernier adjustment. This feature should warrant an inspection by those of us who have spent many weary hours using and losing the tiny weights that are used in the ordinary balance. A new drill press of improved type, complete with diamond core-drill; a driving-motor; and renewal parts for the soil-testing apparatus form the major part of the remaining additions. The highway laboratory has a set of 24 steel individual equipment lockers ordered, which they hope to have installed in time for the spring semester work in C. E. 54, and if the plans of the department are realized another year should see the concrete laboratory equipped with an electric refrigerator for performing freezing and thawing tests on concrete specimens. This action has a decidedly detrimental effect on concrete, in fact, it has caused, most of the concrete failures of which there is record, and yet there is little actually known about the phenomena. It would seem that the place and the time in which to investigate this subject are here and now.

General

Few men realize the value of a general engineering education. It is the common impression that specialized courses should be taken by everyone along the line in which he is most interested. For a man who is not quite sure of just what field of engineering he wishes to enter, it is only logical that the course offered in general engineering is the best for him to choose. Dean Jordan has received the following letter, from an alumnus, which well illustrates this point.

Dec. 17, 1925

Dean H. H. Jordan,
University of Illinois,
Urbana, Illinois.
Dear Mr. Jordan:.

Your letter reminded me of the intention I have had for some time of writing to you about my work and how the general engineering course prepared me for it. So before I tell you about some of the boys with whom I am in touch, I will take this opportunity to include the other matter also.

My work has from the first been of a general nature, while in the Doherty Training School in Denver, it covered not only engineering practice in electrical, gas, and steam heat utility operation, but also accounting, new business, and general office training. I was transferred to the Industrial Gas Sales department of the Kansas City Gas company in September, and the work here is of a very general nature also. Our duties here are to sell gas, and the proper equipment for burning the gas, to industrial users. This brings us in contact with almost every type of industry. Each industry has different problems to solve and different economic and mechanical difficulties to be overcome. To sell a higher priced fuel for replacing a cheaper fuel we must become efficiency engineers and show that although fuel costs are increased, the unit cost of the finished product is decreased due to the reduction of overhead and the like. In many of my problems I am helped materially by the courses in economics I took at Illinois.

For my particular work, the general engineering curriculum is the best I could have chosen. I need every day the basic fundamentals of engineering I received in the different branches, but have as yet never needed a highly specialized training in any one branch. In fact I find that most of the executives I have come in contact with prefer to train their own men on the higher points of their business, preferring a good general education on fundamentals to one more highly specialized.

You might be interested to know which particular subjects that I studied at Illinois have proved most valuable to me. Among the first I would put M. E. 3 and its corresponding theory course, Mathematics of Finance, Business Law, B. O. & O. 4, and Ec. 1. Perhaps, however, had I gone into another line of work others would have taken the places of these. The one subject I regret having missed is accounting, and so important do the executives in our organization think this that each Junior Engineer was compelled to take a correspondence course in accounting unless he had taken it in college.

I have given you these details concerning myself because it occurred to me that if you had at hand the experiences of a number of graduates in a certain course of study it might help you in designing and changing future courses.

Best wishes from one who is greatly indebted to you.

C. C. Young, g.e. '24.

Electrical

Preparations for the 1926 E. E. Show, which will be held April 8, 9, and 10, 1926, in the E. E. Lab and Gym Annex, are progressing nicely under the direction of Ingram Jones '26, manager. As in the past the show will consist of student stunts and commercial exhibits of new and interesting developments in the electrical industry within the past two years. The large number of new and important electrical developments will be well represented in the commercial exhibits and will be of general interest.

The student stunts will be operated entirely by E. E. students. Among the more notable features will be the model electric railway with full automatic control of trains. All details of a railway system with double tracks and yards will be included. Many phases of electric heating will be shown, from electric cooking to the melting of steel. Artificial lightning will be produced. This phenomenon has been seen by few people outside of laboratory workers and is produced with special equipment of gigantic size.

ALUMNI NOTES

G. W. Lyons, ry.e.e. '24, is working for the Department of Gas and Electricity of Chicago.

R. E. Welton, e.e. '23, is with the General Electric Co. at Schenectady, New York.

B. R. Herr, g.e., '25, is doing civil engineering work in Florida.

A. L. Levystein, cer. ex-'25, is assistant research chemist for the Universal Gypsum Co. of Chicago.

H. S. Magid, cer.e. '23, is chief engineer of the Standard Sanitary Ware Company's Kokomo, Indiana plant.

W. H. Seals, arch. '14, of the firm of Batchelder and Scales of Indianapolis, is now in Florida where he has opened a branch office and is in charge of the building of an eleven story hotel at Haines City. He has made his home in Winter Haven.

L. Schmidt, arch. '13, C. F. Dorcher, arch. '11, and H. G. Overend, arch. '17 make up the firm of Schmidt, Dorcher, and Overend, architects at Wichita, Kansas.

G. Hartwell, arch. '18, now operates his own office as an architect.

F. W. Panhorst, c.e. '15, resident bridge engineer for the state of Washington and is located at Everett.

C. H. Mottier, r.e. '10, is engineer of design for the Illinois Central Railroad. He says that the company has 113 Illini in its employ.

W. L. Steel, arch. '96, has contributed an essay to a symposium "Plagiarism as a Fine Art," published in the American Institute of Architects.

C. H. Blockall, arch. '77, is the designer of the new University Theater which is being built at Yale University. It will be the first modern theater of Gothic design.

J. V. Schaeffer, c.e. '88, president of the Cement Gun Construction company, is the doner of the Schaefer prize for papers on engineering subjects.

A. C. Phelps, arch. '94, is professor of architecture at Cornell University. He spent the last summer in Europe with a party of architectural students.

As director of the School of Architecture at Columbia University, William A. Boring '85 is not generally known as an Illinois man. However he was a student of architecture here from 1881 to 1883. Professor Boring has built up at Columbia, one of the leading schools of architecture in the United States. In private practice, he has designed many important buildings in various parts of the country. Among these are the University of Southern California, ten buildings of the Jacob Tome Institute, and the United States Immigration Station at Ellis Island. He practiced as an architect in Los Angeles for three years after leaving the University of Illinois.

Born September 9, 1859, at Carlinville, Illinois, he attended Blackburn College before coming to the University, and for a time was a student at Columbia. He also attended the Ecole des Beaux Arts at Paris. In 1894 he was married to Florence Kimball of Carlinville. They now have homes at New York and New Cavaeer, Connecticut and he has an office in New York.

Professor Boring received gold medals at the Paris Exposition in 1900, at Buffalo in 1901, and at St. Louis in 1904. He is a member of the Municipal Art Commission of New York and a charter member of the American Academy in Rome.

F. L. Thompson, c.e. '96, is written up in a recent issue of the "South Shore Country Club" under the title The article deals with the planning of "Interesting People About Chicago". and construction of the new South Shore station.

B. A. Lewis, arch. '06, died suddenly in Grant's Pass, Oregon. His death occurred as he was returning home from San Francisco where he taught mechanical and architectural drawing in the Lincoln High School.

I. L. Irwin, m.&s.e. '11, is Sanitary District engineer for the water pipe extension, of the city of Chicago.

R. R. Lundahl, m.&s.e. '11, is assistant for the Milwaukee Sewage Commission.

P. G. Ganger, c.e. '13, is a contracting engineer in Germantown, Tenn.

Tsingtu Woo, e.e. '13, is an engineer for the ministry of communications, Peking, China.

George Mattson, g.e. '24; Paul B. Ferris, e.e. '24; James W. Hart, e.e. '24, Len M. Kandelin, g.e. '25; and M. A. Rowley, g.e. '25 are all Junior Engineers in the Doherty Training School at the Public Service Company of Colorado at Denver.

R. J. Rutherford, m.e. '24, was recently transferred from the Doherty Training School to the Surface Combustion Company of New York City. James R. Scott, m e. '24 is also in New York City, in the Budget Department of Henry L. Doherty and Company. He was married Dec. 29, to Miss Jennie Louise Strike of St. Joseph, Mo. Miss Strike was a student at Illinois in 1924-25 and is a sister of Clifford Strike, c.e. '24.

Thomas Ormiston, e.e. '24, is with the General Electric Company in Schenectady, N. Y. Fred Gilpin, e.e. '24, is an electrical engineer with the Kansas City, Mo., Light and Power Company.

J. W. Pringle, e.e. ex-'17, died recently at Perry, Iowa.

L. H. Christen, m.e. '18, has gone to Richmond, Virginia, as chief engineer for the Virginia Steel Supply Company. He was formerly with the Truscon Steel Company at Norfolk, Virginia.

B. B. Shaw, r.e. '11, has returned from Camaguey, Cuba, where he spent two years as chief engineer of the Cuba Railroad. He intended only taking a leave of absence ,but finally decided to remain north. He now resides at Canton, Illinois.

On Jokes

Getting out the joke section of THE TECHNOGRAPH is no picnic. If we print jokes at all folks say we are silly; if we don't they say we have no sense of humor. If we publish original Engineering jokes they say we lack variety; if we publish things from other papers they say we are to lazy to write. What in thunder is the editor to do, anyhow? Like as not someone will say that we swiped this from an exchange. We did.

Prof. Brown: "Mr. Black why are you looking at your watch so often?

Black: "I was afraid that you would not have time to finish your interesting lecture.

Men Have Been Shot For Less

She: "My hands are cold."

He: "Here are my gloves."

The wild ass is hunted in some countries, but over here they don't even take away his automobile license.

Prof: "And in final proof of the theory of evolution we now have the "Intelligentia" instead of the old fashioned "Smart Alec."

Co-ed at football game: "Hold him, George, I know you can."

—California Engineer

He Knew Jack

Jack Beatty in C.E. 75 Class: "Well, I don't understand all about the stuff yet but I'll sleep on it and see if I can't get it."

Prof. Williams: "All right, but wait until tonight."

Photographer: "Watch, and you'll see a pretty little dickey bird come out."

Modern Child: "Oh, don't be an ass expose the plate and let's get this over with!"

Problem in Math. 2

A young woman goes upstairs at 7:45 to dress for the evening. She is 19 years old and weighs 102 pounds. State the wait of the young man downstairs.

Son: "Is it true about the ass disguising himself with a lion's skin?"

Father: "So the fable goes; but now the colleges do it with a sheepskin."

—Bison.

Jones: "I sent a dollar for an appliance to keep down gas bills."

Bones: "What did they send you?"

Jones: "A paper weight."

—California Engineer

She (just introduced): "Somehow you seem familiar."

Senior Engineer: "Good Heavens! I haven't started yet."

Prof: "Did you read the lesson today?"

Stude: "Not all of it."

Prof. (after questions): "Did you read any of it?"

Stude: "No, sir."

—Pennsylvania Tiangle

Post Mortem

"What did the dean want to see you for?"

"Nothing at all."

"What do you mean?"

"A zero in M. E. 85."

—Pennsylvania Triangle

In a Freshman's Eyes

A Senior stood on the railroad track,
The train was coming fast.
The train got off the railroad track,
And let the Senior past.

—Princeton Tiger.

Encyclopedia Illinica—Absent-minded professor, one who forgets to come to his eight o'clock.

"Did you make the Engineers' show?"

"Yep."

"Cast or chorus?"

"Neither, just the scenery and stage."—Pennsylvania Tiangle.

"I hear your wife had an accident with the car."

"Oh, it was not serious."

"Anything damaged?"

"No, just a little paint scratched off both."

Co-ed: "Oh, do they wear those track pants out in the open?"

He-ed: "Naw, in the seat."

—Ohio State Engineer.

Moonshiners

Else: "Why are all senior law students like the moon?"

Jane: "Because they shine best at night and are usually down to their last quarter."

Mask: "What character do you have iu the next act."

Bauble: "I'm not supposed to have any character; I'm in the chorus."

—Wisconsin Engineer.

"That runs into money," said the grocery store cat after upsetting the ink bottle on the open cash register.

Contemporary Engineering News

Motors Made by Students

Similar to the two cylinder engine made in the Shop Laboratories here at Illinois, is the outboard rowboat motor which the students at the University of Minnesota build.

Each student, if possible, makes one complete motor, and when completed, the motors are sold for the cost of the material, which amounts to about twenty dollars, as against the eighty to one hundred dollars charged by a manufacturing concern for a similar engine. The machine weighs sixty pounds, resembles the ordinary type of outboard motor, and develops about two and one-half horsepower, which is sufficient to drive a small boat at twelve miles per hour. All of the parts are made in the various shops as a part of the regular course of instruction, and the heat treating, machining, and final assembling are done in the machine shop, just as is done with our motor.

The engine is being redesigned; the new type will have a vertical cylinder and inclined propellor shaft, thus doing away with gearing and giving a direct drive. This will decrease both the weight and the total number of parts required, and will make is possible for every student to make one complete machine. The water pump on this engine is novel in that it uses the crank case compression of the two stroke cycle engine to drive the piston of the pump, eliminating the necessity for a gear or other drive.

Developments in the Electrical Industry in 1925

The electrical industry, as its habit seems to have become, did a larger business last year than ever before. The total sales, in dollars, only slightly exceeded those for the year 1924, but when this is considered with due regard for the price reductions, the actual growth of output is rather large.

First, of course, come the machines for making the "juice" that we use. Power plants are installing increasingly larger units in turbo- and hydrogenerators, one of which is shown in another article on this page. New expedients and changes in design are constantly being brought out in an effort to cut down the amount of energy required to produce a given amount of electricity, and to approach a little closer to that still-very-far-off one hundred percent efficiency.

In the last year the use of electric drives on all sorts of locomotive apparatus increased very markedly. The largest ships, the lowly tugboats, industrial hauling engines, and the motorbus, are all using this drive. Simply stated, it consists of a prime mover (steam turbine, Diesel, or gas engine) driving a generator. The current from this is fed into a driving motor which is directly connected to the propellor shaft. The advantages lie in the smoothness, convenience and ease of control that the system affords.

Motors for industrial purposes have been greatly improved during the last year. Large synchronous machines, improved and simplified controlling and protecting apparatus, induction motors having speed flexibility, electrically operated excavating shovels, and new drives for printing presses are some of the things that have been developed. It is now possible to start and put on the line a large synchronous motor simply by pressing a button; the switching is all done automatically.

In the high temperature field, high frequency furnaces have been increased in capacity and efficiency; resistors for all sorts of purposes, from lead melting to bread baking, have been made available for use, and in the refrigeration line, newer and smaller types of machines have been made.

Research in all lines has progressed greatly. The new tools made available to the experimenter are enabling him to learn more about the structure of matter, and each new discovery gives him more tools to work with. The vacuum tube has aided greatly in the discovery and investigation of new phenomena.

In the radio field, so much has been done in the past few months that it is difficult to pick out the things which are most important. One of the chief developments has been along the line of larger and more powerful vacuum tubes, which enable continuous wave telegraphy to be put to work on a commercial scale. The high frequency generators used before the vacuum tube were wasteful, expensive, and only practical in the larger sizes. Transmitters for commercial work in all sizes from the smallest up to 100 k.w. are being put into service, with advantages of stability, small space, and convenience over the older arcs and alternators. In some cases, the new method of controlling the frequency by means of a crystal is used, giving great steadiness of output. The set in its usual form uses a master oscillator, and power amplifier combination, the high voltage being supplied from a kenotron rectifier set. Superpower broadcasting and carrier current telephony are receiving their share of attention, and several installations of the latter have been made. This is a method of telephoning over transmission lines by means of high frequency current impressed on the line, and may be used with portable sets as well as from station to station.

In the lighting field there has been some progress also. A type of lamp has been put on the market in which the frosting is on the inside of the globe.

Builders of Muscle Shoals

Standing before one of the great 35,000 horsepower Westinghouse generators, which is now delivering power to the industries and homes of the South, are from left to right—Colonel Hugh L. Cooper, designing and supervising engineer; General Harry Taylor, Chief of Engineers, U. S. Army; and Major M. C. Tyler, Corps of Engineers U. S. Army, District Engineer Wilson Dam.

Generator in operation delivering 20,000 K.W. at time to Alabama Power Company.

Virginian Railway

(Continued from Page 76)

essential in railway work. The resistance is of the fixed-plate variable water-level type. As soon as the motors come up to speed, the resistance is removed, this being necessary for the efficient operation of the system.

The transmission of power from the motor to the wheels is accomplished by means of a pinion, flexible-gear, side-rod arrangement. The spring-cushioned gear absorbs heavy shocks, and also equalizes the loads coming from each side. The latter consideration is very important as the transmission system is a closed mechanical chain.

The two running speeds of the train will be fourteen and twenty-eight miles per hour. The draw-bar pull of the locomotive will be 6,000 horsepower at the higher speed, thus making the Virginian locomotive more powerful than any other steam or electric locomotive in existance.

The induction traction motors become automatically regenerative on the down grades, thus providing a powerful braking action which holds the train speed down to about fifteen miles per hour. The air brakes are necessary only when bringing the train to a complete stop.

Before the traction motors can be started the phase converter must be put into operation. Since the phase converter is synchronous in nature, it must be brought up to synchronous speed before it is self operative. This starting operation is accomplished by means of a series-wound alternating-current motor which is mounted on the shaft of the phase converter. When the phase converter is in operation this series-wound alternating-current motor changes to a shunt-excited direct-current motor which furnishes the charging current for the emergency storage battery of the locomotive.

The transformer of each unit is of the oil-insulated air-cooled type. A motor driven centrifugal pump circulates the cooling oil thru a radiator which is in turn cooled by a blast of air furnished from a blower driven by the same motor as the oil circulating pump. This space thus required by the transformer is much less than that which is ordinarily required by an air-cooled transformer.

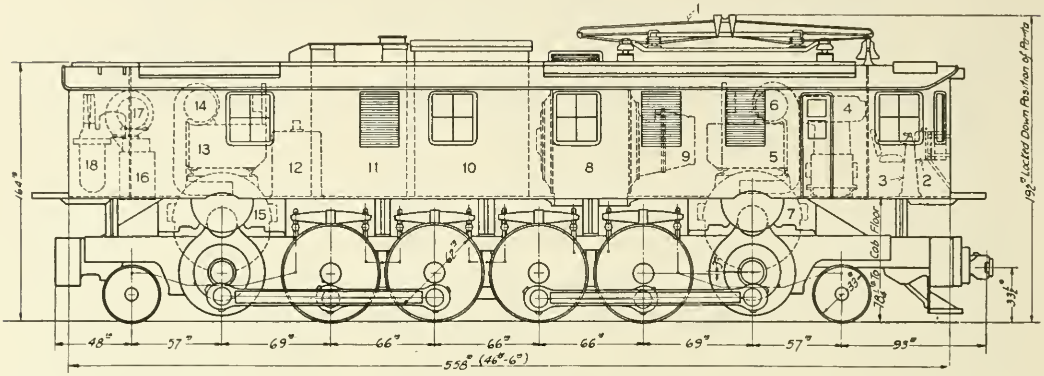


Fig. 3 Line Drawing of One Unit of Locomotive

The unusual features of the Virginian Railway electrification are accentuated by the very massiveness of the structures themselves. Not only has our attention been commanded by the physical aspects of this undertaking, but also by the unprecedented economical conditions that have made this electrification possible.

The Virginian project has attracted wide-spread attention and is considered as an engineering milestone in railway electrification.

Highway Signs

(Continued from Page 74)

from the edge of the pavement. In cities no street should intervene between the sign and the movement it controls. The top of the sign should not be more than five feet above the crown of the roadway and preferably should be somewhat less. The plane of the sign should either be turned out or in at an angle to a line perpendicular to the center line of the road in order to minimize the glare of the vehicle lights on the sign. This angle should be about 15 degrees if the sign is turned in or about five to ten degrees if it is turned out. The first is about the angle made by route markers on the telephone poles.

Color in Romanesque Architecture

(Continued from Page 65)

will be artificially obtained by fire even as the colors of the most beautiful marbles were obtained by natural fires in bygone days." Glass mosaics, clay tiles, colored bricks, terra cotta with the full textured surface of the free play of flames, offer substitutes for marbles, and in themselves are the materials used by the Italians to achieve their charming schemes.

With such a style to refer to for precedent, inspiration, and motifs and with the colorful materials just mentioned we have everything with which to enhance our stone, brick and concrete architecture.

Of the successful examples of the use of color in architecture the California Building in Balboa Park, San Diego, California by Bertram G. Goodhue has been the most discussed. Here a structure of concrete is encrusted on dome surfaces and other areas allowing such treatment with colored tiles. There has come to my notice a shop front at 605-607 Davis Street, Evanston, Illinois which is entirely of terra cotta but which makes use of this material in the Italian manner. The field of the building is cream in two shades. The door jambs, lintels, and the discs and medallions of the spanderels are of black metallic glaze. The incised lettering and raised ornament, the borders of medallions and diamonds, and the bed mould of the cornice are accentuated in gold. The trim of small window, the griffin brackets of the second story openings, and the cornice are done in pale green. This is a good example of what can be in the way of brightening up our commercial architecture.

St. Catherine's College Chapel at St. Paul, Minnesota, cover design of this issue, is a recent structure which follows but does not copy the example set in the Romanesque Architecture. Here the Italian alternation of brick and stone courses is modified to a happy and intriguing procedure of outlining the random travertine blocks of the walls with a single brick course. Windows are framed in brick arches with tile inserts. A band course of colored tiles ties the windows together. Here indeed is a happy relief of surface by change of materials.

The campanille entrance is done in Polychrome tile, shot cut travertine weathered and rusted to cream with sienna streaks, brown lime mortar, and variegated brick. The chromatic scheme was well conceived, and weathering will further tone and soften the structure which stands well to rival the best examples of the style to which the builders turned for inspiration.

"Ah say, Mary, would you yes's soon—"

"Look here, Jim Jackson, don't you git fresh wif me. Mah name's miss Smif, not Mary. Ah don' 'low only mah bes' friends to call me Mary."

"Ah begs yo' pahdon, Miss Smif. But say, Miss Smif, would you je's' soon shif to the oder knee? Dis one's gittin tired."—*The Rose Technic.*

Roll, Brudders, Roll

Preacher: "Rastus, do yo' take this here woman for better or worse?"

Rastus *(from habit)*: "Pahson, Ah shoots de works!"—*Guide Post.*

Graduate Work

(Continued from Page 78)

The young man who feels an interest in graduate study should therefore give himself an examination, and if he passes by the standards quoted above, he should consult his major professor or the head of his department. These men will impartially counsel him as to the advisability of continuing his studies and recommend a suitable school for such work. Due to the expense of offering graduate courses there has been a decided tendency for graduate work in any one subject to be concentrated in a few universities. If he is advised to continue by his major professors, the writer feels no hesitancy in saying that it will be to his ultimate advantage to do so.

In conclusion the writer wishes to offer a bit of personal encouragement to any student who feels awakening within him an interest in graduate work. Graduate requirements are rigorous but not so strict that an average student cannot pass them. The production of a thesis is a difficult task, but a very profitable one, and the writer has yet to meet a student who begrudged the time spent in his thesis work. The field of graduate study in engineering is an open one, and there is ample room for wide awake men of definite purpose.

Something to Do

"Rastus, how is it you have given up going to church?" asked Pastor Brown.

"Well, sah," replied Rastus, "it's dis way: I likes to take an active part, an' I used to pass de collection basket, but deys give de job to Brothah Green, when he returned from ovah thaiah."

"In recognition of his heroic service, I suppose."

"No, sah; I reckon he got dat job in reco'nition o' his having lost one o 'his hands."—*Exchange.*

She: "I can't light this match, my foot is too small."

He: "Scratch it on you—er—better let me light it."—*The California Engineer.*

THE DISADVANTAGE OF POOR LIGHTING.

As thousands of our industrial plants are operating to-day with poor lighting and in some cases with extremely bad facilities, it would seem that the importance of the subject of lighting has not been given the serious consideration by those responsible for such conditions.

Poor lighting is one of the most serious handicaps under which a manufacturing establishment can operate. First of all, poor lighting is the cause of a large number of accidents in industrial plants; and it is singular that accident reports do not yet properly classify the hazards of poor lighting, which in many cases is the primary cause of an accident attributed to what is really a secondary cause. Safety engineers and other officials who make accident reports should always consider the condition of the lighting when working up a report of accident causes, for it plays an important part in a great many casualties and is apt to be overlooked. All accidents due to poor lighting are accidents of neglect, and are preventable. The poor lighting accident hazard is clearly chargeable to management and not men. It is a difficult matter to make such progress with Safety First in a plant which has neglected to provide one of the fundamental requirements of accident prevention—good lighting.

Probably no one single factor connected with the equipment of a plant so directly affects the efficiency and inefficiency as the quality and quantity of the lighting. The curtailment of production of all working under the disadvantage of poor lighting represents a big loss each day; the poorer the lighting the less able is the working force to function efficiently. Quality and quantity both suffer, representing a preventable loss wholly removable by improving the lighting.

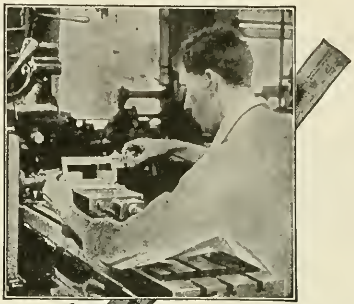
Under poor lighting condition, we cannot expect and rarely do we find an orderly, clean factory. Darkened places encourage careless habits and workers are often led to deposit discarded articles or material which should be deposited elsewhere. The eyesight of those who attempt to use their eyes continually in insufficient light, below nature's demands, is often affected. Too much light, such as is furnished by bright, unprotected lights, is as harmful as too little illumination; both are fundamentally wrong. Nature's own illuminant, daylight, is unequalled for our requirements of lighting.

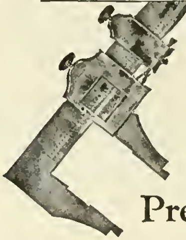
The eye is best suited to daylight in the proper quantity. Sun glare should be avoided, and in the darkened hours proper artificial illumination provided. Daylight should be utilized to the fullest extent. It is supplied free in abundant quantity for our use. Modern invention has supplied a means whereby the interior of buildings can be lighted by daylight, and all the advantages secured which is furnished by good lighting at the smallest cost.

Industrial buildings should have as much wall space as possible devoted to windows fitted with Factrolite Glass, which insures the maximum amount of daylight and which prevents the direct rays of the sun from passing through as it properly diffuses the light.

If you are interested in the distribution of light through Factrolite, we will send you a copy of Laboratory Report—"Factrolited."

MISSISSIPPI WIRE GLASS CO.,
220 Fifth Avenue,
St. Louis. New York. Chicago.





Re-making the World with Precision Tools

IT is difficult to comprehend the tremendous changes made possible in the world by the introduction of practical precision tools. The astounding mechanical progress of the past 50 years, which has completely changed man's environment, would have been impossible without them. They place within reach of all the standards without which working methods in the metal trades would be primitive.

The vernier as a mechanical principle of indicating very small dimensions was invented by Pierre Vernier in 1631. The first practical application of the principle to a measuring tool for metalworkers was not made, however, until 1851, when Jos. R. Brown invented the Vernier Caliper.

The manufacture of this highly useful tool by the Brown & Sharpe Mfg. Co., dated from that year. Today, hundreds of styles and sizes of tools embodying the vernier, and measuring to one thousandth of an inch, are made by this company and distributed all over the world.

The first and original Vernier Caliper, so far as is known, invented in 1851 by Jos. R. Brown, the founder of the Brown & Sharpe Mfg. Co.

BROWN & SHARPE MFG. CO.
PROVIDENCE, R. I., U. S. A.

Ceramic Industry in India

(Continued from Page 81)

ink pots, toys, and flower pots are among the common articles of sale. High class work such as English china tea sets, etc., is patronized by the richer folk. Floor and wall tile is gaining some popularity.

Kaolin of the highest grade, feldspard flint occur at various places. Some of these locations have been shown on the map. The great hindrance to progress of the industry is the high cost of transportation both of the body materials and coal. A pottery company in Calcutta is well established now but some others elsewhere are still in an experimental stage. No reliable data is obtainable as to domestic products.

Historically speaking the pottery art is not new to us. It is said that we got it from Persians long ago. There has existed for a long time a class of people called "Kashigars" who produce glazed ware such as enameled tile, etc. Cobalt blues, and opaques, tin oxide were produced frequently. These men, it is interesting to note, gathered their own materials and treated them in proper manner to get them in proper forms. They may not have understood the complete action in this game. Some detailed accounts on the subject will be found in Ball's Economic Geology of India.

Ceramic Education

Pottery art schools are conducted by the government at Bombay and Madras. Some remarkable pieces of art work have come out of these schools and their graduates. No college course is offered anywhere.

A school for training glass blowers, etc., is maintained on altruistic basis by the people at Talegao. This was a pioneer in that field but is now looked upon as a mother factory. Besides training the boys, the school is also conducting research in all ceramic lines, particularly in refractories.

No attempts have been made to train the large mass of people engaged in these trades. A demonstration school was planned for Bombay district but somewhere it seems to have died out.

A man in a hospital for the insane sat dangling a stick with a piece of string attached over a flower bed. A visitor approached, and, wishing to be affable, remarked:

"How many have you caught?"

"You're the ninth," was the reply.

—*Pitts. Chronicle-Telegraph*

A sidelight on N. Bonaparte

[which your course in European History quite probably failed to give you]

EVEN though his life was filled to overflowing with wars, politics and intrigues, Napoleon wasn't too busy to be a shrewd and far-sighted judge of paving materials.

There are paved roads in Holland built at his command which are still in use after a hundred years' resistance to traffic. Napoleon knew good paving—he specified *Vitrified Brick*.

NATIONAL PAVING BRICK MANUFACTURERS ASSOCIATION
Engineers Building Cleveland, Ohio

A Book *for* Roads Scholars

If "*The Construction of Vitrified Brick Pavements*" is not already a text-book in your courses, let us send you a personal copy. It is an accurate and authoritative handbook of 92 pages which you will want to preserve for reference after graduation.

VITRIFIED
Brick
PAVEMENTS

OUTLAST THE BONDS

Engineering Practices in India

1. Use of plastered walls instead of facing bricks, often with laborious decorations.

2. Setting brick in clay and then filling the seams with mortar and then lim plaster or occasionally with cement.

3. The floors are made of filler material such as broken bricks and gritty earth, and covered with clay. They are then rammed down. Such floors last about five years or so after which time another coat of clay is applied and the floor remade.

4. Nearly always absence of any basement as such except in southernmost part of the country.

5. As far as possible, the tendency goes, make the seams between brick or stone as thin as possible, which is in contrast with the American practice of making them bold and conspicuous.

6. Use of mud plaster with straw, and white washing later.

7. Grinding lime and quartz together sometimes with some fibrous material when it is to be used for plastering. Just whether quartz acts like a filler or the action is similar to that in sand-lime brick is not known. Quite often various organic materials are added to it while grinding.

The Atom as a Magnet

(Continued from Page 82)

of electrons. The conclusion appears to be warranted that all atoms containing an odd number of electrons are magnetic while all atoms with an even number of electrons are not.

Apparently, the electrons in their pairing neutralize each other's magnetic field perhaps in the same way as two bar magnets placed with their opposite poles together. The magnetic moment of the odd numbered atom is simply that due to the extra unpaired electron it contains.

It will be asked: why if the silver atom is magnetic is not a bar of silver attracted to a magnet? The answer is that when the atoms of silver come together to form the massive metal, the magnetic moment of one atom is neutralized by an adjacent atom. The iron atom is not magnetic which seems very surprising at first thought. If we remember, however, that the iron atoms are evaporated from the surface of molten iron and that molten iron is not a very magnetic substance, this does not seem so strange. The remarkable magnetic properties of iron in the mass are as yet something we cannot explain.

Chesterton has said that a thing becomes more wonderful by being explained: sometimes it becomes harder to understand. The magnetic atoms behave in a very peculiar manner when they are passed through the intense magnetic field. The field is diverging, and the atoms are passed near one of the pole pieces of the electromagnet. Under these circumstances we should expect the atom to tend to orient itself in such a way as to be attracted. What happens apparently is that half the atoms turn so that their magnetic field coincides with the field of the electromagnet, and half turn in exactly the opposite direction. The first half are repelled and the second half are attracted. When one realizes that these atoms are being shot through the field with the speed of a rifle bullet, it is difficult to see how they can snap into one or the other of these two positions so quickly, and it is equally mysterious why they do it. Apparently, we have here some more mysteries to be explained by the "quantum theory" when or if it really becomes a real theory.

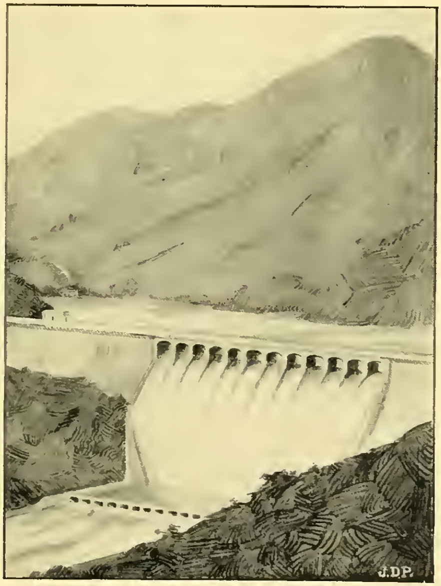
Riff: "Do you know Bill?"
Raff: "Yes, I used to sleep with him."
Riff: "Roommates?"
Raff: "No, classmates."

Bill: "Whence the black eye, old dear?"

Dooley: "Oh, I went to the plumbers ball last night and was struck by the beauty of the place."

THE TECHNOGRAPH

PUBLISHED QUARTERLY BY THE STUDENTS OF THE COLLEGE OF ENGINEERING UNIVERSITY of ILLINOIS



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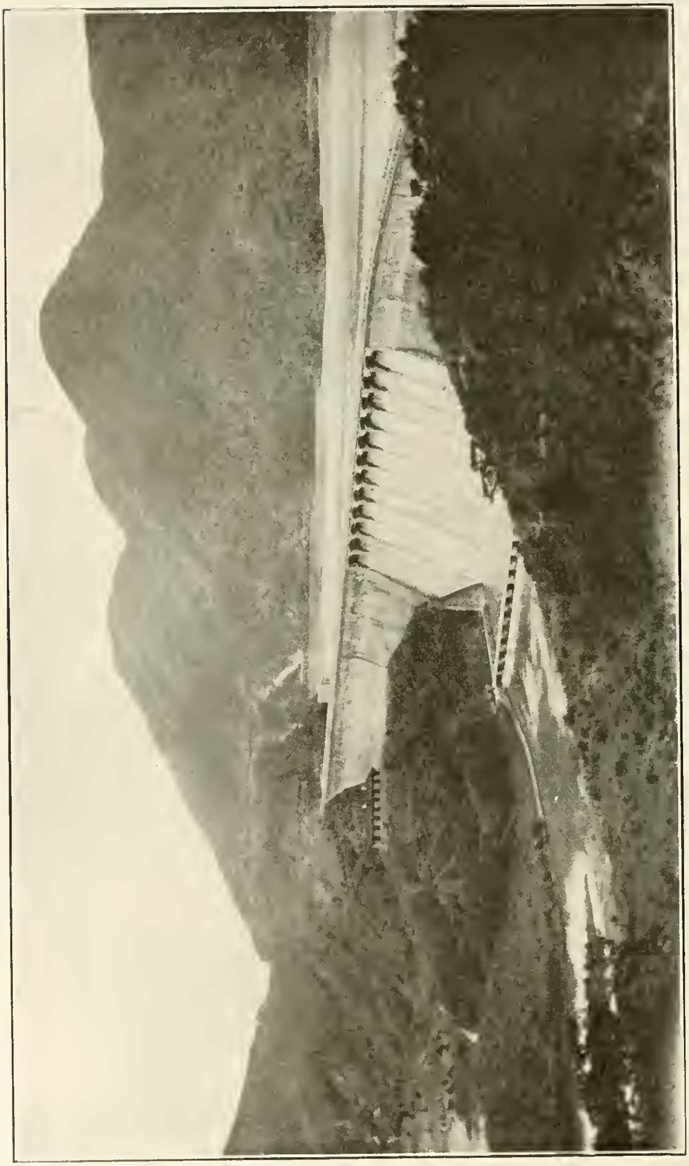

Figure 1—View of Dam at Hong-Kong

THE TECHNOGRAPH

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Glimpses of Engineering Abroad

A. J. COPE, JR., c.e. '26

It was through friendship and association that the writer was included in a group of four men, to whom was presented the opportunity of an extended tour. Needless to say the opportunity was greeted with open arms. The arrangement was that the four men were to act as orchestra on the S. S. President Monroe. The work consisted of playing from 1 till 2 for lunch, 7 till 8 for dinner and 9 till 10 for dancing. The remainder of the time was entirely at their own disposal.

The tour was to last nearly five months and would extend one and a third times around the world. The start was made from New York city on July 10, 1924, whence the ship sailed to San Francisco via the Panama Canal. The Pacific stops were Honolulu; Kobe, Japan; Shanghai; Hong Kong and Manila. Three of the party had previously visited these ports so the thrill of the trip was redoubled when the prow was pointed for Singapore. Enroute there came news that a dangerous floating island was somewhere near the ship's course but the captain fortunately was able to avoid collision with it. After Singapore came Penang, an island port, Colombo on Ceylon, and then Cairo, Egypt. At the eastern end of the Suez canal the party was allowed a three days vacation which allowed them to visit Cairo, inland, and then rejoin the ship at Alexandria. Leaving Alexandria, the next ports were Naples, Genoa and Marseilles—the last foreign port. Then a fourteen day sail brought the ship to Boston and good old United States once more. The stop at New York was seven days and then the boat sailed to San Francisco as described before. Thus the itinerary embraced a total of 21 different ports which afforded a view of some of the most interesting cities of the various countries.

The paragraphs that follow contain a few glimpses of engineering interest, which were obtained at some of the ports visited. The number of things seen was great considering the fact that stops were mostly from one to three days; but the party had no duties to perform from the time of arriving in port until sailing time, which made things extremely nice.

Knowledge about the Panama Canal is rather common now but perhaps a new aspect of it would be instructive. In going from the Atlantic to the Pacific, the ships enter the canal near Colon and pass through a rather narrow stream to the Gatun locks. Along the way, the old French canal is to be seen with rusting equipment nearly covered with growth. The sides of the canal are lined with dense tropical growth and a seaman with a sense of humor tells the passengers to watch for monkeys in the trees. As the locks are approached, negroes come aboard to handle the tow lines, the cables are attached to the electric mules and the ship is towed into the first lock.

The passengers throng about the decks as the ship is raised 90 feet in the Gatun locks, and many weird explanations may be heard as to how the locks work. From the locks, the boats sail into Gatun lake, which is quite a large expanse of water, with the tops of dead trees protruding above the surface. The great dam which makes the lake may be seen in the distance.

As the ships leave the lake for the canal again, buoys are seen. They seem of peculiar shape until closer inspection reveals a small pelican perched upon each buoy. The ships frighten them to awkward flight. In the narrows once more, the ships curve on and on south and east. Along side may be seen a train and extending over the tracks are rectangular frames of steel which are to be used for electrification of the road in the future. The rather humorous remark of a young lady from lower New York upon seeing these, was, "Oh, kid, look at the hurdles."

Alongside, white pyramids, supported on tripods, baffle the best guessers as to their utility. The mystery is later explained when it is noticed that the prow of the ship is directly in line with two of these pointers at all times. Then as the canal bends and twists the pointers pass by on the side. They stand about ten feet high.

Figure 2—A Famous Ancient Egyptian Structure

There are quite a few miles of narrow canal, the sides lined with slopes over which flow small waterfalls and streams. Shortly a huge mountain looms in the distance and the ship approaches Culebra cut. This cut has been made so well that it is almost impossible for the spectator to appreciate the vast amount of work and energy which has been put into it. Passing on, another stretch of canal brings the ship to Pedro Miguel locks. Along the side of the locks huge steel trusses may be seen. They seem to support nothing and their function is not obvious to the traveller. It was later explained that these structures are swung out across the locks and act as temporary lock gates, while the regular gates are repaired or painted. The trusses support collapsible panels which may be dropped down and which interlock with one another to make water tight joints.

Passing through this lock, it is but a short distance to the Miraflores locks and down into the Pacific—perhaps a half a mile. The time taken to pass through the canal is about 12 hours if there are no delays. The charge for passage of ships is according to their tonnage and for the larger ships runs into thousands of dollars.

A visit to the control tower of the Pedro Miguel locks reveals several facts of interest. Ships desiring to enter the canal are signalled to proceed or stop by a large conspicuous arrow which is operated from the tower. The 60,000 ton lock gates are opened and closed by a 25 horse power electric motor. The water used in the locks is not pumped but flows entirely by gravity from Gatun lake. The level of the water in the locks is clearly shown by illuminated gauges on the control table and the entire operation has been simplified as much as possible to avoid accidents. Tunnels below run the full length of the locks giving access to the electrical machinery. All illumination both above and below is by indirect lighting.

During the past few years the canal has been quite profitable and should the demand for passage increase materially, it is planned to raise the water level in Gatun lake to increase the available head of water for the locks. Then a new set of locks, identical with the old would be built alongside the old.

No material has been found to date which is suitable for the lock sills. A wood from New Guiana which has the same effect upon man as poisoned arrows was thought impervious to all attack, but when

Figure 3 Electrical Communication (note telephone pole) and Primitive Raw Rubber Transport. *Figure 4* A River Bridge in Singapore. *Figure 5*—Street Scene in Yokohama After Earthquake (note reinforced concrete remains). *Figure 7*—Looking Down on the Pacific from Panama Canal Locks. *Figure 8*—Remains of the Grand Hotel and Harbor at Yokohama.

taken up showed the same disintegration as any other wood.

The engineer in charge gave it as his opinion that the sanitation of the Canal Zone was the greatest engineering accomplishment of the entire work.

One of the present difficulties of which this man spoke was high surge pressures. When water is drawn for raising the ships, a surge wave follows which makes high pressures on the lock gates. It has been proposed to eliminate this by installing a surge chamber which would diminish or stop the wave.

On the thirteen day cruise from the Canal Zone to Los Angeles about the only kind of engineering which can be seen is that which takes place aboard the ship. The two things which require some engineering knowledge on a ship are the engines and the loading derricks. The latter are rather simple and can be operated with great speed. There is just one point which deserves mention, as concerns them. Nearly everybody has noticed the unsightly steel frames that tower above the decks of most of the shipping board vessels, and wondered why they were there. Their function is to hold the loading jibs in the proper position while

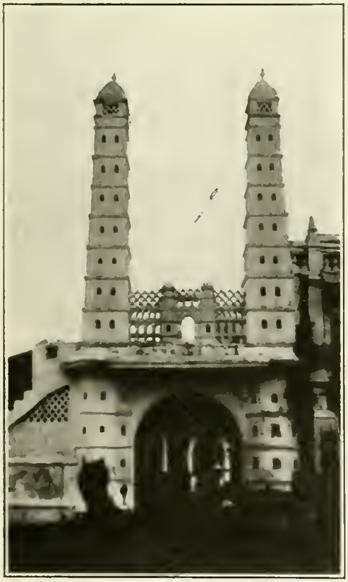


Figure 9—A Malaya Temple. Contains No Furniture.

cargo is handled. These jibs are hinged to the frames at the bottom and are held up at the top by cables which pass over pulleys to the frames. When not in use the jibs may be made fast to the frames in a vertical position, but if the barometer indicates a storm's approach they are let down and made fast to the decks.

The real engineering problem aboard a ship, though, is to be sure that the ship will reach its

Figure 10—A Construction in Progress at Shanghai. Note the Bamboo Scaffolding.

port on time. When the ship is but an hour from a port and the rudder breaks, the engineer must know what to do, and do it quickly. In a certain case the ship weaved aimlessly about while passengers were wildly focusing binoculars on Vesuvius. Ten Filipinos tugger at a rusty hand-wheel on the poop deck to no avail. Finally the chief engineer emerged from below, grime from head to foot, and announced that all was well.

But even more important than this is the consideration that there may be several million dollars worth of cargo aboard and, if the ship is late, each days interest on the cargo is a big figure. Also if the ship can be landed ahead of time the captain and chief engineer often come in for a bonus.

Passing now to the Orient, it is difficult to say much, truthfully, regarding engineering, except that most of the recent work has been done by the English. There are a few interesting things to note about China however.

Due to the intense population of China, most of the work is done by human labor. In fact if a contractor should bring horses on to a construction he might well expect to find their gee-strings cut in a day or so. Stone block and steel members are transported to the construction on carts drawn by men and women, who tug at ropes over their shoulders, side by side. A hand driven pile driver is certainly an amusing sight. The one seen consisted of a platform upon which a dozen or more coolies stood, raising and dropping the hammer. The amusing part is that the coolies yell, each to his own liking, when they strain to raise the hammer.

At Shanghai and Hong Kong modern roads and pavements are to be found, as well as the best of business building construction. The Wing On store at Shanghai is comparable with Marshall Field's. The white stone buildings of Hong Kong make it one of the most beautiful ports of the Orient.

Going now to Egypt, it is well known that the structures of that country have made it a mecca for tourists for many years. One may well ask why there seems to be no construction of such things going on, today. The answer is that the construction of Egypt today is done by the English and the Egyptians lack either privilege, incentive or capital to resume the ancient programs of construction.

Most people are familiar with the Pyramids and the Sphinx but as to the methods used in construction there are few who have any definite knowledge. An interesting bit of information was volunteered by a dragoman, be it true or not. He stated that the covering was removed from the Great Pyramid and taken to a spot within the city of Cairo. It was to be used for the construction of the Mosque of Refa but funds ran low and the stone lay 300 years before it was actually used. The Mosque stands now, one of the most beautiful in the city—and not far from where the stone was originally quarried.

There are a few points about earthquakes, in general, which might well be brought out here—the writer having seen the results of the quake at Yokahama and actually been in the one at Santa Barbara. Structures may often be seen in a different light after an earthquake than before. A church, for instance, might appear to be a blessing before but afterwards may look like the "wrath of God." Some people have even stated that the church that stands is the proper one to attend. That is another question however.

An earthquake probably reeks as complete devastation as any known disaster inasmuch as it is frequently followed by fires, besides having its own effects. The quake at Yokohama, followed by fire, was probably the world's greatest disaster. Stone spalled and fell, reinforced concrete tumbled and bent, brick showered, steel fell. Structures that stood were the exception. The accompanying illustrations help to tell the story.

The Santa Barbara quake was believed to be the most violent ever felt in this country, but was not followed by fire. The attendant at the power house was given credit for having saved the town from fire by pulling the main switch, as the building fell about him. But engineers know that grounded wires blew the circuit breakers at the power house.

After this quake most of the reinforced concrete and steel frames remained intact, the building tile and brick falling, however. The quality of constructions was given a complete test and showed up well except in a few instances. A city water reservoir was cracked and drained and many water mains were broken. Surveys showed that land lines and marks did not change position appreciably.

The importance of engineering was forcibly impressed upon the population by their having to do without heat, light, and water. The entire community was reduced to the living standards of the days of '49 and those who enjoyed camping out surely got their fill.

In conclusion it might be well to say, as so many have said before, that one appreciates this country much more when he has been away from it. This country surely deserves the name of one of the engineering wonders of the world, if for no other reason than the number of educated engineers who practice here. Add to that that we have the most dependable and efficient system of railway transportation for the size of the country, of any nation in the world, and the rest will take care of itself.

It takes but a few glimpses of engineering in foreign countries to convince one of the truth of these statements.

No man who lives a life of ease leaves a record worth remembering

A Mountain Water Supply for Flagstaff

L. B. Straub '23
With Burns and McDonnell Engineering Company

Flagstaff, because of its excellently developed supply of pure soft water which is made available in one of America's most arid territories, is well named the oasis of Arizona. This state, which has an average annual rainfall of ten inches is compelled to spend more money per capita for its municipal water supplies than any other state in the Union. It is not uncommon for water used by railroads, hotels, autos and domestic uses to be hauled one hundred miles or more. The auto tourist traversing the state finds the reserve water tank as essential as the gasoline supply. Hence, the water users are accustomed to paying about three times as much for water in Arizona as they would consider reasonable in Illinois or other Central States.

The town of Flagstaff was incorporated in 1894 and has steadily grown since this date. Recent estimates indicate that the population is about 4,500, which is nearly three times the census of 1910 and 1,400 more than that of 1920.

The lure of the pure, clear, sparkling supply of water developed by this town has done much toward increasing its rates of growth. The Santa Fe railroad is supplied with water for engine use, and to haul in tank cars to the Grand Canyon to supply all developments there. Two large lumber mills are also supplied with water. One of these mills, on account of the shortage of water, is at present using treated sewage as a boiler water. That the domestic use is relatively a small part of the total is indicated by the percentage of water used for various purposes. The railroad uses about forty-five percent, the lumber mills thirty percent, domestic consumers twenty percent, and business consumers five percent.

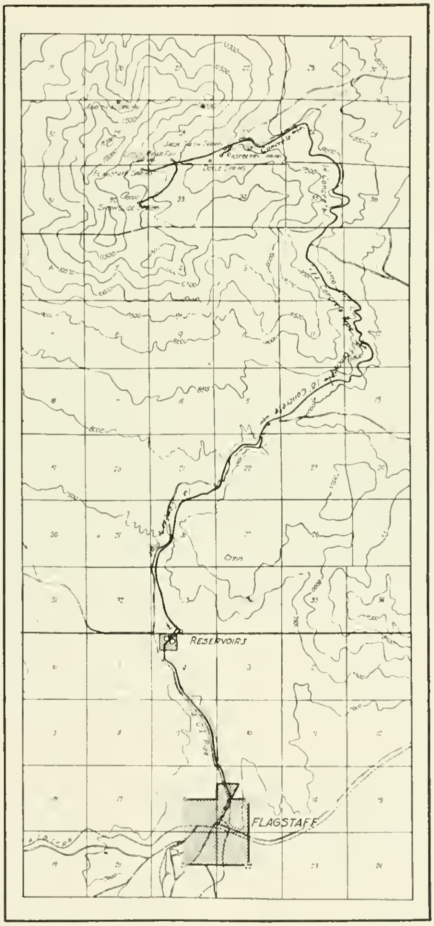


Diagram 1—General Lay-Out of Supply Line

The developments of Flagstaff's present water supply was begun in 1898, at which time a 2,500,000 gallon reservoir was constructed. This supply became inadequate and in 1914 common interests of the town and the Santa Fe Railroad resulted in a contract whereby the railroad agreed to construct the necessary improvements while the town provided for their operation and maintenance, stipulating the amount of water to be allowed the railroad and the amount to be paid for the water. At this time additional flow lines were laid and a 50,000,000 gallon reservoir was constructed near the smaller reservoir.

In recent years water shortage in dry seasons has again brought the town and the railroad together to work out a scheme to finance needed improvements. The Burns and McDonnell Engineering Company of Kansas City was called upon to study available supplies and design additions to the present system. These additions are under construction and will be completed in the Spring of 1926. Under the new contract between the town and the railroad the town is financing the project by means of bonds and the railroad agrees to take no less than a specified amount of water at 20 cents per thousand gallons, provided the water is available over and above the amount needed by the town. Under the old contract the town received only 8 cents per thousand gallons for the water and gave the railroad 200,000 gallons free every 24 hours. As a result, although the improvements will cost approximately one half million dollars the town will have a profitable investment as well as an ample water supply.

A general layout of the entire water supply project together with contours at 500 feet interval is shown in Diagram 1. The scale of the map may be obtained from the spacing of the section lines. Only the new pipe lines from the source of supply to the town are indicated.

The source of the water supply is from springs in the interior valley on the east side of the San Francisco Peaks. These mountain peaks, which are three in number, are about ten miles directly north of the town. They were originally parts of one volcanic cone which rose to a height of 3,000 feet above the 12,000 foot peaks at the west end of what is now known as the interior valley. The eastern wall of this cone was broken out and the interior valley eroded and later occupied by a glacier which left deposits of coarse material which much disintegrated lava.

The annual precipitation in the interior valley is greater than at any other point in Arizona. Snow is accumulated to great depths in the winter months and not uncommonly a large amount of snow remains unmelted throughout the summer. Hence the runoff is prolonged and infiltration into the glacial deposits is fostered. The glacial deposit is a vast natural sponge which takes up a portion of the runoff from rains and melting snows and later returns part of it to the surface in the form of springs at the east end of the valley.

The natural protection of the drainage area, which includes about five square miles, results in a spring water of excellent quality with no evidence of pollution and with a very low hardness and mineral content.

The supply is collected from five springs and six tunnels, Diagram 1, which are several hundred feet apart, making it necessary to collect the water by means of a pipe line to each spring. Each spring is covered by a small criblike structure set over a screen box. The tunnels have a timber lining. Maximum flow usually occurs in the month of June when the snow is melting, and drops off to a minimum in the winter or early spring, depending upon the climatic conditions and the amount of precipitation. In severe winters, frosts penetrating 10 feet or more into the volcanic ash formation completely stops the flow from the springs. Consequently, a large reservoir capacity is needed to carry the supply over seasons of low flow.

After passing through a measuring device near the springs, the water is conducted 15 miles down the mountain side through gravity flow lines to the storage reservoirs. Two of these flow lines, which were put in some years, past, are made up of six, seven and eight inch vitrified pipe. The growth of willow trees which are near the pipe line was augmented by seepage of water from cement joints causing roots to grow and enter the interior of the vitrified pipe lines; hence, has caused frequent trouble by reducing the pipe capacity. The maximum capacity of the two lines is but little greater than the normal needs of the town. A third flow line of 14-in., 15-in. and 16 in. concrete pipe, the laying of which was started at the reservoir end Figure 1., is being added to overcome this difficulty. With this addition, a storage of 100,000,000 gallons can be accumulated in one month at the same time that water is consumed at a normal rate. Concrete sumps with overflows are spaced along the lines about 4000 feet apart. The grades of the lines vary from 2 percent to 4 percent.

The concrete pipe was manufactured and stored in Flagstaff, Figure 2, and hauled to its place along the existing pipe lines, being distributed in position to lay.

A roadway twelve feet wide has been constructed along the pipe line for purposes of transportation during construction and for maintenance after construction. The excavation along this road was largely loose rock but some solid rock was encountered and several short tunnels were built. Figure 3 shows a part of the concrete pipe line before being laid in the vicinity of one of the shorter of the tunnels which were drilled through solid rock.

The pipe lines from the springs wind around the east side of the mountains to the large storage reservoirs which lie about two miles north of the town. When construction is completed there will be three reservoirs having a total capacity of 102,500,000 gallons. As has already been explained two of these, one having a capacity of 2,500,000 gallons, the other 50,000,000 gallons, were constructed some years ago. The smaller, which is asphalt lined, is out of service most of the time except when the larger reservoir is being cleaned. The existing large reservoir is a round structure 480 feet in diameter and holds water to the depth of 29 ft. 6 in. It is concrete lined with two layers of slabs on the floor and inside slopes, water proofing being inserted between the layers. A view across the old 50,000,000 gallon reservoir showing the three San Francisco Mountain peaks in the background is shown in Figure 4.

In recent years the water shortage has become so serious that water famines were not uncommon during the dry seasons of the year. Last winter, after several bad fires had occurred in Flagstaff, the reservoir supply became almost exhausted while at the same time there was practically no flow from the springs. As a precaution the reserve water was restricted to its most essential uses, while the supply for the Santa Fe and the lumber mills was curtained to the point where operation was seriously handicapped.

An addition 50,000,000 gallon reservoir which is nearing completion will aid in overcoming these difficulties. It is similar to the older large reservoir in shape and dimensions and has a concrete lining, the floor being of a beam and slab construction and the side slopes a slab construction covered with membrane waterproofing and a layer of reinforced gunite.

The combined capacities of the reservoirs is believed to be greater per capita than in any other city in the world, it being more than 20,000 gallons for each inhabitant. This large reserve supply, of course, is made necessary because during several months of the year, due to a deep penetration of frost into the volcanic ash formation, the flow from the source of supply is very much less than the normal rate of consumption. At present water is being used at an average rate of approximately 1,000,000 gallons per day. Future requirements are expected to increase at the rate of about two percent per year.

Before recent improvements were started the connection from the storage reservoirs to the town distribution system consisted of two lines of cast iron pipe, one six inch and one eight-inch. The difference in elevation between the reservoirs and the downtown district is approximately 230 feet. As the friction in the supply line depends upon the rate of using the water there is a limit to the amount of water than can be supplied the town for a certain pressure in the distribution system. When using water at the normal average rate of one million gallons per day the pressure at the end of the supply mains in town was little greater than 50 pounds per square inch, a pressure which should be had in the system at all times. The pressure in town was practically zero when using water at the rate of two million gallons per day. As nearly all of the water is used in a twelve-hour day the maximum demand is at least two million at times and hence adequate pressures were not obtained, especially for times when fires occurred. Some sections of town have grown to such an extent that the existing lines are

(Continued on Page 151)

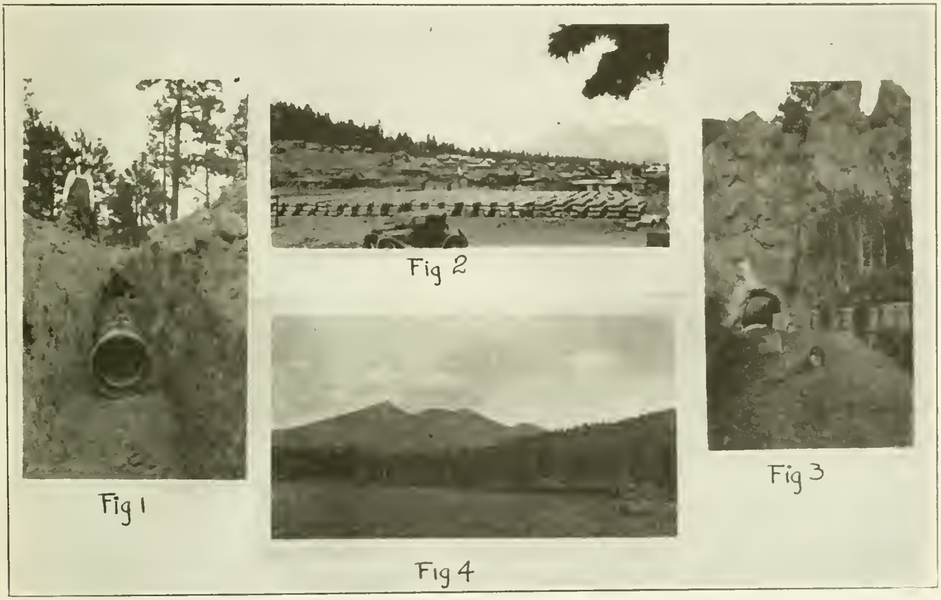
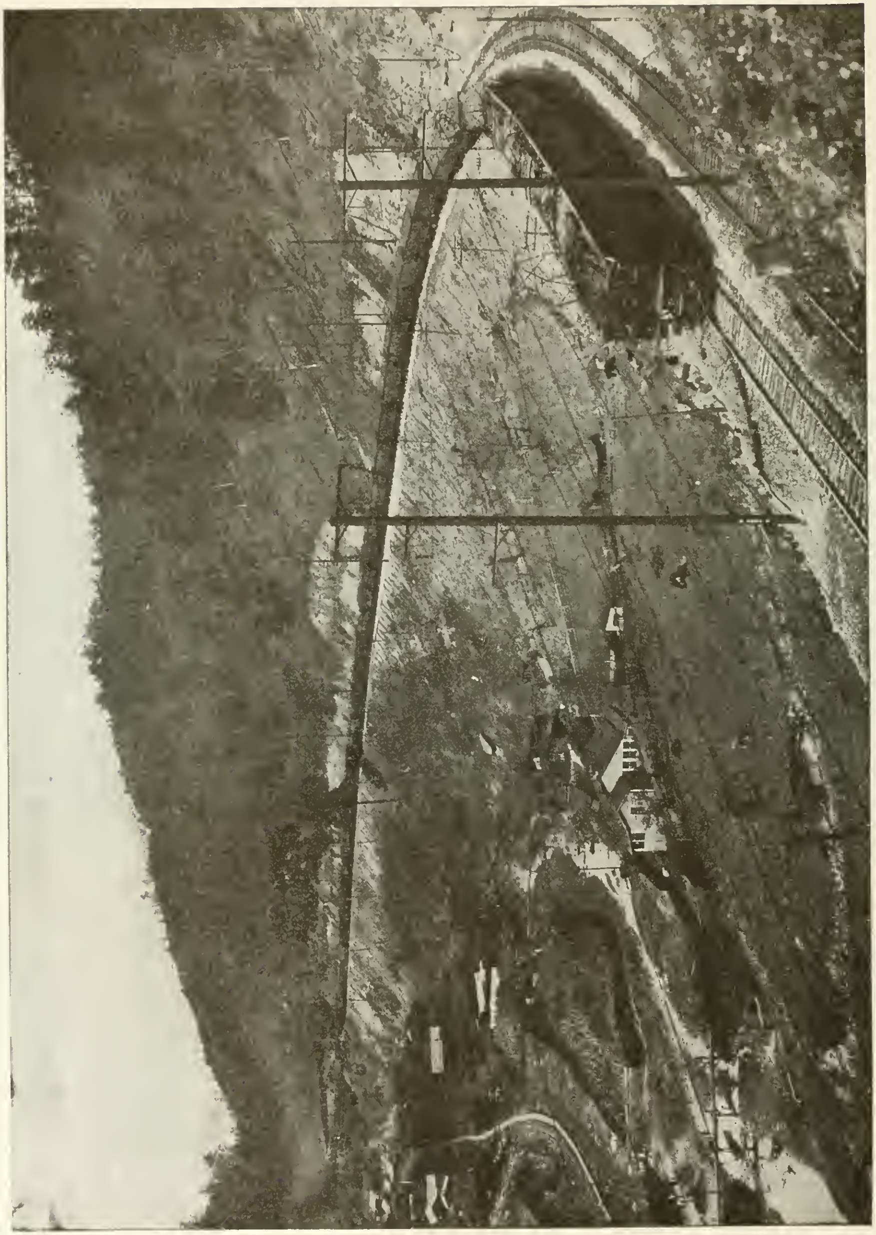


Figure 1—Start of Concrete Pipe Line. *Figure 2*—View of Storage Yard for Concrete Pipe. *Figure 3*—Typical Tunnel through Rock Obstacle. *Figure 4*—View of San Francisco Peaks over Reservoir.



6,000 Ton Virginian Railway Train on Two Percent Grade, Showing Head End and Pusher Locomotives

Frontier Electrical Engineering Developments

L. R. Ludwig, e.e., '25
Graduate Student, Westinghouse Electric & Manufacturing Co.

Today the longest blocks of power in the world are being generated and used in the form of electrical energy and those blocks of power are each year becoming larger. With this development in the machinery for the generation, transmission, and utilization of electric power taking place, it is interesting to get a real picture of the pioneer work being carried on by reviewing the recent progress which has been made in the design and application of electrical machinery. A rather sketchy and necessarily brief description of some of the outstanding products of the year in this field, may make it possible to get this picture of the actual motives to which the design and application engineers are responding.

This development will be discussed with regard to machinery for the generation of alternating current power, the switching and transmission of this power, and its utilization. The synchronous converter and condenser as well as the frequency changer set improvements will be brought out. Recent large alternating and direct current motors which have been built will be mentioned. The electrification of transportation systems has constituted a large and growing problem for engineers. Radio and carrier current applications are interesting, and finally, the progress of engineering education is worthy of comment.

In the generation of alternating current power the turbo-alternator is the king of generating machinery. The limitations have been found in insulation ruggedness and the severe duty imposed by the extremely high speeds at which it must operate. Rotors are usually built of a large solid mass of steel and must usually be wound by hand, both insulation and winding must be forced very tightly into slots, using wooden wedges. Careful balancing at several times full speed is essential for smooth operation. Despite the limitations, construction is under way on an 80,000 kv-a. cross-compound generating unit which is the largest ever built in this country. Each generator is rated at 40,000 kv-a., 1800 r.p.m., and the set will be operated as a single unit. It also operates at 1800 r.p.m. and is the largest undertaken by that company which operates at that speed.

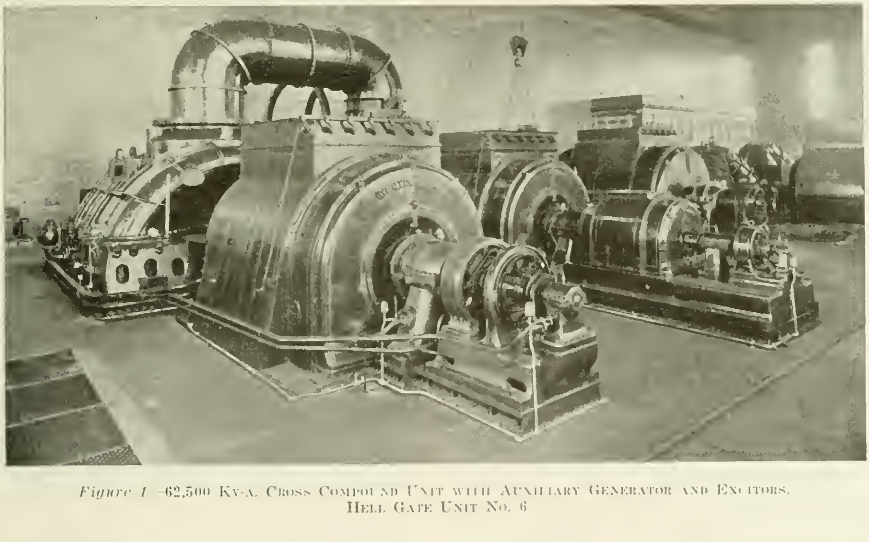


Figure 1 —62,500 Kv-a. Cross Compound Unit with Auxiliary Generator and Exciters. Hell Gate Unit No. 6

The past year has seen much experimental work conducted with regard to these machines. Micarta channels for end turns and micarta lining for retaining rings have been successfully developed. The problem of insulation is still very much unsolved so that engineers are always striving for a more perfect form which will meet the varied and severe conditions under which it must operate. Micarta and other forms of mica insulation applied by rollers under high temperatures have proved very successful.

Ventilation and heat flow from the windings have been studied from both large and small models. Theoretical calculation, together with the empirical data thus obtained, have given rise to mathematical formulas quite satisfactory in the design of these alternators. The effects of short circuit and transmission line surges have also been carefully studied in order to give a generator which is capable of continuing operation during the period when trouble on one section of the line is being cleared.

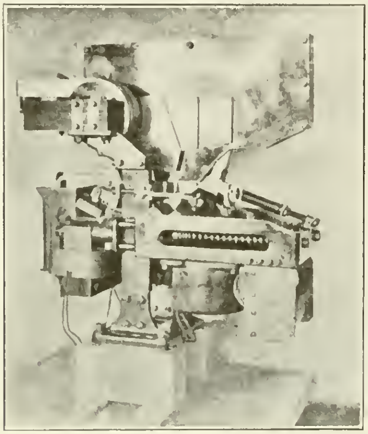


Figure 3—High Speed D-C. Circuit Breaker.

A 28,000 kv-a. waterwheel generator, the largest horizontal machine placed in service, has been built during the past year. It is shown in Figure 2.

These machines, considered impossible a few years ago, are just a step toward the designs which may prove to be ultimate in size. The huge amount of central station work almost sure to result from the agitation of super-power principles will cause larger machines to be built as the restrictions are gradually extended through research and experiment. It is with these problems that the men in power engineering design and application are dealing, and their work is built on the foundation of that of the research engineer.

In the switching and transmission of this power, a sketch of development of circuit breakers, switchboards, transformers and transmission line problems will be given. Truck type switching is finding wide application. The advantages are, the ability to remove a large breaker for repair, and replacement without shutting down a line or portion of the system for more than a few minutes. Heavy oil circuit breakers which can be used in net works handling large amounts of power have been developed, the main feature of such breakers being that they reconnect a high tension feeder to its system automatically when the proper voltage and phase relationships have been re-established. Particularly in railway work the need of a quick acting direct current breaker has caused the design of one which permits short circuit on the ordinary machine at the commutator without causing flashover. Such a breaker built by the Westinghouse Company is shown in Figure 3.

Steel switchboards are finding general usage owing to their lightness, durability and better appearance. The automatic substation with supervisory control is a forward step based primarily on the perfection of the various forms of relay. (This type of development has mainly to do with the usually termed supply engineering.)

The development of the transmission line and a study of the surges which it sometimes conveys has been helped in a large way by a recent instrument, the Klydonograph. The Klydonograph works on a basis of electrical stress thrown on the emulsion of an ordinary photographic plate. On developing the plate in the ordinary way, figures appear which give details of the voltage impressed on the plate. The instrument records voltages of extremely short duration and the interpretation of these plate figures furnishes the clue to many line surges.

The largest 220 kv. transformers yet produced are being built for the Southern California Edison

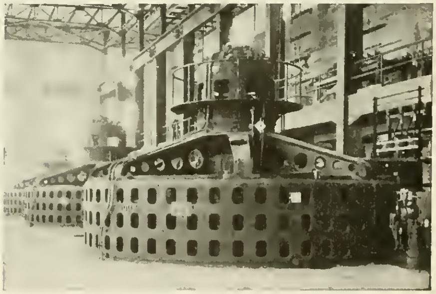


Figure 2—18,750 Kv-a. Vertical Water Wheel Generators. These Machines Are of Particular Interest Because of Their Special Ventilating Arrangement.

Company. They will form a bank having a capacity of 75,000 kv-a. and will tie together the company's 72 kv. and 220 kv. lines. Four 25,000 kv-a. units will be placed in service, one being retained as a spare. The efficiency is 99¼%. The defects of oil cooling which are sludging of the oil, etc., are being overcome by the use of forced circulation, water cooling, and the Inertaire transformer.

In the Inertaire transformer nitrogen is used above the oil surface and air is excluded. This prevents the formation of sludges and also prevents explosions due to mixtures of vapor and air. The nitrogen used is obtained by drawing air in through a breather containing deoxidizing chemicals. A "breathing regulator" conserves the nitrogen when it is once formed. Transformers of this type have been built up to 14,000 kv-a.

A large amount of alternating current power is being converted into direct current before utilization, largely by means of synchronous converters. Converters are being used quite extensively in automatic substations. Several 2,000 kv-a. converters for this purpose have been recently built for the Imperial Government Railways of Japan, and are shown in Figure 4. The first converter equipment with step regulator transformer tap changing provisions under load used on Edison 3-wire system has been an achievement of the past year. Along the line of the converter considerable work has been done with the frequency changer and synchronous condenser. The largest frequency changer ever built is a 40,000 kv-a., 25 and 60 cycles, set constructed in the last year by the Westinghouse Company. The design of the 60 cycle end of the machine incorporates an arrangement by which the stator is shifted through a rotating gear. The provision is for the purpose of adjustment of phase position and hence load adjustment. Another smaller set has been built with a spring mounted

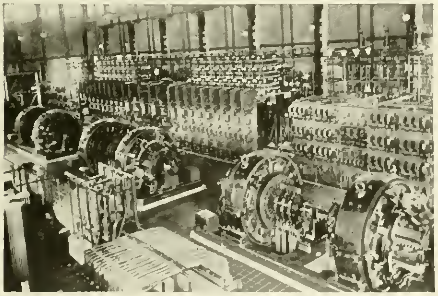


Figure 4—Installation of 2,000 Kw. Synchronous Converter Units in an Automatic Substation for Imperial Government Railways of Japan.

stator to eliminate single phase torque effects and resulting station vibration.

The largest synchronous condenser ever built, a 40,000 kv-a., 3 phase, 60 cycle, machine, has recently been placed in service. One of the interesting achievements of the engineers of this design is that the total loss is but 2% of the total kv-a. rating. The rating of the largest condensers of today is 20 times that of the largest machine of 1912.

Of the motors providing mechanical power for the industries, the recently introduced synchronous

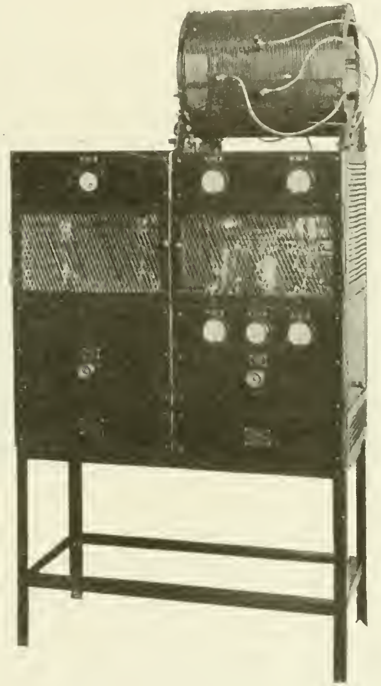


Figure 6—High Power Transmitter for Power Line Telephone Communication.

motor of the clutch type has found wide application. The drive of this motor is through a magnetic clutch with the result that the inherent high power factor and other desirable features of the synchronous motor are combined with high starting torque and low starting current. In the line of direct current motors a steel mill has recently had installed a 7,000 hp. continuous rating reversing motor, the largest which has been built in a single frame.

The Virginian Railroad, now equipped with the most powerful locomotives in the world, is the outstanding heavy electrification of the year. Its success and that of similar systems speak well for the possibility of electrifying a number of strategic transportation systems. The locomotives shown in Figure 5 consist of three distinct units, and develop 6000 hp. continuously. A starting tractive effort of 300,000 lbs. is available. Two 3-phase motors are placed on each unit of the locomotive and driven from a single phase trolley through a synchronous phase converter and a Scott two or three phase connection.

On test these giant locomotives have performed most excellently and their tremendous power is obtained with high efficiency. They are equipped for regenerative braking. Some of the mechanical problems of electric locomotives have been well up with the electrical problems, such as matters of drive and good tracking in both directions. Another electrification of a different nature was that of the Detroit, Toledo, and Ironton. These locomotives, also fed from a single phase, 11,000 volt trolley, reduce the voltage through transformers, and convert the power to direct current motors by means of motor generator sets. The drive through D. C. motors is extremely flexible and e__cient. This is the only large system of its type in operation. An interesting development in multiple unit trains is a system of regenerative braking during the period of stopping. This Booster Regenerative Control system includes two booster motors, an air operated sequence switch, four electro-pneumatic switches, two engineer's brake valve switches, and several relays. Equipment has been placed on a Chicago rapid transit car for the purpose of making a field test. Twenty-five percent of the energy of stopping can be saved as shown by the wattmeter on the car.

Figure 5 —The Most Powerful Locomotive in the World

In the line of radio tremendous growth is still taking place. Wired wireless communication over power lines and carrier current apparatus is being developed. A power transmitter for power line telephone communication is shown in Figure 6. Control of power circuits by means of superimposed frequencies is being developed. Street lighting over the lines of the New York Edison Company is controlled by relays actuated by such superimposed frequencies on the power lines themselves. Recent tests have indicated the entire feasibility of a booster radio repeating system and of super power broadcasting. Fading of signals is another problem which is being solved by using quartz crystal frequency stabilization.

The educational system which is moulding the young engineers is undergoing some criticism and a little revisal. Several colleges are making a six year curriculum of the college course. It is their purpose to allot time for the teaching of more than fundamental principles and also allow the insertion of a few purely cultural subjects. Industry, which must certainly dictate the needs which the college must fill, is getting away from the subject matter classification of its engineering work and substituting a functional classification. Industry deals with design, research, application, sales engineering and the like. Reports of teachers' societies indicate that the same attitude is being reflected in the colleges. Two years ago a report was presented to the Society for the Promotion of Engineering Education urging such a functional basis.

The difficulty in the way of the undergraduate studying engineering is for him to visualize clearly the field he is entering and the work he will do in that field. If he is able to perceive the real nature of the phases of engineering work and also obtain a grasp of the inspiration and future of the industry, the problem of his future will be greatly simplified. The complete functional classification is pure research, design, manufacturing, erection, application and sales engineering. When it is remembered that each of these is necessary to each branch of the electrical industry, such as power, motor engineering, railway, switchboard, control and supply engineering, one can appreciate the real complexity of the engineering field as it actually exists.

There is a great amount of inspiration in electrical engineering as soon as the engineer begins

(Continued on Page 151)

The Cheat Haven Dam

L. V. Carpenter, M.S., C.E., '00
Graduate Student

The Cheat Haven Dam is built across the Cheat River about three miles above its mouth. It is a hydroelectric development.

The Cheat River is a mountainous stream formed in the Cheat Mountains in West Virginia and flows north emptying into the Monongahela River at Point Marion, Pa. During the spring, when the snow is thawing in the mountains, the runoff is quite large while the summer flow is small. The United States Geological Survey maintains a stream gaging station on the Ice's Ferry Bridge about three miles upstream from the dam site. March 12, 1917 showed a discharge of 51,000 sec. ft. while Aug. 4 of the same year showed 135 sec. ft.[1] During 1917 the mean monthly discharge varied from 450 to 11,000 sec. ft. The water shed, comprising 1,116 square miles consists mainly of second growth timber land. None of the villages use the river as a source of water supply but the whole drainage area is a popular place for summer homes and bathing beaches. The rainfall for a period of 25 years (1891-1915) averaged 41.55 inches. The maximum year was 1907 with 52.15 inches and the minimum 1904 with 33.33 inches.[2]

The dam was originally started in 1912 but the work was suspended in the fall of 1913. The reason for the suspension was not made public. In 1912, construction was begun on the east side of the river and approximately 300 feet of the dam and the foundation for the power house were completed. Work was resumed in May, 1925 and the old concrete work had weathered badly but was repaired and incorporated in the plans of the new structure.

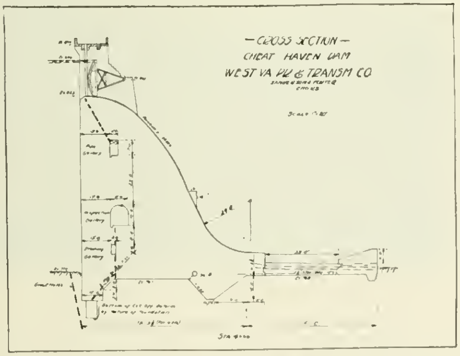


Figure 2—Typical Cross-Section

Much preliminary work had to be done before the actual construction of the dam could be started. This included the building of a standard gauge railroad to connect with the Baltimore and Ohio railroad at Cheat Haven, a large camp for the accommodation of workmen and a number of cottages for engineers, foremen, and their families. On the east bank of the stream below the location of the dam were erected blacksmith, carpenter and machine shops, pumping houses, time office and a large concrete mixing plant. During the past summer, a high way bridge at Ice's Ferry was raised 18 feet at one end and another span of 160 feet added. The floor of this bridge is only 10 feet above normal pool level. About a mile of country road had to be rebuilt and many summer houses moved.

Excavation for the completion of the dam was started in May 1925 on the west side of the river. On January 1, 1926 a large part of the masonry work was completed and water running over the spillway at Ele. 853. See Fig. 2. The concrete crews worked day and night in order to pour all concrete before cold weather. About 750 men were employed at one time.

The total length of the dam is approximately 1,000 feet; its bottom width including the apron 140 feet, and the maximum height to the top of the bridge 135 feet. The spillway section is 624 feet long and is equipped with 26 Tainter Gates, each 21 feet long and 17 feet high. Inspection, drainage and pipe galleries are provided in the cross section. The water is diverted through four intakes at the east end of the dam, into penstocks connected to four hydraulic turbines located in the power house which is built into the dam. See Fig. 1. After passing through the turbines the water is discharged through draft tubes which are at a considerable depth below the level of the pool. When the dam is filled to the top of the Tainter gates, it will back up the Cheat into a lake, 13 miles long, from one quarter to one half miles wide and 80 feet deep at the head. The reservoir will cover about 2,000 acres, and contains approximately 23,600,000,000 gallons.

On account of the narrowness of the valley, it was necessary to locate the concrete mixing plant about a quarter of a mile below the dam. This was constructed so as to permit the use of either gravel or limestone for the coarse aggregate. Gravel was used as the coarse aggregate on the inside and limestone on the wearing surfaces.

The bin above the concrete mixers was divided into five compartments; two for gravel, two for limestone and one for sand. Cement was delivered from an adjoining cement house which had a storage capacity of 5,000 barrels. All of the aggregates were measured in batch boxes. Three mixers of the tilting type turned out about 20 cubic-yard batches of concrete per hour. Concrete was dumped directly into two yard buckets on flat cars and hauled by dinkey engines to the dam, where it was swung into position for dumping by a derrick. One of the records made was 1,160 cubic yards of concrete in 11 hours.

Figure 1—Dam and Power House

The total concrete required for the completed job is approximately 150,000 cubic yards. Part of the gravel was obtained from the river bed by means of a drag line and hoist. This was washed thoroughly and the coarser material discarded.

Figure 4—East Building, Gatehouse and Dam

Eight twenty ton derricks, each operated by a 100 horse power hoist were used for handling the material. The derricks were set on cribs to handle the excavation and pour the lower part of the concrete. As the dam was built up the derricks were attached to a platform which was fastened on the down stream face of the dam and served by a peg leg track also attached to the downstream face.

Figure 3—Power House from North

During the construction of the dam the natural flow of the river was taken care of by three tunnels through the west spillway section of the dam. These were closed with concrete before the dam was filled.

Fig. 3 shows the power station which is located in the west end of the dam. It is of steel and brick construction, 167 feet long, 109 feet wide and 100 feet high. The turbines are located in the basement and the generators on the first floor. The control and switching equipment is on a mezzanine overlooking the first floor. A 100 ton crane for handling the machinery was installed. The transformer banks

Figure 5—Upstream Side of Dam

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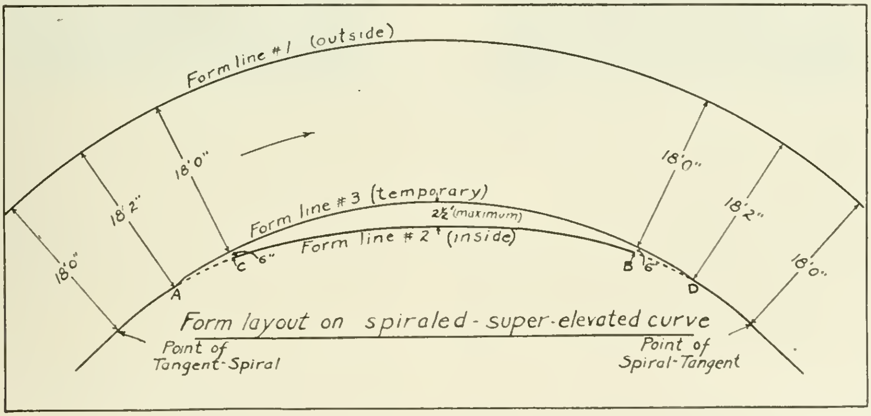
Spiraled Super-Elevated Curves

E. C. Bray, c. e., '26

In the early summer of 1923, the first concrete spiral super-elevated highway curve was laid in the Dixon district by the Illinois Division of Highways. Up to this time, the curves had all been circular, and the pavements had been the same width on curve as on tangent. The spiraled curve called for a width of pavement varying from 18 feet at the point of tangent-spiral to 20.5 feet at the center of the curve. On this job, neither the contractor, the district construction engineer, the resident engineer, or the mixer inspector (myself) had ever seen one of these curves laid. The standard finishing-machine in use on the job rode on the side forms which served as a track. The wide flanged wheels of this machine could take care of a variation in width of pavement of not more than 2 inches.

It was the contractor's idea to put in pavement 18 feet wide and later to add a strip to one side of the slab. This was objected to because of the joint between the two sections, and because of the weakness of the thin portion to be added at the beginning and end of the spiral. It required much persuasion on the part of the engineers to make the contractor see the necessity for placing the entire slab at the same time.

It was the engineer's idea to place one form-line at the outer edge of the curve, and another temporary form-line at a distance of 18 feet from the first one. This temporary form-line was so placed that the finishing machine could be operated around the entire curve, leaving only the widening to be tamped and finished by hand. A third form line was so placed on the inside of the curve as to give pavement of the proper width at all points on the curve. The distance between the temporary form-line and that at the inside of the curve increased from zero at the point of spiral to a maximum of 2.5 feet at the center of the curve. As the widening was on a spiral, this distance at a point 50 feet from the point of spiral was only two inches. With careful attention, the finishing machine was used on forms spread enough to give the required width up to this point (point A on sketch). Here, however, the rate of departure from the 18 foot width became more rapid, and at this point, the temporary form-line (No. 3, see sketch) was started. Owing to the fact that the base of the forms used was 6 inches wide, the two form-lines could not be made to converge at point A and, consequently, a gap A-C was left in form-line No. 2, the form line at the inside of the curve. This gap was made an exact number of form-lengths by laying the inside form-line continuously from A past C, then removing enough forms so that the widening at C was 6 inches, thereby allowing form-line No. 3 to pass. When the finishing machine had completed its work up to the point C, the temporary forms A-C were slid over and fastened in place as a part of line No. 2. Stakes at the form-joints marked the proper position of these forms on the spiral.



Form layout on spiraled-super-elevated curve

At the point C, the longitudinal reinforcing bar was placed immediately against the inside of the temporary form, and at the next bar joint, this steel was placed 6 inches inside of form-line Figure 2. When the temporary form at this point was removed, the ends of the bars were brought together and wired, making the reinforcing continuous around the curve.

From C to B, as fast as the finishing machine had passed over a temporary form for the last time, did not meet due to the difference in curvature of the two lines between A and D. A two inch plank was cut to fit between the forms to serve as a rail for the finishing machine. At point B, the reinforcing bar was again brought inside the temporary form; the two ends being wired together as before described at C.

When the widening had been completed to D,

Fig 1

Fig 2

Widening being made

Fig 3

Fig 4

its pins were pulled and the form was removed. Concrete for the widening was carried back from the mixer in 12 quart buckets by six men. This concrete was placed, tamped, and finished by hand; a very slow process after the widening amounted to more than a foot. To make sure of getting a bond, because of this slowness, the edge of the 18 foot slab was roughened where a slight set had taken place.

At a point B, the widening had decreased to 6 inches again. When the finishing machine had completed its work to D, where the widening amounted to only 2 inches, the forms B-D of the temporary form line were moved over as a part of form-line Figure 2. Here, however, the form-joints the curve was practically finished as the remainder could be handled by the finishing machine. A construction-joint could be made at any point past D. A construction-joint at any point on the curve where temporary forms were necessary was objecionable as the joint could not be made at a right angle to the center-line for the full width of the pavement. It was necessary to leave one temporary form in place back of the joint in the 18 foot slab; this to keep the finishing machine out of the way when the pouring started again. This would leave a piece of widening 10 feet long which was connected to the rest of the slab only at its ends; there being prac-

(Continued on Page 160)

Begg's Mechanical Solution of Statically Indeterminate Structures

E. C. Hartmann, '21

"Does not the layman estimate the severity of stress in an elastic structure by observation of its distortion under load? Why then should not the engineer closely observe the deflections of model elastic structures and so estimate their reactions, moments, shears, and thrusts . . . . . ?"

When Professor George Erle Beggs, associate professor of civil engineering at Princeton, made the above statement* he not only explained what sort of considerations lay behind his interest in the mechanical solution, but in a way he presented the whole method which grew out of that interest. The Beggs mechanical solution of a statically indeterminate structure consists of determining by observation certain relative displacements on an elastic model of that structure. By means of Maxwell's theorem of reciprocal displacements these can then be used to determine stresses or reactions. It is the purpose of this article to show how relative displacements may be used to determine stresses, to explain the Beggs apparatus in general, and to tell how it was used in analyzing the supporting structures for the Illinois Central R. R. electrification at Chicago.

In order to illustrate the theory of the mechanical solution, the very simple case of a two-legged, framed bent with pin ended columns will be used. Consider Fig. 2-A. Suppose that the bent shown is an actual structure and that it is required to determine the horizontal reaction acting on the pin at *A* due to a load *P* applied at some point *B*. The magnitude of the reaction cannot be determined by the use of the equations of statics alone, since it depends upon the elastic properties of the bent. The first step in the analysis is to imagine that point *A* is put on rollers as in Fig. 2-B so that it may be deflected side-wise freely without any vertical movement. From Figs. 2-B and 2-C,

$$\frac{H}{P} = \frac{b}{b_1}$$

By Maxwell's reciprocal theorem it can be shown that in Figs. 2-C and 2-D

$$a_2 = b_1$$

Substituting in the first proportion

$$\frac{H}{P} = \frac{b}{a_2}$$

Now consider Figs. 2-B and 2-D. If a_2 is just equal to a then H is equal in magnitude to the horizontal reaction required to hold a motionless when the load P is applied at B. Therefore substituting a for a_2 gives

$$\frac{H}{P} = \frac{b}{a}$$

where H is the horizontal reaction that was to be found. It is clear that if by some means the ratio b/a can be determined for the bent, then the problem is solved.

Now suppose that instead of representing the actual structure, Fig. 2 represents a small scale model constructed of some homogeneous material for which Hook's Law holds, and let the moment of inertia of the various parts of the model be proportional to the moments of inertia of the structure. If such a model be given a displacement horizontally at *A* as in Fig. 2-B, then the ratio b/a for the model will be the same as the ratio b/a for the structure since the elastic properties of the two are identical. The mechanical solution has for its purpose the determination of the ratio b/a for the model. The theory back of the determination of moments and thrusts follows the same steps as those given above for horizontal reaction or shear at a pin.

The type of model used by Beggs and his apparatus for determining accurately the displacement of those models are quite interesting. His first model was a stick of wood with nails as supports which represented a three span continuous truss. The accuracy obtained with this simple set up led to the use of celluloid and cardboad models and to the development of the convenient defometer gages and microscopes. The defometer gage is a device for producing a known displacement, such as a in Fig. 2-B, quickly and accurately. Since in the general case it is necessary to know the shear, the thrust, and the moment for a complete stress analysis at a section of a structure, the gages are so constructed that they can produce a known displacement perpendicular to the axis of the model, a known displacement along the axis of the model, or a known rotation of the axis of the model. Fig. 3 is a drawing of a defometer gage with normal plugs and the three other types of plugs which are used in producing the displacements. The gage consists of two pieces of steel, *A* and *B*, held together by means of springs near the ends. By inserting different sets of plugs into the notches *C*, the relative positions of *A* and *B* may be changed. The gage is shown with a pair of normal plugs in position so that *A* and *B* are parallel to each other and a convenient distance apart. Now if the normal plugs be removed and the larger set of thrust plugs inserted instead, *A* and *B* will move apart slightly with no

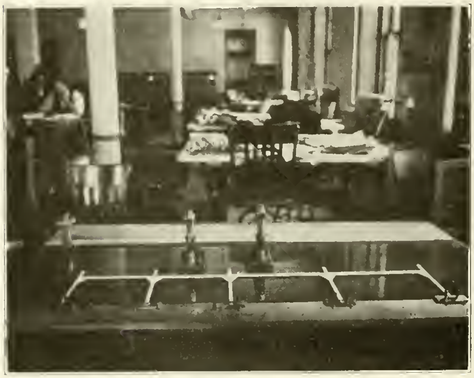


Figure 1—MODEL ROOM

rotation or side movement. Similarly if the smaller set of thrust plugs be introduced into the notches, the two pieces will move toward each other. All plugs are so machined that one-half of each total displacement takes place on each side of the normal position which is desirable both for checking reading and for preventing excessive bending in the model. The shear plugs are inserted first as shown, and then in the dotted position, resulting in a side wise movement of *A* with respect to *B*, but with *A* parallel to *B* and the normal distance away. The moment plugs are inserted first as shown and then in reversed position which causes *A* to rotate with respect to *B*, but with no relative displacement of the two pins at *D*. Four screw holes are provided around the pins so that a model may either be clamped down to the gage with a small plate provided for that purpose, or may be pin connected. The small wooden wedges are used to separate *A* from *B* when it is desired to change the plugs. The holes *E* are used to screw either half of the gage to some fixed base when it is used at a point of reaction on the model. The total relative movement of the pins at *D*, due to either the shear plugs or the thrust plugs, is about 1/20 of an inch.

The microscopes are especially adapted for use with models. They have heavy bases so that they may be set down at various places with little risk of accidental movement. For measuring displacement they have a pair of movable cross hairs that measure movements as small as .0002 of an inch. They can be used to calibrate the gages and plugs with which they are used by merely measuring the displacement of these gages for the different sets of plugs.

Cardboard furnishes an excellent material for the models because it is fairly uniform, easily cut and inexpensive. Since the thickness is constant for a model, the widths of the members are proportioned according to the cube roots of the moments of inertia of the members of the real structure. The dimensions of the model along the center lines of the members should be made to some convenient scale of the real dimensions and further, the widths of the members in the model should scale very nearly the same as those on the structure. This last condition can only be approximated due to the moment of inertia requirements. Haunches, gussets, kneebraces and other irregularities require some study before the model is cut but if they are made about to scale no serious error is likely to be introduced.

For the purpose of illustrating the use of the Beggs apparatus, consider that a model has been cut from a cardboard to represent the bent in Fig. 2-A. This model is laid flat on a drawing board and a gage with normal plugs in place is set at the foot of each column at right angles to its center line. One half of each gage is screwed securely to the board and the foot of each column is pierced to receive the pins from the movable pieces. In order that the model may deform freely it is "floated" on small steel balls rolling on glass. A microscope is set

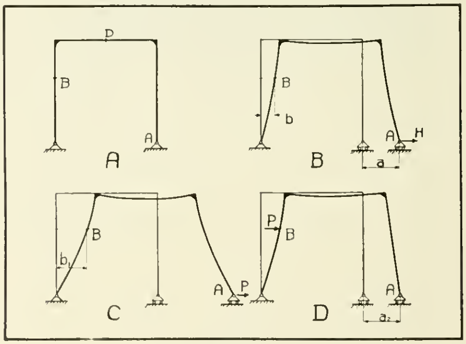


Figure 2

over point *B* and the cross hairs are adjusted to read displacements in the direction of the load to be investigated. Allowing the gage at *C* to be undisturbed, use the shear plugs at *A* as described before and read the microscope for each of the two positions. The difference of the two microscope readings corresponds to the value of b while the movement of the gage as determined by calibration is a. The horizontal reaction on the real structure at A due to a load of say 5 lbs. at B is equal to $5 \times b/a$.

If it is desired to treat the bent as having fixed ended columns the model would be clamped to the movable part of the gages instead of being pinned. Otherwise there would be no change in the procedure for finding H. The vertical reaction would be found by using the thrust plugs but the microscope readings would still measure the displacement of B in the direction of the load. To determine the moment at the base of the column the moment plugs would be used and instead of a linear displacement, a, there would be used the angular rotation of the gage in radians.

To show another use of the gage suppose it is desired to obtain the moment at D due to a load at B. Normal plugs would be used in the gages at the column bases and the model would be cut at D. A third gage with normal plugs would be placed at this cut at right angles to the center line of the member, each half of the gage being clamped to one of the cut ends. After this gage had been placed on steel balls so that it might roll freely, the moment plugs would be used in it and readings taken on the microscope at B as before. The moment at D, due to a load say of 5 lbs. at B, would then be equal to $5 \times b/\theta$, where θ is the rotation of the gage due to the moment plugs as determined by calibration. It might be stated here that while definite rules may be set up for determining the directions of the moments and reactions, it is usually easier to do it by inspection.

The foregoing examples of the use of the Beggs apparatus have dealt with single loads. Perhaps the greatest value that this method has is its application to influence lines for stresses and reactions. Return once more to Fig. 2. When it is understood that the point B may be any point on the structure and that the displacement b is always measured in the direction of the load under consideration the use of the apparatus in drawing influence lines follows easily. For example if point A is given the regular horizontal displacement with the shear plugs and the horizontal displacements of a number of points on the center lines of the members of the model are read with the microscope and plotted with respect to the center lines as a base, the resulting curves will be influence lines for horizontal reactions at A due to a moving horizontal load of P = a. In other words, a picture is plotted of the deflected structure showing only one component of the deflection. The Beggs solution is then nothing but the mechanical application of the deflected structure—influence line principle of structures, and to the reader who is familiar with this principles the writer owes an apology for having so long deferred this simple explanation of the whole method.

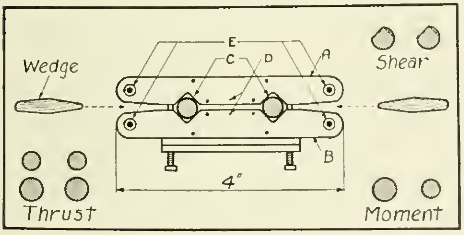


Figure 3—Deformeter Gage and Plugs.

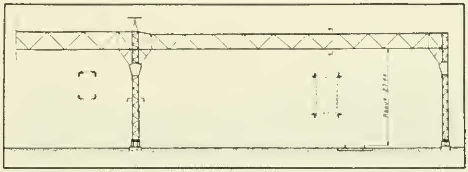


Figure 4—Supporting Structure I. C. R. R.

As an actual case of the use of Begg's apparatus in the analysis of statically indeterminate structures some design work for the Illinois Central R. R. with which the writer was identified will be described. An excellent general article on this Chicago terminal electrification will be found in the Engineering News-Record for Feb. 25, 1926. An overhead caterary system of power supply was adopted and it was the supporting structures for this system that were analyzed by the mechanical method. These supporting structures are of rather light construction and may be described as long continuous trusses supported on slender columns which are rigidly connected to the trusses by means of kneebraces. Fig. 4 shows a part of a typical structure. It was necessary to investigate these structures not only for the dead load of the overhead equipment, but also for various combinations of ice loads, wind loads, signals, curve pull and temperature charges. The preliminary designs were based on approximate analyses and certain features were standardized to simplify fabrication and erection. The chord angles for all trusses were 3½x3½ angles and the sections for various span lengths were obtained by varying the thickness of these angles and by using truss depths of three, four, or five feet. For the web system of all trusses single 2 1/2 x 2 1/2 x 5/16 angles, flattened on the ends, were used. Practically all columns were built up of four 1x1 angles, different strengths being obtained by variations of the thickness of the angles. The along track width of column was determined by the width of the truss and the across track width was usually set by strict clearance requirements. Bar lacing was used on all columns. The field splice at the columns came at the large gusset plate at the foot

Figure 5—STRUCTURE DESIGNED WITH APPARATUS

of the kneebrace, so that the upper part of the column was really a part of the truss. Since the along track loads had to be resisted by the columns acting as cantilevers from the foundations, they were anchored to the concrete by two or four large anchor bolts. These bolts were placed close to the along track center line of the columns, so that in analyzing the frames for across track loads the columns were considered to be pin ended. The snap shot in Fig. 5 shows one of the first structures of this type to be erected. The ungainly appearance of the large cantilever on the right hand end may be explained by the fact that it is really part of a future extension.

The Beggs method is no exception to the rule that no accurate analysis of an indeterminate structure can be made till one has some sort of structure to analyze, so the cardboard models used in this case were cut to suit the preliminary design already referred to. The members of the models were beams whose moments of inertia were proportional to the moments of inertia of the built up members of the structure as determined from their chord angles. There is a question as to whether the beams of the model will deflect nearly enough like the latticed members of the structure, but in the opinion of the writer this can introduce only a slight error since the deflections used are relative values. The kneebraces were left solid after an experiment showed no change of deflection due to trimming them out. All models, while in use, were floated on steel balls rolling on a sheet of glass as is shown in Fig. 1.

These supporting structures can be solved completely by statics if once the reactions of the bases of the columns are known, so it was decided to use the Beggs apparatus to determine the influence lines for horizontal and vertical reactions at the bases of the columns for each bent. No attempt was made to determine internal moments by cutting the models because this would spoil the model for future work.

The procedure in taking readings on a model for these influence lines was somewhat different from what one might expect after reading the explanation of the simple case. Three microscopes were used so that the movements at three points could be measured for each change of plugs in a gage. The shear and thrust plugs were used at the bases of all columns for each setting of the microscopes so that three points on each influence line could be obtained without changing the positions of the microscopes. This method had the double advantage of increased speed and of allowing a check by statics for every set of readings. In this manner readings were taken at a number of points along the full length of the truss and on all columns. The results were divided by the calibration factor of the plugs and plotted as influence lines, those for the truss being plotted separately from those on the columns to avoid complicated figures. Where irregularities appeared in the curves it took but a minute to check the reading and replot the point. Having these influence lines plotted it is but a matter of statics to analyze the stresses for any loading condition. In cases where such an analysis showed a decided weakness or excess of material in the original design, the model could be trimmed to suit the changes or a new model cut to check the new design, but this was rarely necessary. When the entire number of spans of a structure were not to be erected at once, any number of spans could be checked without a new model by simply removing the gages from the columns not included and allowing the future extension part of the model to ride freely on the balls.

Knowing how the method is used one might well ask, "How accurate is it?" There are only two points to be questioned: 1. Does the model gives the same relative deflections as the structure? 2. Can the instruments and the operator be relied upon? In answering the first question the writer feels that with the same data given, a careful person can produce a cardboard model that will give relative deflections as near to those on the real structure as will the elastic theory applied in the ordinary way. Professor Beggs states that the model may even come a little the closer since it takes into account the actual condition at joints. As for the reliability

(Continued on Page 152)

COLLEGE NOTES

Preliminary Intra-Mural Debate

The Engineering College intra-college debate preliminary was held Tuesday, February 23, 1926, and of the ten candidates entered from the College of Engineering the following men were chosen: C. E. Eickhorn '27, W. A. Irwin '27, G. H. Zenner '27. F. P. Cromwell '28, and T. A Saddam '29. H. A. Vagtborg '26 was student representative of the student-faculty committee and served as the chairman.

The candidates who survived the preliminary eliminations will be allowed two weeks in which to prepare for the college finals. In this debate two men will be chosen from the above five to represent the college in the inter-college debates. Each of these men will be awarded a prize of twenty-five dollars. The date of the all-University debates has as yet not been set.

Each member of the team winning the all-University debate will receive fifty dollars and the members of the losing team will each receive twenty-five dollars. In addition to these prizes a silver cup, upon which the names of the debaters and the years will be inscribed, will be presented to the college whose team wins the final debate.

The American Physical Society

The November meeting of the American Physical Society was held in Chicago. At this meeting, several papers written by members of the physics department were presented. The following is a list of the papers which were read: "Energy Distribution in the Continuous X-Ray Spectrum," by C. N. Wall; "Linear Amplification of Galvanometer Deflection by the Photo-Electric Cell," by F. E. Null; "The Electrical Conductance of the Halides of Sodium," by T. E. Phipps, W. D. Lansing and T. G. Cooke; "Optimum Reverberation in Auditoriums," by Prof. F. R. Watson; "The Role of Magnetism in Valence," by E. H. Williams; "Investigation of Photo-Electric Valves Coated with Potassium," by V. M. Albers; "An Optical and Electrical Study of the Striated Discharge in Alkali Vapors," by A. J. McMaster; Mobility of Ions in the Corona Discharge," by W. M. Young; and "Spectrum of Berryllium," by R. F. Paton and W. H. Sanders.

The annual meeting of the society was held in Kansas City, Missouri, December 28, 29, and 30. At this meeting, C. N. Wall presented the paper, "Measurement of Air Velocity by Means of a Rayleigh Disk." Mr. Wall was introduced by Prof. F. R. Watson.

Experiment Station

Bulletin No. 153, "The Effect of Temperature on the Registration of Single Phase Induction Watthour Meters," by Abner R. Knight and Max A. Faucett. This bulletin contains the report of an investigation which was undertaken to determine the effect of temperature upon the registration of two-wire, single-phase watthour meters. Since such meters are often located in places subject to wide changes of temperature, it was considered important to ascertain how the regisration is affected thereby.

The effect was investigated for three cases, namely, with 100 per cent power factor, with 50 per cent power factor, current leading, and with 50 per cent power factor, current lagging, each with four different loads—35 volt-amperes, 350 volt-amperes, 500 volt-amperes, and 610 volt-amperes, respectively.

The results are presented in the form of curves, and also in a table of temperature coefficients, and may be summarized as follows:

(a) In the case of one meter, increase of temperature caused an increase of regisration under all conditions and loads.

(b) In the case of two meters, increase of temperature of regisration with 100 per cent power factor, and with 50 per cent power factor, current leading, for all loads, while for 50 per cent power factor, current lagging, the effect was negligible.

(c) In the case of two meters, increase of temperature caused an increase of regisration with 100 per cent power factor, and with 50 per cent power factor, current leading, for all loads, and a decrease of regisration for 50 per cent power factor, current lagging, for all loads.

The results obtained could also be applied to self-contained meters of other capacities as well, since these meters operate on the same principle and would therefore be affected in the same way by variation of temperature.

J. W. Greene '26 Appointed Dance Chairman

Members of the Engineering Dance Committee were appointed at the February meeting of the Engineering Council. The dance was held on Friday, March 26, in the Gym Annex. The men on the committee were J. W. Greene, '26, chairman, F. A. Dollinger, '26, H. W. Lockner, '27, P. H. Tartak, '27, E. F. Viehl, '26, C. C. Baumgardner, '27, K. C Helms, '26, W C. Jones, '27, H. G. Moore, '27, H. D. Arkema, '26, E. R. Martin, '26, G. W. Norris, '26, and N. A. Klerup, '27.

The dance was proclaimed a great success and proved to be one of the leading social events of the year.

C. F. Hendrick, c.e. '26, who has been co-editor of the "News-Reel" for some time, has been appointed associate editor of the Technogarph to fill the vacancy caused by the resignation of R. A. Merrill, ry.e. '26. Hendrick will fill this position for the remainder of the semester. His appointment was approved by all who are familiar with his work.

EDITORIAL

Do You Sell Your Textbooks?

It is a common practice nowadays to sell a textbook just as soon as the immediate use for it is over. At the beginning and at the end of each semester the second hand book market does a lively business. The need or the desire for a few extra shillings seems to blind the student to the realization that he is making an awfully sorry trade. At the end of a semester's work he has acquired a group of books with which he is so familiar that they will be almost priceless as works of reference in later years. He has in his possession the nucleus of an engineer's library about which he can build as time goes on. Yet he squanders his inheritance for a mess of pottage.

We believe that every student in the engineering college intends to enter engineering work as his career. If this be so, he will most certainly need a reference library. Just a five or ten foot shelf of assorted books won't suffice; they must be books with which he is thoroughly acquainted. Experience has shown that textbooks are the most valueable reference books than an engineer can have. The freshman and sophomore texts on chemistry, drafting, trigonometry, descript, surveying, and analytical mechanics will always be useful, and the junior and senior texts, without exception, will always be handy and often essential in the engineer's library.

A Plea for the Student Chapter

Next year the men who are now seniors will be out in practice and today's freshmen, sophomores and juniors will be advanced one class toward graduation. We spend four years studying our branch of engineering, four years surrounded by other students, four years absorbed in a sometimes hectic array of academic courses and then, after graduation, we get a job and with it the necessity for an entirely different slant on life. While we are in school our diet is almost wholly theoretical and we are so bent on learning what has been done in the past that we are prone to neglect that which is being done now. The change from student to practicing engineer is so great that it is liable to be very disconcerting if made abruptly.

The student chapter of your national engineering organization is undoubtedly the best medium for effecting this transition. It is the policy of these student chapters to bring befor you lecturers who are established in your field of engineering and who talk to you about topics of current interest among practicing engineers. Thus, if you join your student chapters and attend its lectures, you unconsciously acquire while still in school something of the professional attitude and interests, which will render the matter of readjustment much more simple when you enter field work.

Membership in these student chapters is uniformly one dollar a semester and entitles you to the privilege of attending the lectures and makes it possible for you to get the published proceedings and committee reports of the professional organization. It is a good investment. Join now and get lined up for next year.

The Engineers and Debating

Yes! The Engineers lost out in the intra-mural debates of this year. Our team lost in the debate with the College of Liberal Arts and Sciences. We did not lose because we could not debate effectively enough, but because we had the wrong side of the question which was the affirmative of the issue: Resolved, That the Dickinson Farm Surplus Bill Should Be Adopted by Congress. Our team of W. R. Irwin '27 and G. H. Zenner '27, excellently supported their side but the judges did not decide in their favor. However, the L. A. & S. team had to fight hard for what they got. We congratulate them.

The Engineers have not given up the idea that they can debate. We can. Another year is coming and with it another chance at forensic honors. Every man in the College of Engineering is urged to watch for the dates for tryouts which will be held next winter. Come out and make the team. Make the team and win honors for yourself and our dear old College "north of Green Street."

Our Little News-Reel

About three months ago a miniature engineering publication appeared in the College of Engineering halls. It has appeared every second week since then and will continue to appear at the same intervals in the future. It is a paper for the students and by the students of the College of Engineering. Its purpose is noble in that it strives to create a better spirit in our college, to promote and create interest in activities such as debating, the Open House, the E. E. show, the Engineering Dance, and so forth, and to give advance notices of meetings and lectures in the interest of engineering students.

It is a noble paper and deserves the support of all. It is your paper and waits with open arms to receive contributions, suggestions, or criticisms from you.

Read it and make use of it.

Contemporary Engineering News

Largest and Smallest Electric Locomotives in the World

There were some striking contrasts when the Midget and the Giant of the Electric locomotive world were compared at the East Pittsburgh Works of the Westinghouse Electric and Manufacturing Company, recently.

With a capacity of 1½ horsepower the Midget serves the purpose of a mechanical mule in various mining operations.

The Giant of the rails designed for the Virginian Railway, with a capacity of 10,000 horsepower, is the world's largest and most powerful locomotive. It will be used to haul a loaded train nearly two miles long over one of the heaviest grades in the country.

The contrast between the Virginian locomotive and its smaller prototype of the industrial field is indicated by the following figures; midget, 41½ inches long; its larger brother, 152 feet in length; weight of midget,—one and one-half tons; weight of giant—637.5 tons. Midget's drawbar pull—100 pounds; Virginian locomotive's drawbar pull 270,300 pounds. The smaller one derives its power from a 60 volt storage battery; the larger one from a 11,000 or 22,000 volt trolley.

Efficiency of Oil Electric Locomotive Is Demonstrated

The efficiency of the oil-electric locomotive,—the most recent development in the motive power field, but now an assured success after years of experimentation,—was strikingly demonstrated in a series of tests made by the Central Railroad of New Jersey during December.

At the Bronx Terminal in New York City a sixty ton oil-electric, operating for 24 days during December, in 347 hours of locomotive service handled a total tonnage of 61,556 at a total fuel cost of $72.58. A steam locomotive, operating under almost identical conditions in December, 1924, in 24 days rendered 297 hours service, and during this time moved a tonnage of 50,493 at a cost for fuel and oil of $349.46.

The oil-electric, in other words, handled 11,000 more tons than the steam locomotive and at a fuel cost of approximately 20 per cent as compared with the steam engine.

The cost of fuel per 1,000 tons handled was $1.16 for the oil-electric as compared with $6.92 for the steam locomotive.

The saving in fuel costs is only one of the many economies made possible by the oil-electric. It will make possible elimination of coaling plants, ash pits, turn tables, and expensive round houses and hostling services. Very little water is necessary, thus eliminating costly watering stations and troubles due to bad water conditions.

Use of the oil-electric locomotive would reduce locomotive maintenance costs by one-half; each oil-electric, during the course of a year, would be able to render twice as many hours of service as are now obtainable from the steam locomotive.

Another noteworthy example of the efficiency of the new locomotive was given by a 100-ton oil-electric which was recently bought by the Long Island Railroad Company. A few days prior to its delivery to the company this locomotive made the longest run ever made by an engine of this type hauling a loaded freight train. The run was made from the plant of the General Electric Company at Erie, Pennsylvania, to New York City—a distance of 537 miles. No fuel or water was taken on during the trip; and the total cost of both fuel and lubricating oil for the 537 miles was only $26.15. The average fuel cost per locomotive mile was 4.86 cents. The total kilowatt hours generated was 3,810, and the fuel cost per kilowatt hour generated was .685 cents. The fuel cost per 1000 ton miles was 12.90 cents.

As is well known, the oil-electric locomotive consists of an internal combustion engine which drives a generator, the current from which is applied to motors geared to the axles of the locomotive. The 100-ton locomotive which made the trip from Erie to New York is about 46 feet long. The nominal rating of the traction motors at 600 volts is 200 H. P. each, or 800 H. P. for the four motors. The generator is operated by two 300-H P. internal combustion engines using low-grade fuel oil, and is of the direct-current, compound wound, commutating pole type, developing 600 volts. For test purposes, the oil engines were operated continuously during the entire trip; an additional fuel saving could, of course, have been attained by shutting down during long stops.

This locomotive was first publicly put through its paces early in December of 1925, when it was demonstrated at the plant of the General Electric Company at Erie for the benefit of a visiting party of railroad officials, engineers, and transportation authorities. Starting from standstill at the foot of a one percent grade, with a trailing load of 1,315 tons, the locomotive accelerated up the grade to a speed of 6 miles per hour. Another test showed that the oil-electric locomotive, with two cylinders cut out of one of the engines, balanced perfectly between the motors.

This engine was first demonstrated to the public at an invitation-demonstration given by the Vice-President of the Long Island Railroad. The guests, more than 100 in all, included members of the New York public service and transit commissions, members of the legislature, railroad officials, newspaper men, motion picture operators, and representatives of the General Electric, American Locomotive, and Ingersoll-Rand companies, joint builders of the oil-electric locomotive. The uniform smoothness of the performance was the subject of much favorable comment, and all along the line of travel the silent, invisible power of the engine, without smoke and cinders, and with "no visible means of support" was the cause of some interested perplexity from the crowds that gathered to see the new-fashioned wonder.

Principle of Central Propulsion of Vessels

Central propulsion of vessels is a new principle devised by an Italian inventor to eliminate the vibration in modern high speed liners and warships due to the fast revolution of the propellors. He proposes to place the propellors in special recesses formed in the sides of the vessel nearly amidships, making it possible to have them in direct connection with the geared turbines, and thereby eliminating the long lines of shafting, with their bearings, tunnels, tail-hafts, and lubrication difficulties. This is a very important feature of the system, in that the efficiency of the power transmission is increased, and more space is made available for cargo. Other important advantages of the system are: (1) It is impossible for the propellors to leave the water due to pitching of the ship, (2) The handling of the vessel is facilitated in that a vessel of this type can turn about almost on her own center, thereby obviating the necessity for tugs when maneuvering in harbors or narrow channels, (3) Two propellors of the new type amidships can replace the three or four now placed at the stern.

H. M. Byllesby Memorial Research Fellowships in Engineering

The announcement by Lehigh University, in Bethlehem, Pennsylvania, of two research fellowships in Engineering brings to light an interesting example of the activities of public service industries in research. The funds are to be administered and the work directed by the Institute of Research of Lehigh University, and in common with all other activities of the Institute, the work will follow lines of pure research and the results will be immediately available to the engineering profession.

The two Henry Marison Byllesby Memorial Research Fellowships will be awarded for a period of two academic years, with an annual stipend of $750 and freedom from University fees. Half of the time of the fellows must be devoted to research work on some problem in electrical, mechanical, or hydraulic engineering, the other half to graduate study. Application or requests for information should be addressed to President Charles Russ Richards, of Lehigh University.

West Point Admitted to Engineering Institutions

At the recent annual meeting of the Association of American Universities in New Haven, the admission of the United States Military Academy to membership under the class of Technological Institutions was formally approved. This approval was voted after careful investigation by a representative of the Association had established satisfactorily the breadth of the curriculum and the high collegiate standards maintained in the educational training at West Point.

The immediate effect of the Military Academy's membership in the Association will be to give to any of its graduates who may be selected as Rhodes Scholars a regular senior standing when they report at Oxford. The Association of American Universities is recognized by the authorities of the English Universities as the premier body accrediting the best institutions of college grade in this country. Students who are graduates of institutions that are on the list of accredited universities, colleges, and technical schools published by the Association are granted senior standing without question and are in a position to elect individual courses adapted to their own desires and to do graduate work for honors.

Three recent graduates of the Academy were selected as Rhodes Scholars and are now enrolled as resident students at Oxford. They are: Lieutenant Francis Rarick Johnson, Class of 1923, 3901 North Mullon Street, Tacoma, Washington; Lieutenant Charles Eskridge Saltzman, Class of 1925, c/o Chief Signal Officer, War Department, Washington, D. C.; Lieutenant Standish Weston, Class of 1925, 1664 Columbia Road, Washington, D. C.

World's Largest Single Condenser Completed

Another world's record in engineering achievement was attained with the completion July 24 of the largest single steam condenser ever built, at the South Philadelphia Works of the Westinghouse Electric and Manufacturing Company.

Weighing almost 1,000,000 lbs. and rising to a height of nearly 30 ft., this colossal piece of machinery when operating at maximum capacity upon its installation at the new Richmond Station of the Philadelphia Electric Company, will be able to circulate approximately 150,000,000 gallons of water per day. This is equivalent to half of Philadelphia's daily water consumption of 300,000,000 gallons.

The main condenser which has a cooling surface of 70,000 square feet in a frame of 85,000 square feet capacity, was ordered last winter for the Philadelphia Electric Company's new power plant at Port Richmond, which upon its completion will be the largest single steam power unit in the world. How great this plant will be may be gathered from the fact provision has been made for the ultimate installation of twelve condensers of this giant type.

Inside the shell, which alone weighs considerable above half a million pounds, are a total of 12,734, one inch tubes, 21¼ feet in length. This is equivalent to a total length of more than 270,000 feet, or in excess of fifty-one statute miles of condenser tubes. The function of these tubes is to convert the exhaust steam from the turbines into water. Their total weight is approximately 150,000 pounds.

Part of the condenser equipment consists of two circulating pumps each with a maximum capacity of 78,000 gallons per minute, or 4,660,000 gallons per hour. This in turn is equivalent to more than 112,000,000 gallons per day. If, however, both pumps are operated simultaneously, their joint capacity will be 100,000 gallons of water per minute, corresponding to 6,000,000 gallons per hour, or a total of 144,000,000 gallons every 24 hours.

By way of comparison, it is interesting to note that the combined waterworks and pumping stations of the City of Philadelphia during the twenty-four hour period, under normal conditions, pump a total of 300,000,000 gallons of water to supply the city's needs. To operate the two circulating pumps, the condenser when erected will be equipped with two 500 H. P. Westinghouse motors, the weight of the condenser and auxiliary equipment totaling 985,000 pounds.

The work of dismantling the huge piece of machinery is now under way, preparatory to shipping it from the South Philadelphia Works to the Port Richmond plant of the Philadelphia Electric Company. Almost a dozen of the heaviest type steel flat cars will be required for the transportation of the equipment from one point, around the city borders, to the place of installation.

S. Q. Lee, cer., '24, is employed by the Ogden Engineering Company at Ottawa, Illinois.

F. S. Markut, cer., '24, is now at Cleveland, Ohio, working for the Ferro-Enamel Supply Company.

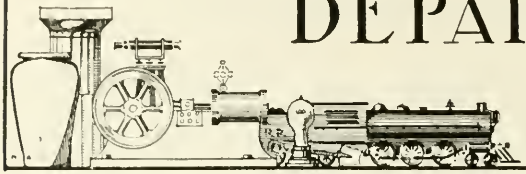
H. F. Borland, cer., '23, is employed by the Thurber Brick Company at Thurber, Texas.

C. M. Marsh, cer. '06, is plant manager for the Illinois Glass Company at Alton, Illinois.

L. Mosiman, e.e. '06, is an electrical contractor at Morton, Illinois.

L. P. Hoff, m.e. '06, is vice president and chief engineer at the Allen-Sherman-Hoff Company of Philadelphia. He makes his home at Cynwyd, Pennsylvania.

I. I. Edwards, m.e. '06, has headquarters in New York as manager of the rock drill division of the Chicago Pneumatic Tool Company.



DEPARTMENTAL NOTES

Architectural

The Architectural Society at a meeting held in Ricker Library, on Thursday evening, February 19, was addressed by William Jones Smith, prominent architect of Chicago. He gave a very interesting and instructive talk on "The Relation of Architectural Education to Office Practice." Mr. Smith is a member of the firm of Childs and Smith, who are the architects for the new Y. M. C. A. which is to be built at the corner of Chalmers and Wright Streets. They were also the architects for the new Chi Beta fraternity house.

Work on the final exercise in the thirteenth annual Plym Fellowship is now in progress. The three men picked to compete in the final drawing were Arthur Gallion, A. R. Eastman, and Lincoln Abbot. The subject is "A Municipal Building." The winner of the competition is awarded a prize of $1200, which is to be used in defraying the expenses of a year's study in Europe.

On February 27, students of the department for the first time participated in the preliminary exercise for the Paris Prize. The subjects was "An Entrance to an Art Exhibit." Any student of architecture in the country is eligible to compete for the prize.

In the recent Beaux Arts Institute of Design competition, Ralph Kloppenburg, '26, received the award of Second Medal on the problem "The Main Floor of a Large Hotel." First mentions were given to Harley McKee, '26; C. T. Miers, '25; Le Roy Berner, '26, and William Kramer, '26. At the present time the seniors are working on "A Municipal Carillon Tower." The Municipal Art Society of New York is giving a prize of $50 for the best solution and $25 for the second best. In addition, G. Broes Van Dort of Chicago is offereing $15 worth of books to the best local solution, and $10 in books as a second prize.

Mr. Van Dort is also offering a similar prize to the juniors on their problem, "A Community Concert House." He has been offering this prize annually to the seniors, but this year he is also giving the prize to the juniors.

The architectural department has had the good fortune to add to its faculty Mr. Vivian Davis to instruct the junior and senior classes in freehand drawing. Mr. Davis is a graduate of the Ecole des Beaux Arts in Paris, and has also studied at the world-renowned Julian Art Academy in Paris. Three of Mr. Davis' paintings were exhibited in the 1924 Paris Salon. Mr. Davis is a very valuable addition to the teaching staff of the department, and through his pleasing personality and exceptional ability has become very popular with the students.

The entire department is rejoicing over Professor Rexford Newcomb's decision to remain at Illinois. Recently Professor Newcomb was offered the chair vacated by the retirement of Professor A. D. F. Hamlin at Columbia University. Professor Newcomb is assistant head of the department, Architectural Editor of the "Western Architect," President of the Central Illinois Chapter of the American Institute of Architects, Architectural Advisor to the National Tile Manufacturers Association, and an authority on Spanish and Mission styles of architecture in this country.

Electrical

The new laboratory in the E. E. department is practically completed. As soon as some delayed materials arrive it will be put into use. When finished, it will accommodate two sections of thirty men each. One section will work with alternating current apparatus and the other with direct current machines.

A new thousand volt storage battery has just been received and is being used in the research laboratory. Other new equipment ordered includes a new lathe for the department shop, a small converter to change 3 phase to 6 phase A. C. for the laboratory and a motor-generator set for battery charging. This set has an automatic overload release and reversing current switch. In charging with this set there is no loss due to a series resistance. The set of 260 volt storage batteries will have every cell fused for protection against short circuits.

The new radio broadcasting station WILL is under construction. The tower and studio will be located on Illinois field.

All the meetings of the senior seminar course this semester have been addressed by outside talent. Prof. Slater of the college of commerce discussed the economics of electrification of railways. Mr. Moloney of the Cutler-Hammer Mfg. Co., Mr. Chandlee of the Century Electric Co., and Mr. Ludwig, '25 of the Westinghouse Co. brought to our attention various facts relating to their respective companies. Prof. Willard of the mechanical engineering department explained certain investigations made here at the University to solve the problem of ventilating the vehicular tunnel underneath the Hudson River.

Chemical Notes

At the January meeting of the American Chemical Society, D. B. Keyes, director of research of the U. S. Industrial Alcohol Co., Baltimore, Md., gave an interesting talk on "Solvents for Lacquers." Not only was the subject well presented from a technical and practical viewpoint, but the speaker interspersed his talk with well chosen stories of humorous incidents relative to the subject, pleasingly characteristic of Dr. Keyes and his likable personality.

Lacquer solutions contain nitrocellulose, solvent, resin, plasticizer, diluent, and pigment. Solvents for lacquer from the standpoint of chemical constitution may be grouped into alcohols and esters. The esters dissolve the nitrocellulose and the alcohols and some esters dissolve the resins. Ethers, aldehydes, and ketones are not commonly employed. Lacquer solvents are divided into three physical types:

1. Low boilers—as ethyl alcohol and ethyl acetate.

2. Medium boilers—as butyl alcohol and butyl acetate.

3. High boilers—as ethyl lactate and butyl propionate.

The function of the low boilers is to dissolve with a resultant low viscosity so as to make application easy; but the low boiler must not have too high a vapor pressure or evaporation will take place too rapidly leaving a weak film; acetone for this reason is unsatisfactory.

Medium boilers impart flow. Diethyl carbonate ranks very high in this class and is used for some purposes in place of butyl acetate.

The high boilers serve to produce a nonblushing film and give gloss to the final flow. Ethyl lactate being both an alcohol and ester and a remarkable solvent for resins or nitrocellulose is a very desirable solvent in this class. As little as 5 percent gives marked effects on the final film.

Considerable emphasis was placed on anhydrous ethyl alcohol and acetate, for they are extremely good solvents for lacquer components; there is an abundant source of raw material for their manufacture; dry ethyl alcohol plus dry ethyl acetate is very near a universal solvent for all resins; and finally, both solvents can be produced at a low price.

Plasticizers also closely related to the lacquer solvents proper impart final flow, nonblushing, blending of solid components, and gloss to the lacquer film. A good plasticizer must be a solvent for nitrocellulose and must mix with resin. Diamylphthalate and tricresyl-phosphate are examples of satisfactory plasticizers.

Dr. Keyes recommends thorough drying of each coat of lacquer applied to a surface to insure the complete evaporation of those solvents such as the medium boilers which if allowed to remain will finally break down and disrupt the film causing failure. A forced drying temperature is desirable where feasible.

Each new lacquer product put on the market for a scientific purpose naturally differs from lacquers for other uses, and so we have the most highly developed automobile lacquers, brushing lacquers, floor lacquers, etc., each having a different formula.

Dr. Keyes predicts that the future of lacquer will be in the field of interior decorations, and that coal and petroleum will be the basic raw materials for the production of lacquer solvents for lacquer coatings; and a new "lacquer" or protective coating for surfaces will in all probability be a condensation product from two solutions using a suitable powerful catalyst which when mixed just before using will then chemically react after application and unite to form a perfect permanent and beautiful finish for every surface.

Civil

HIGHWAY SHORT COURSE

The Highway Short Course was so well attended this year that the meeting place was moved to the Auditorium. As there was plenty of room, students, residents of the Twin Cities, and other interested persons were invited to the meetings. Monday morning was taken up with registration and the first session of the course officially opened at 1:30 o'clock in the Auditorium when Dean Milo S. Ketchum of the College of Engineering welcomed the visiting delegates. C. R. Miller, director of the Illinois department of Public Works and Buildings, gave a response to the welcome, and the session began with addresses by David R. Forgan, vice chairman of the National Bank of the Republic, Chicago, Frank T. Sheets '14, chief highway engineer for Illinois, and Professor C. C. Williams, head of the department of civil engineering. Mr. Sheets explained how the state road program for 1926 has been blocked by an insignificant clause in the $100,000,000 Illinois road bond issue. This clause requires that all contracts for the past $60,000,000 bond issue shall be let before contracts on the new bond issue can be granted. However he said that before the year was over the old contracts would be granted and the difficulty overcome. On Tuesday the meeting was presided over by R. F. Fisher, Superintendent of highways of Champaign county. Prof. T. D. Mylrea featured the program with an illustrated lecture on "The Economical Design of Highway Bridges." He stated that the days of reckless and unscrupulous bridge design were gone and now the whole crossing must be taken into consideration in building a bridge and due weight given to cost, life, and maintenance.

G. F. Burch of the Illinois Division of highways gave a talk on "The Interdependence of Design and Construction of Bridges and Culverts," in which he emphasized the necessity of field measurements and supervision of construction. On Wednesday the feature addresses were given by Prof. C. C. Wiley, director of the course, and G. E. Patterson, general manager of the Illinois Central Railroad. Their respective topics were "The Design of Arterial Highways Through Municipalities" and "Recent Progress in Transportation." Prof. C. L. Stewart, chief of agricultural economics, gave an address on Thursday afternoon on "The Relation of Improved Highways to Rural Wealth" in which he stated that when average prosperity returns to corn belt agriculture it will be due in a large measure to our modern highway system.

The next day brought the close of the Short Course with talks by F. B. Leonard, attorney, Champaign, and W. F. Lodge, Past President of the Illinois Municipal and Highway Contractors Association. Mr. Leonard gave an address on "Contract Bonds and Liens in Highway Work" and Mr. Lodge told what he had learned about engineers in twenty years of contracting. Prof. Wiley and Frank T. Sheets made the concluding remarks and Prof. C. C. Williams made a short address telling of the work of the late Prof. I. O. Baker and praised the man who was so well known to the engineering profession. The total enrollment was 312 which is a new record and great credit is due to Prof. Wiley and members of the civil engineering department for the success of the Highway Course.

A. S. C. E.

The Central Illinois section of the A. S. C. E. held a joint meeting with the student chapter on the evening of Wednesday, February 24th, at the Inman Hotel. After a dinner which was of the Inman standard of excellence, Mr. Charles F. Loweth, chief engineer of the C. M. & St. P. Railroad, was introduced by Prof. Enger. Mr. Loweth gave a very interesting address on "Railway Mergers" After a historical sketch on the development of railroads, he told of the changing opinion in regard to railway mergers and described the present plan for mergers which is before Congress. The proposition is to separate about 95 percent of the railroads into 21 district divisions in order to cut down overhead expense and to minimize operating charges. Mr. Loweth advocated the plan and pointed out the phases of the situation which were of especial interest to engineers.

Notes

Mr. C. F. Smith of the University

of Utah is a new graduate assistant in research. He is taking the place of J. E. Keranen on the Austin scholarship and will cooperate with Mr. Finlay in research on :"Earth and Gravel Roads."

Professors Hardy Cross and T. D. Mylrea of the department of civil engineering attended the recent meeting of the American Concrete Institute held in Chicago.

Ceramics

THE SHORT COURSE

The short courses in clay working and enameling were held from January 11 to January 23 in the ceramics department under the direction of Professor C. E. Parmelee.

The following courses which were very interesting because of practical value were given during the two weeks of instruction:

"The Origin and Properties of Clays," by Professor Parmelee.

"Ceramic Chemistry," by Professor Andrews.

"Explosions and Blasting," by Professor Callen.

"Business Law," by Professor Harker.

"The Composition and Properties of Coal," by Professor Parr.

"Steam Engines and Boilers," by Professor Kratz.

"Boiler Waters," by Professor Busweel.

"Dynamos and Motors," by Professor Paine.

"Drying," by Professor Hursh.

"Burning," by Professor Hursh.

"Maximum Production from Equipment," by Mr. Benedict.

"Pyrometers," by Dr. Westman.

"Glazes," by Professor Parmelee.

"Prospecting and Sampling," by Mr. McVay.

"Periodic Kilns," by Professor Hursh.

"Continuous Kilns," by Professor Hursh.

"Car Tunnel Kilns," by Professor Hursh.

"Care and Maintenance of Machinery," by Mr. Casberg.

"Winning of Clays," by Mr. McVay.

"Clay Haulage," by Mr. McVay.

"Burning Brick for Color," by Mr. McVay.

"Fuel Economy," by Professor Hursh.

"Plant Problems," by Professor Hursh.

"Dies and Augur Machines," by Professor Hursh.

"Refractory Materials," by Mr. Booze.

"Vitreous Enamels," by Mr. Danielson.

"Bodies," by Professor Watts.

"Grinding," by Mr. McVay.

"Screening," by Mr. McVay.

Along with these courses, Dean Ketchum, Dean of the College of Engineering, gave an address.

The Short Course in Clay Working which has been given by the department of ceramic engineering from time to time since 1913 has been attended by a large number of men from various parts of the country. It has been highly commended by those who have attended. The latest and perhaps the most interesting statement regarding its value has been contributed by Mr. Mitlin Hood of Atlanta, Georgia in an article "Pioneering in Southern Burned Clay Products" published in Manufacturers Record of a recent issue.

Mr. Hood states that as a result of his attendance at the session of 1914 "I started a new industry in the South called Hood's Pottery Clay Products Company, and built a new plant at the base of Walden's Ridge, where the first quarry floor tiles ever made in the South were manufactured. It was this plant that was the first to turn the tide and ship burned clay products from the South into the North and bring back Wall Street cash."

Furthermore he states "the great benefit derived by me from the intensive course in ceramics at the University of Illinois caused me to wish some Southern university would offer such a course to southern boys, and I therefore knocked at the door of the Georgia School of Technology. . . ."

The plan of Mr. Hood was interrupted by the war. It culminated in 1924 in the appropriation by the Georgia State Legislature of money for the maintenance of such a course.

Notes

Prof. R. K. Hursh spent the first week of March in New York City at a meeting of the Committee of American Society of Mechanical Engineers. The type of refractories used in boiler plants was the subject of discussion.

The ceramics department has purchased an automatic carbon dioxide recorder which operates on the principle of the varying thermal conductivity of gasses.

Prof. C. W. Parmelee and Dr. Andrews attend the annual meeting of the American Ceramics Society which was held recently at Atlanta, Georgia. They also visited the city of Macon and several of the clay deposits in that vicinity. At McIntire and Gordon, Georgia, they inspected refining plants and clay pits. On the return trip Prof .Parmelee stopped off at Chattanooga, Tenn.,in order to investigate the clay industry in that locality.

The ceramics department has taken over the rooms on the third floor of the Ceramics Building which were formerly occupied by the Bureau of Mines.

Mr. T. N. McVay is at present very much interested in the "Microscopic Examination of White Clay." He is doing considerable research including the examination of kaolins, secondary kaolins, and all other white burning clays.

Railway

A most interesting series of tests is being carried on by the railway engineering research department and the Illinois Central Railroad under the direction of Prof. Tuthill and D. L. Fiske. An effort is being made to determine which train offers the greatest resistance, one with loaded freight cars next to the engine or one with the loaded freight cars at the rear of the train and the empties next to the engine. To the casual observer it would seem logical to place the loaded cars behind the engine but there are many conditions which may make the other the better way. The tests are made with the Illinois Central and University Test Car, the freight train being furnished by the railroad, and run from Rantoul to Ludlow, as there is a maximum grade between the two stops.

The Railway Test Car presents an interesting operating plant. The motion of the train is relayed from a set of wheels dropped upon the rails when the train is in motion to a revolving roll of paper, over a yard wide. By means of ruling pens twenty-nine different things are recorded on the paper during the operation, of the car, such as draw bar pull, distance, time, curvature, wind velocity and direction, speed of train, application of airbrakes and locomotive operation in general. The interpreter then takes the roll of paper and deduces results which give us the efficient train operation we have today.

Mechanical

A. S. M. E.

First, a glimpse into the future. It comes on Wednesday, April 14—a talk by Wm. C. Anthony on "European Aeroplane Developments." Now there's some real romance about Mr. Anthony. Not only is he an eminent mechanical engineer, being president of the Anthony Company, Inc., of Streator, Illinois, manufacturers of self-dumping Ford truck bodies; but he is also a distinguished traveler as well. South and Central America have been until recently his favorite foreign haunts; however, last summer he spent several months abroad roving over the European continent in an aeroplane. Incidentally, through the courtesy of personal friends in the British Air Service, he was able to investigate thoroughly the latest developments in European aeronautic engineering. Finally, M. E.'s, Mr. Anthony is a 1911 graduate of the University of Illinois. Let's be at the M. E. Lab. lecture room at 4:00 P. M. on Wednesday, April 14.

A new system of arranging entertaining regular meeting programs was initiated at the end of last semester. Something entirely original. The planning, directing, and giving of these programs has been put into the hands of different selected groups of M. E. seniors. In this way variety and novelty of subject matter, lively talks, and animated discussions are always assured.

At a regular meeting on January 20, S. I. Rottmayer gave a short talk on "High Pressure Steam." Unquestionably the future of this desirable item in power production is at present particularly optimistic. Following Mr. Rottmayer's talk, J. H. McCullough told of his experience in connection with the construction of locks and dams on the Illinois waterway project at Lockport and Marseilles.

As an instance of a varied program, examine this one of February seventeenth: R. Wikoff gave a review of the remarkable life of Judge Gary, the steel king; W. G. Schlieting brought up some interesting points concerning internal grinding and grinding wheels; and R. H. Stone explained the methods used in Southern Illinois coal mining. Could a brief hour's program of an engineering nature hardly be more charmingly diversified?

Those M. E.'s who failed to attend the special meeting and smoker of the A. S. M. E. on Friday night, February 19, missed not only a good smoke and an inspiring illustrated lecture, but also some excellent cider and doughnuts, as well as the latest M. E. gossip. Undoubtedly Frank B. Chase with his lecture on "The Survival of the Fit" furnished the outstanding performance of the evening. Mr. Chase is the head of a Chicago firm of engineers and architects which designs modern industrial plants. Here are a few of the points be brought out.

"Man can't work for a deficit," said Mr. Chase; "a margin of profit must be earned. Present competition is keen, at times even destructive. Only the fit survive. Modern industrial plants must be located right, they must be properly laid out, and they must be so planned as to take care of possible future expansion or they will be crushed out of existence."

"Buildings must fit," Mr. Chase further explained; "hence there is no such thing as standardization of building design. Although the plants themselves may manufacture identical products, localities differ; controlling natural and artificial conditions are never the same."

In addition to being an illustrious engineer, Mr. Chase is also somewhat of a moralist and philosopher. "If you don't love your job," he said, "get out of it. Immediately!"

"Consistently play life's game on the square. If you are ever called upon to be a salesman—as most likely you will be—don't misrepresent the product or service sold. Deceit never pays."

As a conclusion to his lecture, Mr. Chase exhibited a number of slides showing the design and interior arrangement of a modern newspaper plant in Milwaukee planned and built under his supervision.

Mining

At the last meeting of the Mining Society, Jan. 12, 1926, of the first semester, Mr. C. D. Borror presided over an unusually large attendance. Prof. I. M. Marshall spoke to the society on a subject of universal importance to all engineers, "The Human Factor in Industry," in which he summed up his experiences and gave out many pointers in handling mine labor as a shift boss.

Prof. Marshall does not believe it necessary to go through the various stages as foreman, etc., to become a good manager, but he does believe that the experience and knowledge acquired while going through the stages to managership is extremely helpful in bringing out the five qualifications of a mining man. The mining engineer must:

1. Know his work.
2. Understand human nature.
3. Be able to distribute the work among his men with the greatest efficiency.
4. Be loyal to his company always.
5. Command the respect of his workers.

Some men are naturally gifted with these qualifications while others must strive hard to attain them. As a general rule a "boss" should never make promises unless he intends to keep them. No matter how small the promise may seem, a broken promise is hard for the workers to forget. A boss should be firm, yet not domineering, and in mining where a rough element must be handled, he should never fight unless struck first. He must take pains to be courteous to his men, but should never patronize or fraternize with them. Last but not least he should keep himself morally clean.

Activities

After some effort on the part of the mining faculty and students the department succeeded in securing a film from the Bureau of Mines entitled, "When a Man's a Miner." The picture was shown Thursday afternoon, 4:00 P.M., 228 N. H. and was witnessed by a goodly number. It was not, as one would expect, a purely technical picture, but had a bit of a love story woven into the plot in a mining setting. The picture showed how a careless miner was brought to grief by his own foolishness in his disregard for the safety of his working place. This accident made him an invalid for a time; and during his convalescence he realized the full meaning of the slogan: "The Best Safety Device Known Is a Careful Man." He began studying the safety bulletins; and the climax shows the same man as a cool headed leader of a group of men who have been trapped in an entry following an explosion. The picture shows clearly the method of barricading an entry against the entrance of poison gases so that the good air remaining may be used to the best advantage in sustaining life until rescue is effected. Finally the men were rescued by the rescue team and thus a happy end.

The Mining Smoker, the first meeting of the second semester, was held Feb. 16, 1926 in the Union Building, and an ample "gang" enjoyed cider and doughnuts not to mention the smokes.

Since variety is the spice of life, the members and guests were entertained by a three-round boxing bout between Joe Larson and R. R. Hoff.

Fraternity Activities

Tau Beta Pi

Tau Beta Pi, as the majority of engineering students know, is an honorary engineering fraternity which sponsors high scholarship. The organization was founded for that purpose by Edward H. Williams, Jr., B.A., A.C., E.M., Sc.D., LL.D., of Woodstock, Vermont. The first chapter was established at Lehigh University, South Bethlehem, Pa., in June 1885. The chapter at Illinois was the fifth to be added to the roll, being given that honor in 1897. At this time forty-five chapters, established at the leading universities, complete the chapter roll together with six alumni chapters established in various parts of the country wherever the needs for such an organization warranted its establishment.

To best state the principles and ideals of Tau Beta Pi, it might be well to quote the preamble from the constitution:

"To mark in a fitting manner, those who have conferred honor upon their Alma Mater by a high grade of scholarship as undergraduates, or by their attainments as alumni; and to foster a spirit of liberal culture in the Engineering Schools of America; we do hereby ordain and enact the following:"

From this preamble it may be seen that Tau Beta Pi recognizes the fact that an engineer in order to be successful must have a certain amount of culture. An engineer should know something of music, of art, of literature, of history, and of the various other cultural subjects in which he is known to be very much deficient—deficient not because he wants to be, but because his curriculum is limited in these subjects. With this in mind, Tau Beta Pi has tried, and is trying to raise the engineer from "boot, pick and shovel" level to that of a respected technically trained man.

Delta Mu Epsilon

The honorary mining fraternity held its formal initiation banquet at the Inman Hotel on Sunday evening, Dec. 6. The pledges were B. Melvin, L. Volyz, and R. Lager. The honorary members are Professors A. C. Callen and I. M. Marshall. Further initiation activities will be held later.

Phi Alpha Lambda

The following officers for the ensuing year were elected at the regular meeting of Phi Alpha Lambda honorary general engineering fraternity held on March 2, 1926: M. E. Johnson, '27, President; D. M. Fritts, '27. Vice President; J. L. Pertl, '27, Treasurer; R. G. Henry, '27, Secretary.

Some very good work has been done by this organization since its establishment, and although its name has not been flaunted in the headlines or its deeds shouted from the housetops of the engineering school, yet it has won its place as an organization on the Engineering Campus.

Phi Alpha Lambda, since it is purely general engineering, faces a somewhat peculiar problem inasmuch as the enrollment of this department is comparatively small. Yet few organizations can boast of a more representative group of men or of a more practical code of ideals on which it chooses its men. The aims and purposes of Phi Alpha Lambda take it out of that class of super-academic honoraries that justify their existence on the samewhat narrow, egoistic and empty ideal of pure scholastic attainments.

In keeping with the scope of the General Engineering Department, the activities of Phi Alpha Lambda members is about as diversified as the g.e. curriculum itself. Among other things, the work it has taken for the immediate future is the reorganization of the now more-or-less dormant General Engineering Society.

Chi Epsilon

Chi Epsilon, honorary civil engineering fraternity, installed the following officers at a meeting held January 19, 1926: President, D. R. Conner; Vice-President, O. T. Parker; Secretary and Treasurer, F. A. Dollinger; Corresponding Secretary, Reno Niles.

Following installation, short talks were given by C. S. Hendrick, J. C. Voorhees, and D. H. Pluta, regarding the work in which they had been engaged during the summer months. These talks proved to be very interesting as well as giving the members an idea of some of the problems to be met upon their entry into practical work.

Pi Tau Sigma

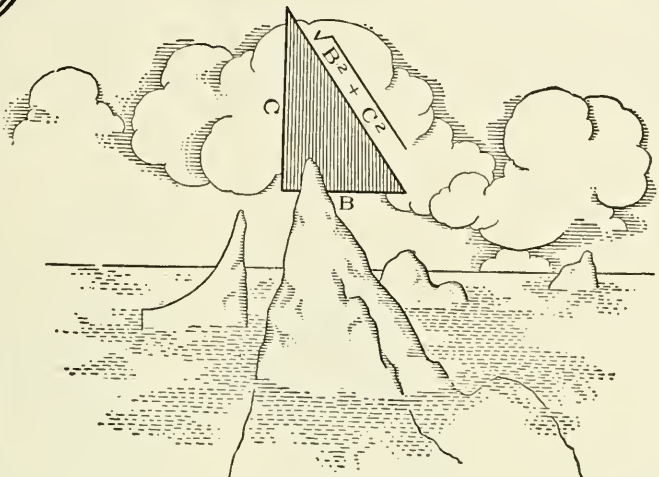
The eighth annual convention of Pi Tau Sigma was held at the University of Illinois on November 5, 6 and 7. The local chapter made every effort to show the visiting delegates around the University of Illinois Campus and Buildings, and to make their sojourn at Illinois a pleasant one.

The grand officers, Supreme President G. A. Young, of Purdue, Supreme Vice President G. L. Larson, of Wisconsin, and Supreme Secretary J. V. Martenis, of Minnesota as well as two delegates from each of the chapters; University of Wisconsin, University of Minnesota, University of Missouri, Purdue University and Armour Institute of Technology were present.

The program as outlined by the committee on arrangements was a worthy attempt to fulfill the desire of the local chapter, namely to extend a real brother greeting. The program began with a smoker at the Warm Air Research Residence on Thursday evening. The convention was held at the War Air Research Residence, a privilege allowed by Professor Willard. The opening session of the convention was held on Friday morning, the delegates were entertained by the faculty members of Pi Tau Sigma at a 1:00 o'clock luncheon at the University Club after which a tour of the campus and University buildings was made.

The golf championship was won by Illinois Alpha represented by Professor Goodenough. Although Professor Martinis assisted nobly in the capacity of caddy, he declared that the victory was in no way due to his own efforts.

A model initiation was held at Wesley Foundation on Friday evening. Initiatory work was conducted by Julius Muller. The chapter was honored by the presence of Mr. W. L. Abbott, chief operating engineer of Commonwealth Edison Company, who was initiated as an honorary member into the fraternity. The candidates for active membership were: E. H. Taze, C. U. Smith, H. J. Anderson, and E. E. Veihl of the senior class and G. H. Zenner, K. D. Knoblock, C. C. Baumgardner and J. R. Connelly of the junior class. The initiation was followed by a banquet at the University Club. Dean Ketchum was the guest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of honor. Professor A. C. Willard acted as toastmaster. Each of the national officers as well as a delegate from each chapter were the speakers. The closing address was delivered by Mr. W. L. Abbott.

The final session of the convention was held on Saturday morning. The delegates were guests of the local chapter at the Chicago-Illinois game Saturday afternoon. The convention was very successful and hopeful for the future of the fraternity. Several petitions for new chapters throughout the east and middle west were voted upon favorably. A very conservative policy of expansion was adopted. The organization adopted the publication of the local chapter known as the Condenser as its official magazine, the paper is to be published by the supreme secretary.

The local chapter plans a series of luncheons for the coming semester and as has heretofore will continue to give the student branch of the A. S. M. E. its full support. Illinois Alpha will attempt to bring closer association among the sophomores, the juniors and the members of the Mechanical Engineering Faculty as well as to strengthen the bonds of friendship and loyalty within the Mechanical Engineering Department.

Sigma Epsilon

Sigma Epsilon fraternity was organized as an honorary railway engineering fraternity in 1923 and was incorporated under the laws of the State of Illinois in February of that year. Membership in the fraternity is confined to juniors and seniors in the railway department and its faculty. From the eligible enrollment a few men are picked each year on the basis of scholarship, collegiate activities and general interest in their chosen profession. With the organization of the fraternity came the thought of adding other collegiate chapters but as there are no other distinct railway schools, as we have at Illinois, the fraternity has been locally confined. Besides the advantages the fraternity offers its own members, it works to the promulgation of all the activities of the railway department, and sponsoring the Railway Club

The present officers of the fraternity are: H. G. Mason '26, President; T. C. Stressor '26, Vice-President; J. H. Smith '26, Secretary; W. L. Hunt '26, Treasurer. The recent initiates of the fraternity are H. L. Kunz '26, P. J. Thoma '27, H. G. Moore '27, N. E. Allen '27, and E. F Hogart '27

Eta Kappa Nu

Eta Kappa Nu is an electrical engineering fraternity organized for closer cooperation and mutual benefit to students and others in the profession. Alpha chapter founded here at the University of Illinois on October 28, 1904 is the mother chapter. Eta Kappa Nu now has twenty active chapters located at leading technical universities throughout the country as well as eleven alumni chapters established in the more important cities. The members of the active chapters are chosen because they have shown exceptional interest and marked ability in electrical engineering. Naturally then, scholarship is one of the requirements of membership. It is one of the aims of the fraternity to stimulate in every possible way the interest of undergraduates in the attainment of scholarship.

The offcial publication of Eta Kappa Nu is, "The Bridge," which appears quarterly. The magazine contains news of the various chapters, items of interest to the profession, and notes on the activities of various alumni and active members. Through this medium undergraduates come in closer contact with the men who are the real leaders in electrical engineering and hence cannot help but be benefitted.

The local chapter has twenty-four active members at the present time. The main activity before the members now is of course the electrical engineering show which is to be held this spring.

The officials who are leading H K N this semester are:

President, W. T. King; Vice-President, P. W. Emley; Recording Secretary, J. O. Ephgrave; Treasurer, J. E. Baudino; Sergeant at Arms, E. M. Sobota; Corresponding Secretary, W. S. Duncan; Associate Editor of "The Bridge", W. T. King.

Sigma Tau

Sigma Tau was founded at the University of Nebraska in February 1904 with the express purpose of binding together engineering students of merit by fraternal ties as well as the ties of classroom friendship.

In its membership requirements and relations to other societies, it was founded strictly as an honorary fraternity. Believing that scholarship alone was not the only mark of a successful engineer, the founders incorporated two other qualities on which to test the prospective members. The first of these, sociability, defined for our purpose to mean the art of mixing easily and making lasting friends (public spiritedness). These cond, practicability, the ability to put theory on a working basis and to apply it in the solution of practical problems.

These three qualities, rightly applied, select for Sigma Tau the best to be had in a real, all-around, fellow-engineer.

Theta Chapter was founded at the University of Illinois in February 1914. It is the custom of every chapter of Sigma Tau to recognize each year that sophomore who made the highest grades during his first year of engineering work. On December 9, 1925 Theta chapter awarded the Sigma Tau Scholarship Medal to Peter V. Jensen for an average of 4.93 in Civil Engineering.

Membership is from among juniors and seniors only selected in the upper one-third of their class with a minimum average of 3.9. Our new men of this year are:

HONORARY

J. A. Goff

ACTIVES

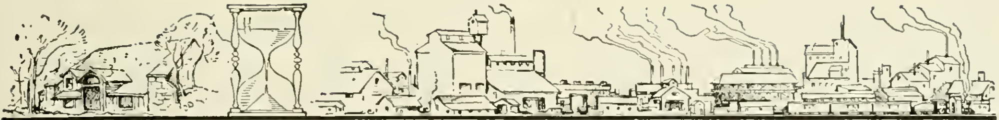
H. E. Schlenz	R. T. Reichel
J. P. Breen	B. H. Melvin
H. G. Moore	J. J. Roland
C. L. Thompson	Jos. Pertl
N. A. Kleerup	P. C. Smith
H. W. Lochner	E. P. Wells
H. A. Vagtborg	C. A. Butts
C. F. Hendricks	J. A. Volkmann
O. T. Parker	M. J. Crosett
V. Gunloch	P. J. Thoma

The news and activities of the present eighteen chapters of Sigma Tau are published in a quarterly magazine, the Pyramid, a national publication edited by the Grand Council.

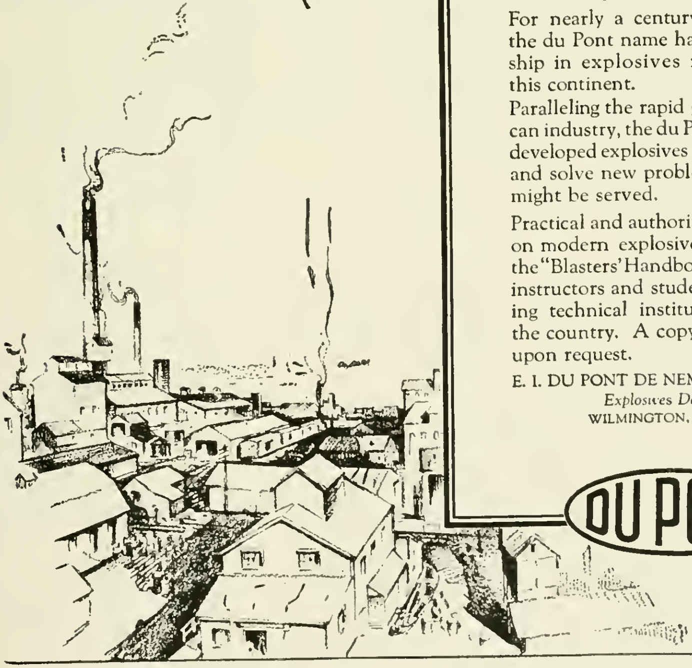
Sigma Tau encourages and welcomes active interest from the honorary and faculty brothers in the running of chapter business.

Mu San

Mu San is the professional Municipal and Sanitary engineering fraternity. It was organized in 1911 at the University of Illinois for the purpose of creating a closer relationship between students and between students and faculty of the department. The organization also binds closer the friendships of post college life. This was evidenced by the extremely successful banquet held in Chicago during the inspection trip period being attended by many of the alumni of the department. Even though the department is small the fraternity chooses carefully.



The oldest du Pont powder mill—built in 1802



Partial view of Repauno Plant, one of the largest explosives plants of the du Pont Company.

ALUMNI NOTES

The oldest living graduate of the University, Alphonso S. Gates, c.e., '83, died November 23 at Hamilton, Ill., aged 91. For many years he lived in Spearfish, South Dakota, where he was a city engineer, but his health failing, his thoughts turned back to the days of his boyhood, so he returned to Hamilton to live with his sister. He had never married.

Mr. Gates was twice as old as the average student when he first came to the University in 1879, he was only four years younger than Regent Peabody. He had picked up what education he possessed in home study, in the public schools, and in two years at Knox College. At Illinois, after a year in the old academy, he was enrolled in Civil Engineering and graduated with the class of '83. Three years later he received the degree of c.e. On leaving Illinois he took up mineral surveying among the silver mines of South Dakota, which was to be his life work. He was U. S. deputy mineral surveyor and state and county surveyor of Butte county. Then he became city engineer of the canyon town of Spearfish, South Dakota, a position he held up to within a few years of his death. He took active part in Masonry at Spearfish and at Deadwood, having achieved the 32nd degree. He had traveled extensively, both in this country and abroad.

He continued his engineering studies by enrolling in the International Correspondence Schools. He always retained great affection for the University of Illinois, though he seldom if ever came back to the reunions. While a student here he lived at the old Page Club on Wright Street. He was something of a recluse taking no part in student activities, and attending diligently to his studies.

Mr. Gates was born in Cass county, Michigan, November 17, 1834; his father came from Connecticut and his mother from Pennsylvania. They settled at Monetbello, Illinois, where his father had the first mill.

W. L. Abott, e.e. '84 was initiated into Pi Tau Sigma, honorary mechanical engineering fraternity, at the national convention of that organization on the campus recently. While on the campus Mr. Abbot presided at a meeting of the State Public Utility Research Committee of which he is chairman. He is also chief engineer of the Commonwealth Edison Company of Chicago.

A. W. Gates, cer. '92, is president of the Gates Fire Clay Company of Calchester, Illinois, and lives in Monmouth, Illinois. The firm specializes in tile for flues, but also produces considerable pottery.

Alfred Fellheimer, a.e. '95, is an architect and engineer in New York City.

H. C. Este, r.e. '96, is office engineer in the office of the chief engineer at the Chicago and North Western Railway.

G. Boyd, c.e. '96, is editor of the engineering department of the Railway review.

J. F. Sheets, c.e., '11, chief of the Illinois State Highways Department, recently addressed the student branch of the A. S. C. E. on the location of hard roads.

C. H. Shook, c.e., '15, is a member of the firm of Shook and Belliter, general contractors, of Dayton, Ohio

H. W. Orr, e.e., '14, is an electrical engineer at Ft. Thomas, Kentucky.

J. R. Fletemeyer, c.e, '16, is president of the Frank N Cooper Company, general contractors, of Detroit, Michigan.

A. L. Pillsbury

The American Institute of Architects recently held a memorial meeting in honor of A. L. Pillsbury, arch. '95, who was killed in an automobile accident on October 24. An address, "Pillsburg—the Man and Architect," was delivered by David Felmley, president of the Illinois State Normal School. Rexford Newcomb, '11 and J. W. Royer '95 were also on the program.

C. J. Boesen, r.e., '20, has opened an office as transportation engineer in New York City.

H. H. Reeves, e.e., '10, is merchandize representative in Japan for the International General Electric Company.

M. Stem, m. and s.e., '09, died recently in Chicago after a period of illness. He was working for the Sanitary District of Chicago and had written a text on the operation of rapid sand filter plants. He was a member of Sigma Xi and was graduated from the University with preliminary honors.

V. L. Glover, c.e., '20, is engineer of materials for the Illinois State Highway Commission. He was formerly a road engineer.

(Continued on Page 156)

We Slam Ourselves

First Co-ed: "Whew! my laundry bill last week amounted to $4.97."

Second Co-ed: "Gracious, that's five times as much as mine was."

First Co-ed: "Yes, but you don't go with an Engineer."

Full Dress

Co-ed (answering the door bell): "Time for the dance?"

Frosh (beholding an evening gown for the first time): "Yes, put on your dress and come on."

You can't kiss a girl unexpectedly. The best you can do is to kiss her sooner than she expected.

Wasting Time

Night Watchman, on the south campus: "Young man, are you going to kiss that girl?"

He (straightening up): "No, sir."

Night Watchman: "Here then, hold my lantern."

The average co-ed has a difficult time trying to decide the question of whether it is wise to be foolish, or foolish to be wise.

"Didn't know you had met Harry before."

"Oh yes, we slept together in college."

"Roommates?"

"Nope classmates."

Little Willie: "Mother where do they keep the cross-eyed bear in Sunday School?"

Mother: "What in the world do you mean?"

Little Willie: "Why, we're always singing about the holy cross I'd bear."

First Maid: "How did you like working for that college professor?"

Second Maid: "Aw, it was a rotten job. He was all the time quarreling with his wife, and they kept me busy running between the keyhole and the dictionary."—Punch Bowl.

"What's the last thing the doctor does when he operates on your father?"

"I'll bite; what is it?"

"Sews your old man."

Yea Chicago!

(Suggested yells for Chicago:)

Baseball! Feetball! Svimming in the tanks!
Ve've got money, but ve keep it in the banks.
Collech! Collech! Oi, Oi.
Hooray, Hurray! Ve von! Ve von!
Vat? Ve lost?
Dey cheated!

Sorority sister: "Alice has been wearing a strange expression lately, hasn't she?"

Ditto: "Yes, she's trying to resemble her photograph for the Illio."

Artist: "How do you like my picture of an Arabian donkey?"

Admirer: "Wonderful! You put so much of your self into it."

—Virginia Reel

A Motto

Late to bed and early to rise, makes the college boy sleepy but wise.

—Centre Colonel

Too Fast

"Is Barbara fast?"

"Fast? Why, her mother won't even let her accompany a young man on the piano unless she is well chaperoned."

A Sure Road To Wealth

An Engineer started as poor as the proverbial church mouse 20 years ago. He has now retired with a fortune of $50,000.00.

This money was acquired through economy, conscientious effort to give full value, indomitable persevorence, and the death of an uncle, who left the contractor $49,999.50.

Inquisitive old gentleman: "And what are you digging for my good man?"

Digger: "Money."

"You don't say so! And when do you expect to find it?"

"Saturday night!"

She's Done Gone

A salesman bringing his bride South on their honeymoon, visited a hotel where he boasted of the fine honey.

"Sambo," he asked the colored waiter, "Where's my honey?"

"Ah don't know, Boss," replied Sambo, eyeing the lady cautiously. "She don't wuk here no mo'."

"Is he a nice boy?"

"No, dear, I think you'll like him."

It Will Happen

He took her hand in his and gazed proudly at the diamond engagement ring he had placed on her finger three days before.

"Did your friends admire it?" he inquired tenderly.

"They did more than that," she replied coldly. "Two of them recognized it."

Mique: "I hear your roommate has a baby saxaphone."

Ique: "Yeh, and it'll be an orphan soon."

Water-Supply for Flagstaff

(Continued from Page 119)

much too small to deliver the required amount of water from the supply main.

To obviate these difficulties a 14-inch cast iron pipe line, Diagram 1, has been laid from the reservoir to town to replace the six-inch and eight-inch lines which are being taken up and reclaimed. The pipe reclaimed from the flow line will be relaid in the distribution system for reinforcing the pressure in the parts of town where most needed.

After scanning the history of the Flagstaff water supply, the project appears to be one of sound economic development as well as one possessing unique records in water supply problems. Insurance companies have promised a reduction of 15 percent in rates now existing in most parts of the town when proposed improvements are completed. In addition, the supply being brought to the user entirely by gravity and requiring no treatment for purification, operating expenses are negligible and interest on the investment will be more than counterbalanced by the sale of water to commercial consumers.

Frontier Electrical Development

(Continued from Page 124)

frontier work on new problems whose answers are not in textbooks. The industry is not cut and dried, but a carefully balanced system liable to reorganization under the stress of a new discovery or developed theory. It is an elusive industry slowly crystallizing into what may become ultimate form. The extreme flexibility of electrical power is hardly realized, but has throughout been the basis of this magnificent progress.

A DARK REFLECTION

Rastus: "Dat baby of yours am de perfect image of his daddy.

Rasta: "He suah am. He am a reg'lar carbon copy."

GEE WHIZZICA

After Jessie had been at boarding school a few weeks, she began signing all her letters home, "Jessica."

Brother Tom replied as follows: "Dear Jessica, Dodica and Momica have gone to visit Aunt Lizzica. Uncle Samica is considering buying a new machinica, but he doesn't know whether to get a Fordica or a Chevica. The old cowica had a calfica. I was going to call it Nellica, but I changed it to Jimica because it was a bullica. Your affectionate brother, Tomica."

The Cheat-Haven Dam

(Continued from Page 126)

will be located on the outside of the building on the down stream side of the dam.

The station will contain four 18,000 horse power turbines each directly connected to generators with a combined capacity of about 51,000 kilowatts. The turbines will revolve at the rate of 133 revolutions per minute and each will require about 2,000 sec. ft. of water.

Completion of the project is assured for September of this year. This hydro-development will supply electrical energy over a large area of northern West Virginia and will be interconnected by high voltage steel tower transmission lines with the Rivesville, West Virginia Power Station, of the Monongahela West Penn Public Service Company, and the West Penn System in Pennsylvania.

Sanderson and Porter are the engineers and contractors and the writer is indebted to them for much of the material used in this article.

FOOT NOTES

[1] U. S. G. S. Water Survey Bulletin No. 473.
[2] U. S. Weather Bureau Climatological Data—1916

Beggs' Apparatus

(Continued from Page 132)

of the instruments there is little to be questioned because they are rugged and may be easily recalibrated at any time. The personal element can hardly affect the readings unless the operator is very careless. Temperature and moisture changes will affect the readings only in case there is an unusual lapse of time between the two halves of one reading.

It may be of some interest to know that very good agreement is found between the values obtained by taking readings on a model and by applying the elastic theory to it. For a two legged bent such as in Fig. 2, Beggs reports that the values of H found by the two methods differ by 8% for a vertical load at the center line, by 1.4% for a horizontal load on a column, and by 0.5% for the combined loading. For a model of a fixed ended arch with a concentrated load near the crown the differences in the moment and thrust at springing as determined by the two methods were 3.7% and 1%, respectively. Of course such considerations do not tell us how closely the computed stresses are to the real stresses that will exist in the structure after erection.

While not a particularly speedy method of analysis, the Beggs apparatus offers several advantages where it is desired to obtain a complete set of influence lines. It allows a routine to be established in an office, it does not require technically trained men for its operation, and the work can be easily checked. It also offers an interesting means of in-

(Continued on Page 158)

BRINGING MORE DAYLIGHT INTO INDUSTRIAL BUILDINGS.

Dr. George M. Price, writing on "The Importance of Light in Factories," in "The Modern Factory," states: "Light is an essential working condition in all industrial establishments, and is also of paramount influence in the preservation of the health of the workers. There is no condition within industrial establishments to which so little attention is given as proper lighting and illumination. Especially is this the case in many of the factories in the United States. A prominent investigator, who had extensive opportunities to make observations of industrial establishments in Europe as well as in America, states: "I have seen so many mills and other works miserably lighted, that bad light is the most conspicuous and general defect of American factory premises."

"My own investigations for the New York State Factory Commission support this view. In these investigations it was found that 36.7% of the laundries inspected, 49.2% of the candy factories, 48.4% of the printing places, 50% of the chemical establishments, were inadequately lighted. There was hardly a trade investigated without finding a large number of inadequately lighted establishments."

Inadequate and defective lignting of industrial buildings is not confined to the establishments in New York State alone. The same conditions prevail in most sections of the country.

Such conditions as mentioned above are entirely opposed to the laws of health, sanitation and efficiency. Wherever poor lighting conditions prevail, there must be a corresponding loss of efficiency and output both in quality and in quantity. American industry is not using nearly enough daylight and sunlight in its buildings. Every endeavor should be made to use as much as possible of daylight for lighting purposes. To obtain this it is of course necessary that the rays of daylight and sunlight are permitted to enter the interior of the buildings as freely as possible, with the important modification that the direct rays of the sun must be properly diffused to prevent glare and eyestrain. A glass especially made for this purpose is known as Factrolite, and is recommended for the windows of industrial plants. Windows should be kept clean if the maximum amount of daylight is to pass through the glass, but the effort will be well repaid by the benefits secured.

In the presence of poor lighting, we cannot expect men to work with the same enthusiasm as when a well lighted working place has been provided. The physical surroundings have a deep effect upon the sentiments of the employes, and where bad working conditions are allowed to prevail, there is invariably a lessening of morale and satisfaction created thereby. Neglecting to utilize what nature has so bounteously provided, daylight, and which is so essential toward industrial efficiency, we have an instance of wastefulness, but now that the importance of good lighting is becoming recognized, undoubtedly more attention will be given by progressive industrial employers to furnishing the means which are essential for their workers to secure and maintain the efficiency, which counts for so much in the success of any industrial concern in this competitive age.

If you are interested in the distribution of light through Factrolite, we will send you a copy of Laboratory Report—"Factrolited."

MISSISSIPPI WIRE GLASS CO.,
220 Fifth Avenue,
St. Louis. New York. Chicago.

Alumni Notes

(Continued from Page 146)

Ralph Waldo Elden, c.e., '05, advertising expert and author of several widely circulated advertising booklets, committed suicide last June by hurling himself off a 300-foot cliff at Elk Roock into the Willamette river near Portland, Oregon, so we learn from the "Palm" of Alpha Tau Omega. He was missing June 3, and his body was found two days later in the river. He had been in a highly nervous condition for several weeks. He was strongly temperamental, with imagination and vivid loyalties. Scores of half burned cigarettes and a litter of torn letters on the cliff indicate that he spent considerable time there, where his automobile, coat and hat were found.

Born February 11, 1879, at Elburn, Illinois, he attended the Elgin academy before coming to the University, where he was a member of Alpha Tau Omega, Sigma Xi, Phi Pi Epsilon and was manager of the Illio. After graduation he was with Dolese & Shepard Company, Chicago, for a year, then secretary and later assistant engineer of the state highway commission, Springfield. In 1907 he held an editorial position on the Engineering Record, and next year was secretary of the New York state highway commission. In 1908 he took up farming and seed producing and moved to Oregon, but in 1910 returned to Elburn, Illinois, where he was a member of the Elburn Coal and Lumber Company. In 1911 he returned to Medford, Oregon, and was connected with the Northwest Finance Company of Portland until a year ago, when he resigned to open an advertising office.

Benjamin Bruce Shaw, r.e., '11, newly appointed contracting engineer with the Robert & Shaefer Company, Chicago, of which Warren R. Roberts, c.e., '88, is president and E. E. Barrett, c.e., '93, vice president. Shaw has been mixed up pretty generally in railroad work ever since his graduation, his last connection having been as chief engineer of the Cuba Railroad on the island of Cuba. His big job there was the building in record time of a 61 mile branch line from Camaguey to Santa Cruz del Sur on the south coast. Mr. Shaw told entertainingly in a recent issue of the "Railway Age" of his adventures in building this road. Before going to Cuba in 1922, Shaw had been rodman, assistant engineer, and division engineer of the Arkansas-Louisiana division of the Chicago, Rock Island & Pacific. He was born in 1886 at Canton, Illinois.

J. E. Pfeffer, m.e., '96, has offices as a consulting engineer in Chicago.

J. F. Kable, m.e., '99, is chief engineer for the Pacific Iron Works of Portland, Oregon He taught engineering drawing at the University from 1899 to 1901.

C. L. Eddy, r.e., '00, professor of railway engineering at Cleveland, Ohio, will probably be chosen president of the athletic association there. He has been chairman of the faculty committee on athletics for several years.

W. P. Ireland, c.e., '03, is a civil engineer in Chicago.

S. Thompson, min.e., '04, is chief engineer for the Illinois Zinc Company of Peru, Illinois. He makes his home in La Salle.

C. L. Comp, c.e., '05, is engineer of construction for the Anthracite Bridge Company of Scranton, Pennsylvania.

E. R. Troche, m.e., '25, is in refinery design work with the Standard Oil Company at Whiting, Indiana. He says that the engineering department at the Whiting plant is about 80 per cent Illini.

Beggs' Apparatus

(Continued from Page 152)

vestigating very complex structures. The writer likes the following statement made by F. E. Richart in his discussion of Beggs' paper.

"This method, in showing the actual deformation of a miniature structure, appeals directly to the physical sense, and enables one to visualize the action of the structure."

* *Proceedings Am. Concrete Institute.* 1922. p. 58.

MATHEMATICALLY SPEAKING

Two men, P and Q, are seated at a four place table, in a cafe, Q drinking twice as much as P. It follows that Q's path will deviate more from a straight line than P's. Why?

At a given moment, at one extremity of the room, Cosine, the dancer, appears. She rotates on her axis and revolves about the room, disrobing as she goes. As she removes each parenthesis, she exchanges signs with the men located at different points in her locus. With each successive revolution she approaches nearer and nearer to the table where P and Q are placed. P is in his normal form, but Q has an unknown expression on his face. Suddenly Cosine, plotting all the time, reaches the maximum point in her dance, remains stationary a moment and then disappears. Q rises and traverses the same path, but with more unequal slope, and comes to her dressing room. He knocks (n) times and then projects himself into the room.

Another man whom we will call Y is standing motionless at the point of intersection between Cosine's glance and Q's. He has a revolver in his hand whose angle is such that if the trigger were pressed, the projectile would intercept Q.

"L," mutters Q, "What's this man's function?"

"He is my husband," cries Cosine, "Go!"

"L," mutters Q again, "A relative error!" But instead of going he moves forward toward Cosine one unit.

It is left as an exercise for the pupil to finish.

—*The Transit*

"What's the matter, little boy?"

"Ma's gone and drowned all the kittens."

"Dear me! That's too bad."

"Yep, she—boo-hoo—promised me I could do it."

Two students were laboring in the foundry. The instructor went up to one of them and said: "Look here you! your partner's cutting four times as much sand as you are."

"Well," came back the student, "Don't blame me. I've told him about it a half a dozen times already."

Elevated Curves

(Continued from Page 128)

tically no bond, and no steel across the longitudinal joint.

The steel center strip was set by measuring from one of the outside forms a distance equal to 9 feet plus one-half the widening at that point; a simple problem, but one which could be trusted to no one whom I have yet found on such a job. Half a distance in feet and inches, added to 9 feet (plus a correction for a broken tape) meant trouble unless the inspector did it.

The consistency of the concrete is the most important single item affecting the labor involved in such a curve and the quality of the finished job. The mix should be as dry as possible and still be workable. The consistency should be as uniform as possible as one wet batch will cause untold trouble with a steep cross-slope. The mixer operator has a most important part to play, and a difficult one, especially when the moisture content of the aggregate varies.

To obtain a cross-section even approximating that required, means continuous and conscientious effort on the part of the finishers. The concrete must be dragged up from the low side by floats where slump occurs. Where the rate of super-elevation is appreciable, concrete must be carried back and placed against the upper form-line. Care must be taken to remove the ridge at the center of the pavement caused by slump against the center steel. Unless considerable care is exercised, the lower half of the pavement will present a concave upper-surface instead of one which is convex.

During the past summer, the paving outfit with which I worked used a much better method of filling the widened portion of the curve than that of carrying back concrete in buckets. On this job, the mixer placed concrete for the full width of the pavement. This was much more rapid than the other method and, consequently, a better bond was secured between the 18 foot portion and the widening. Men with shovels carried back what little concrete was needed to fill the space left when the temporary forms were removed. On one curve having a super-elevation of three-fourths inch per foot, it was necessary to place a plank track about 4 inches high for the lower tread of the mixer. This was made necessary by the loss of material from the lower side of the skip as it was raised, and also by the mixer operator's inability to swing the boom up the slope.

As you drive over one of Illinois spiraled super-elevated curves, do not criticize too severely the riding qualities of the finish of the slab. The dfificulties met in the construction of such a curve explain and make excusable slight superficial faults.

First Co-ed: "Why didn't you find out who he was when the Prof. called the roll?"

Second Ditto: "I did try to, but he answered to four different names."—*The California Engineer.*

"She's very photographic."

"Really?"

"Yes, sits in a dark room and awaits developments."—*Mass. Tech. Voo Doo.*

She: "I'm telling you for the last time that you can't kiss me."

He: "Ah, I knew that you'd weaken eventually."

Fresh Frosh: "See that man over there? That's the captain of the team."

Second: "Yes?"

"See the pipe in his mouth?"

"Uh, huh."

"See the smoke coming out? It's lit."

"Sure."

"Well, he did that with my match."

—*Brown Jug*

CALORIES

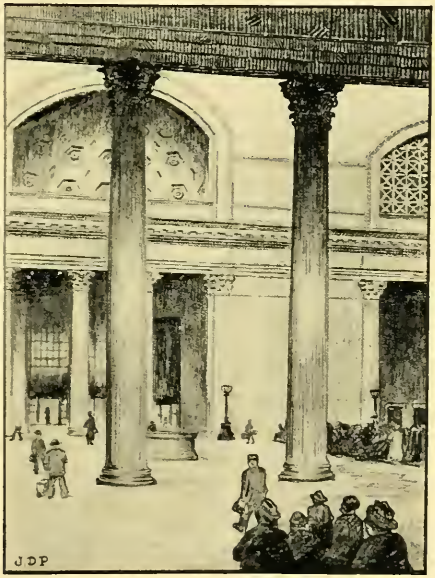
Batty: "Betty do you smoke?"

Betty: "Almost."

THE

TECHNOGRAPH

PUBLISHED QUARTERLY BY THE STUDENTS OF THE COLLEGE OF ENGINEERING UNIVERSITY of ILLINOIS



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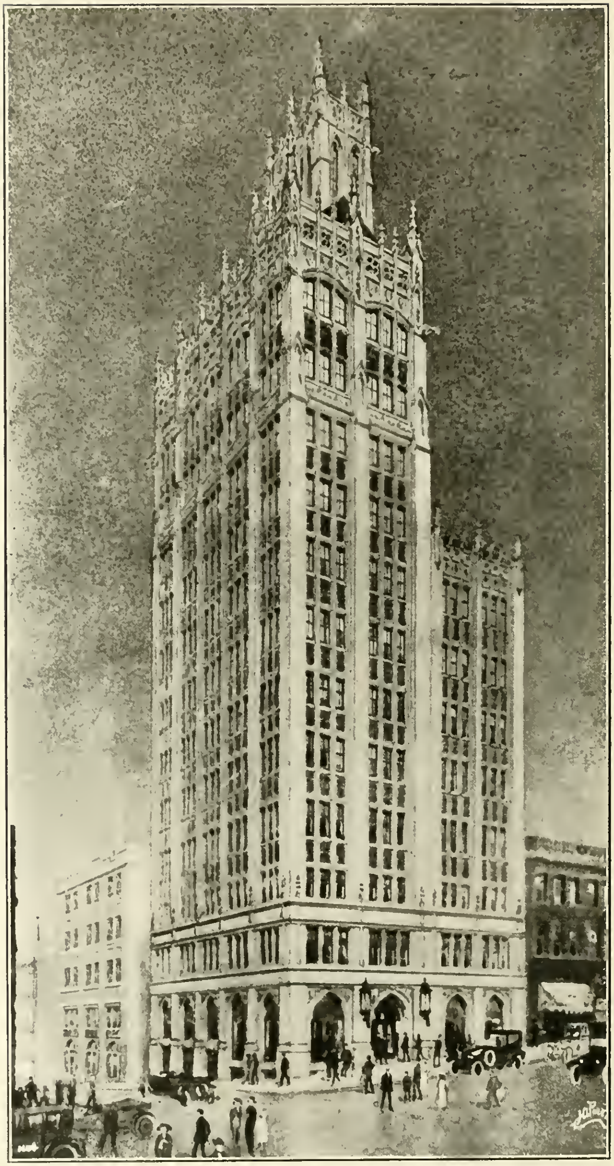

THE JACKSON OFFICE BUILDING

THE TECHNOGRAPH

Published Quarterly by the Students of the College of Engineering—University of Illinois

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The Jackson Office Building

C. F. Hendrick, c.e., '26

First Prize, Shaeffer Competition 1925-1926

The L. B. Jackson Office Building at Asheville, N. C., was built in 1923 and has the distinction of being, in a sense, the highest building of its type east of the Mississippi, since its base rests high in mountains at an elevation of 2500 feet above sea level. The building was designed by Ronald Greene, an architect of Asheville, and the structural steel frame was designed, fabricated, and erected by a local firm, the Asheville Supply and Foundry Company. Architectural publications throughout the country have commented favorably on this building as an example of the adaption of Gothic Architecture to the design of office buildings of slender proportion, and it is almost unique in that its construction is fireproof, there being no wood or other inflamable material in the entire building. The exterior walls are built of face brick, terra cotta, and hollow tile, and the windows have steel sash. The frame is of structural steel, the floors are made of concrete with metal lath and joists, and the partitions are constructed with studs of pressed steel channels and metal lath. All of the interior finish work such as stairs, doors, and moulding is also of steel construction. A photograph of an architectural rendering of the completed structure is shown on frontespiece. In it the facade and the general view of the building are faithfully shown. Attention is called to the fact that the building is somewhat wider below the tenth floor.

The writer was employed by the Asheville Supply and Foundry Company for a little over two years prior to September 1924, as draftsman and engineer and it was during this period that he worked on the Jackson Office Building. The general structural design was made by J. B. Hutchings, of Louisville, Ky., who was at one time connected with the office of the University of Illinois Architect, and the work of detailing, checking, and detail designing was done by Mr. Hutchings, the writer, and others. The blue prints submitted with

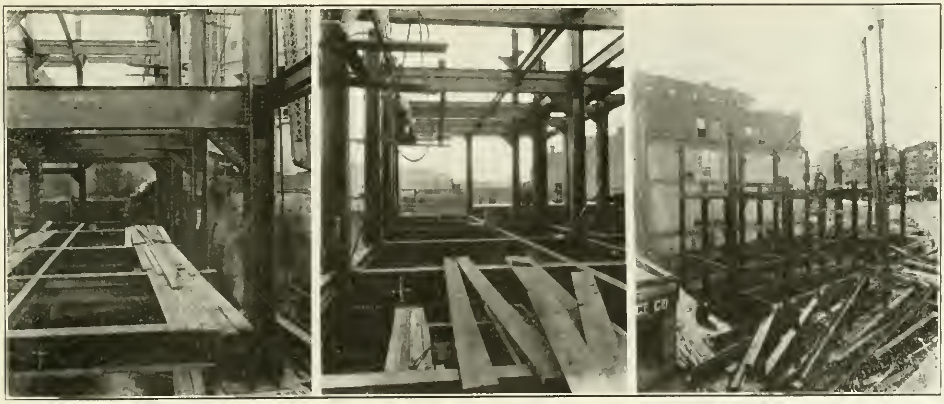

Figure 1 | Figure 2 | Figure 3

this paper were selected by the writer as being typical of the more interesting parts of the design and detail. They are from the files of the Asheville Supply and Foundry Company and from a part of

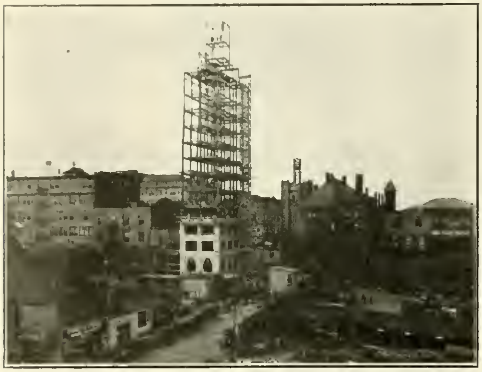

FIGURE 4

the set of one hundred and seventy-five sheets that were drawn for this job.

As is shown in Fig. 6 the Jackson Building is rectangular in plan, measuring 23′-5″ by 60′-0″ and is approximately 200′ high. It contains 247 tons of structural steel and 35000 rivets. The columns are H sections manufactured by the Bethlehem Steel Company and all except the minor beams were rolled by the same mill. The Bethlehem shapes were selected because they are lighter than Standarde shapes for a given strength, and because the beams have wider flanges which facilitates the detailing where brackets are used for wind bracing. The cost of the structural steel work on this job was $135 a ton, distributed about as follows: steel, $60; erection, $40; fabrication, $30; engineering and overhead, $5.

The structural steel work on this building was unusual in several respects. The frame was so very narrow in proportion to the height, the proportion being almost 1:10, that wind stresses became of real importance. Then there were a number of complications due to the architectural requirements, and a mistake in estimating the required length of the first tier of columns caused trouble in detailing.

The design and construction of the wind bracing presents, perhaps, the most interesting feature of the job. Several methods of providing this bracing were investigated, but the only suitable method was the use of brackets. The arrangement of the offices was so irregular that it was out of the question to employ truss bracing and there was not sufficient clearance at the heads and sides of the windows for deep spandrel girders or long knee braces. The analysis for wind stresses in the columns and beams was made graphically, considering the building as a cantilever truss. The writer does not know how the brackets were designed or by what method the wind stresses were distributed to the various bays, but the photographs, Figs 1, 2, and 3, and the detail drawing, Fig. 5, illustrate the type of bracing that was used. Brackets, top and bottom clip-angles, and a variety of special connections were used. The provision against wind stresses was made complex by the eccentric spacing of the columns. Looking at Fig. 6 it is seen that the columns are out of line both the length and breadth of the building. This caused, in the case of the main floor-beams, an eccentric connection at one end, and in order to reduce the moment in the columns these were staggered one above the other. Fig. 6 shows this arrangement in the plans and Fig. 5 is a detail of a column provided with connections for these staggered beams. It will be noted that the beams framing into this particular column are on center at the basement, side connected at the first floor, and on center again at the second floor. This scheme is carried out for thirteen stories. Wind bracing by means of brackets is the most expensive of all the methods that were studied. The clearances for riveting are small and the rivets are numerous. And where the work is contracted at a fixed price per ton as was the case on this job, the number of rivets and the shop labor required for fabricating a ton of brackets runs to a high figure. As bracing, though, the bracket is good. There is no perceptible vibration in the tower of this building even when the wind is blowing a gale.

As mentioned before, the first tier of columns was ordered too short. This brought about a peculiar situation where the basement floor-beams con-

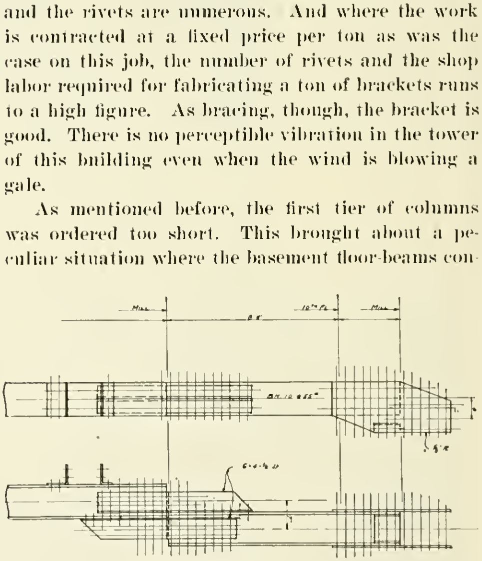

FIGURE 7

nected to the columns. The clearance between the bottom of these beams and the top of the column footings was so small that the beam connection, the wind bracing, and the column base and anchor bolt framed together at the same place. This connection is shown in the right foreground of Fig. 1. In this case the beam connected to the center of the column and was joined by means of a forked gusset plate so constructed that the nut of the anchor bolt could be reached. It will be noted that the gusset plate is double and serves three distinct purposes. It connects the beam to the column, it provides wind bracing, and it acts as a seat and stiffener for the anchor bolt. On the adjacent exterior column, barely discernable in Fig. 1 but shown on the detail in Fig. 5 the floor-beam connects on the side of the column and rests on a seat fastened to the guessets at the base of the column. The typical provision for a floor-beam connecting on the side of a column is seen just above this connection, at the second floor line.

Another unusual condition was encountered on this job at the tenth floor where the building becomes smaller. The exterior columns all around the frame were moved inward about nine inches. The problem consisted of designing a splice that would transmit to the lower section not only the 150 kips compression but also the moment due to the eccentricity, and at the same time be within the limits of the outside wall and the office room wall. No detail photographs were made of this point after erection, but a general view of the splicing is given in Fig. 4 on the left hand side and the detail shop drawing of a typical column at this point is shown in Fig. 7. The column in Fig. 7 is perhaps of more interest than the others because it is a corner column and hence has two offset splices, one on each horizontal axis. Wherever it was possible to do so the floor-beams were connected to the lower section of the column immediately under the splice and served as a seat for the upper section of column. Fig. 7 gives some idea of the difficulties met

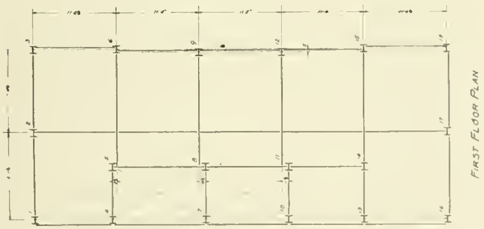

FIGURE 6

with at this stage in the construction. The columns were off center, the beams were off center and at different elevations, and with it all, provision had to be made for wind bracing, attachment of terra cotta and brickwork and supporting the exterior wall at each floor.

The erection of the structural steel frame of the Jackson Building required about five months time for an erection crew of fifteen men. The work was begun in the summer of 1923 and was finished just

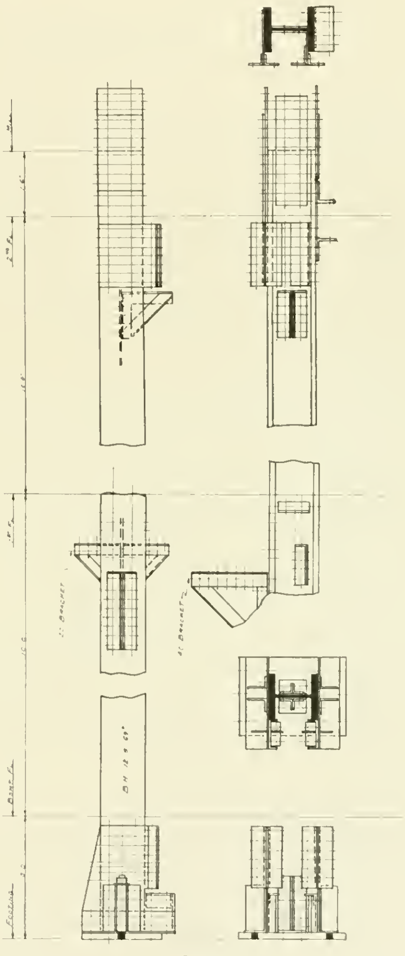

FIGURE 5

before Christmas of that year. The equipment used in erection consisted of a steel guyed-derrick, Fig. 3 and a smaller derrick of the stiffleg type which is shown on top of the building in Fig. 4. The building was erected, plumbed, and riveted in two-story sections. Fig. 4 shows the type of scaffolding, or stageing, used by the men who did the riveting. Almost two thirds of the total number of rivets on

(Continued on Page 216)

Construction Engineering

J. H. Ellison

President Associated General Contractor of America, Vice-President Winston-Dear Co., Contractors, Minneapolis, Minn.

(Before Student Chapter A. S. C. E., May 6, 1926)

I presume that you all know that Construction is probably the oldest, and is certainly next to the largest industry of the world. Only Agriculture surpasses it in the number of persons employed and in the volume of expenditure per annum. The importance of its contribution to the public welfare, therefore, makes it doubly important that its work should be well done, and that its votaries should be both qualified and efficient. Incidentally, don't make the mistake of believing that these two adjectives are synonyms.

Construction has three direct agents; the Architect, the Engineer, and the Constructor. The last named agent is generally called the Contractor—a title which does not at all define his function, and hence leaves much to be desired in that respect. Let us hope that the word "Constructor" will ere long come into general use. The specific function of the first two agents is to design and supervise; of, the last, to execute.

We have always recognized the necessity of technical training for architects and engineers. It is only in comparatively recent years that we of the United States have come to realize that the Constructor must, of equal necessity, have proper training to adequately meet the requirements due to the immensity and complexity of much of our modern work.

I can recall the time when the highest rating given a "Contractor" by the general public was that of a "rough-neck," and those qualified for even that low social rating were supposed to be rare. Most of us were regarded as potential, if not actual "crooks." This situation has radically changed in recent years—the "rough-neck" has practically disappeared and, while the "crook" like the poor "we have always with us," we are glad to be able to say that the proportion of honest and reliable constructors to those of the other class will compare favorably with the relative proportions of the two groups in any other important industry.

Most of the more important constructing organizations are made up today of men technically trained, a large percentage of their membership is of college graduates, principally from engineering schools. The successful builders, who are not college men, have acquired their technical education in the "school of hard knocks," and by study in their otherwise idle hours.

The art of putting into tangible form, the vision of the architect or engineer, is as justly denominated a profession as that of either of the designers. It is true that there is some overlapping in the distribution of the responsibility for perfecting the structure or work. The designer and supervisor must work hand in hand with the builder if the finished job is one to which either or both can point with pride.

For the further purposes of this talk, I shall use only the terms "Engineer" and "Constructor" in referring to the triumvirate of construction. When I say "Engineer," you may apply that term to either architect or engineer, as the particular case demands. Monuments to the ability of that triumvirate to conquer most of the known forces of nature and harness them for the benefit of mankind are distributed in rich profusion over the entire civilized world. It is the function of the engineer to visualize the project as a finished whole. He must possess the requisite skill to transcribe that vision on paper, in the form of drawings and specifications—so that others can read and understand. It is the province of the constructor to translate that vision, thus depicted, into a tangible and material object, useful for the purpose for which it was designed. The Engineer is, in his function as engineer, very little concerned with methods; what he seeks is results. The Constructor is also interested in the result, but he is more immediately concerned with methods because this is his part of the job.

The owner—to use a short term to designate the individual or agency which furnishes the funds for a construction project, and who expects to use and operate it when completed—is generally interested only in two things:— First, what will it cost? Second, will I be able to utilize or operate it when completed, all conditions considered, at a profit? The successful Engineer as his adviser, usually after consultation with the Constructor, must be able to answer with sufficient accuracy the first of these questions, and give useful assistance in finding the answer to the second.

Many important projects are inaugurated and carried to satisfactory completion today that would have been impossible of profitable accomplishment thirty years ago. Improved methods and machinery, coupled with a largely increased demand for large developments in the whole field of construction, has made this possible. Take one illustration—the development of the modern steam shovel, together with the requisite equipment for making long hauls of excavated materials, has made possible the build of railroads with easier grades and reduced curvature and distance, resulting in great economy of operation. Under the old methods of railroad grading the expense of that type of construction was prohibitive.

It is my opinion that the field in which the engineer, as such, will function most largely as a constructor for the present and for the future is in the designing of better machines and better methods for doing the work that lies before us.

There is today, and always will be, an insistent demand for men, and particularly for young men, of executive ability—men who have not only the ability to visualize the right consecutive processes of a job from start to finish, but also the ability to know and handle men and inspire them with at least some degree of their own enthusiasm for and consecration to their chosen work.

Most, if not all of you, will go out of your college to take subordinate positions in engineering and will probably soon be intrusted with the supervision of some contract job. First of all, do not forget that you are occupying the position of an umpire—that in your requirements and decisions you are charged with the responsibility of seeing that substantial justice is rendered to both parties to the contract. Too many young men leave the technical schools under the mistaken impression that when employed in responsible charge of contract work, their sole duty is to protect their employer against the rapacity of the Constructor.

Time-honored custom includes in many construction contracts, conditions intended to be used as clubs when needed, and quite generally "more honored in the breach than in the observance" by the older and experienced engineers. I repeat that your responsibility in your position is to do your best to see that both parties get a square deal. Your judgment should of course be guided by the conditions of the contract, but try always to read the spirit as well as the letter, and make your decisions in accordance with that spirit.

One of our earlier engineers is reported to have begun his address at an engineers' banquet, thus:—

> "There are three essential qualifications of the successful engineer. The first is Good Judgment; the second is Good Judgment; the third is Good Judgment."

There is more than a thread of truth running through his characterization. If you always use the best judgment with which the Lord has endowed you in your decisions, you will sometimes make mistakes —we all do; but you will be using that which is your own and which will grow better and better by use, and only by use. Don't be afraid to have convictions, and to practically apply them to your job.

There are two types of men who have visions—one who has a beautiful dream which cannot be practically applied to or for any useful purpose; and one who is able to translate his dream into a useful article or avenue of material service. We call the first a visionary, the second a genius. The successful engineer must belong to the second type; he may not always be of the first-water, but he must be in the class. It is further true, that not all successful engineers can make good as contracting constructors, some necessary administrative quality seems to be lacking. History is replete with proofs of this fact. Statisticians tell us that more than ninety per cent of those who embark in a revenue-producing business fail, and constructing is universally regarded as a unusually hazardous business. The business mortality among contractors (I use that title in this place intentionally because many of them were not entitled to be called constructors) during the past fifty years has been great. In view of the constantly increasing skill and intelligence among constructors today, we hope that the death rate will soon be materially reduced.

There may be among you some who hope to become constructors. To you I can say that you will be daily under inspection by constructors with whom your work brings you in contact. They will be "sizing you up," measuring you for a place which they have, or hope soon to have, to fill. To the extent that you measure up to their conception of the type of man they want, will they keep you in mind, and the one who in their mental examination has the highest markings will get the first offer of a connection. There are many points which a competent constructor considers in selecting a new man for his staff. Some of the principal ones are:—first, those of character, such as honesty, loyalty, persistence, personality, etc.; second, those of attainment, such as general knowledge, technical proficiency, etc.; and finally, those qualities that are the resultant of the combination of character and attainment, viz— ability, judgment and general dependability.

Knowledge is essential to success in any field of human endeavor, but knowledge alone is not wisdom. Tennyson says "Knowledge comes; but wis

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Significance of Municipal and Sanitary Engineering

J. C. Sager, m.& s.e., '26

To many people a Municipal and Sanitary engineer is a high class plumber. No doubt this idea was fixed in their minds as a result of passing a large plumbing establishment which bore the name of "Blank & Blank Sanitary Engineers". A plumber installs and repairs fixtures and appliances in the home or building for the handling of water and waste matter. A sanitary engineer is not primarily interested in fixtures and appliances; he is interested in the purity and quality of the water delivered through the fixtures and what is to be done with the wastes flushed from the building.

The average person seldom stops to think about the purity and quality of the drinking water he uses unless its odor or taste makes it unpotable or an epidemic is prevalent in that community. Then he takes notice and gives some thought on the subject. Much less time is spent by the average person in considering what is done with waste matter after it is sent to the sewer unless conditions become so bad that they are noticeable to the senses or some agitation is going on in the community for a bond issue to take care of a much needed sanitary improvement.

Until a few years ago, a man of medical training was considered the chief sanitarian of a community. If he were the health commissioner, it was his business to maintain conditions of sanitation that insured a healthy environment. At that time when conditions were not as complicated as they are at present, the terms hygiene and sanitation were looked upon by most people as synonymous. However, hygiene is strictly personal and sanitation is largely impersonal as its field is of the air, soil, climate and surroundings—a science of environment. From this distinction it can be readily understood that a man trained only in medical science is at a loss to fulfill a position of sanitarian of a large community. Unless a sanitarian can link the knowledge of sanitary conditions with the necessary knowledge of maintaining these conditions, he is not fitted for the job. This where the training of a Municipal and Sanitary engineer covers the field and fits him for the job. He obtains enough medical knowledge to know what health standards should be maintained in the community and has the engineering training which enables him to design and operate the facilities for maintaining these standards.

In communities of 10,000 or less, problems of sanitation are not so very involved provided the officials of the community take the responsibility of maintaining sanitation. But in a great many places of this size, the officials do not take this responsibility. They are not financially able to hire a sanitarian who is fully qualified and that is partly the reason for the backwardness of the rural and small communities in the better sanitation movement which is in progress. Let me cite a case of such a small community.

There is a small city of 5,000 located on the Desplaines River, most of the population residing about a mile from the Chicago Drainage Canal. The water supply is drawn from a deep well (or rather was a deep well as it has since been filled in with sand from the sides to such an extent, that the yield of the well is so reduced that water service is limited to about six hours out of the twenty-four) about six hundred feet from the canal. The water is pumped into a small reservoir which is in a bad state of repairs. It is not watertight and there are several privies close by. A factory in this town supplies its working force of 225 men and women with drinking water from a well on its own premises. This well is 88 feet deep. A creek into which waste matter is emptied, flows within twenty feet of this well and the well is not more than one hundred feet from the old Illinois and Michigan Canal which is a scummy, odorous channel during the summer months. Last summer about fifteen cases of typhoid fever were reported within a period of three weeks, and fifty percent of these cases were fatal and most of these drank from the factory well. After these deaths occurred, the water was chlorinated. Here is my point: had there been a sanitarian in that community who was fully fitted for the job, it is very likely that there would not have been any typhoid cases reported, but as it was, the local health officer was ignorant of the conditions which caused the epidemic. Such is the small town health officer—a person who tacks up the placards on homes indicating a communicable disease, orders schools closed for fumigation and compulsory vaccination of students. This is very good in its way but does not weigh enough to fulfill the needs of sanitation as are indicated by the progress of the nation as a whole. The State Department of Public Health is the only means at present of reaching these small communities but I believe a county sanitary engineer would

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The Element Illinium

H. G. Dawson, chem., '27

It was first suggested in 1913 that when the elements are arranged in a series in the order of their increasing atomic weights beginning with 1 for hydrogen and 92 for uranium, the number corresponding to each element in this series is exactly equal to the number of elementary positive charges on its atomic nucleus. The number of an element in this series is called its atomic number. The probable truth of this idea was brought out by the remarkable results of Moseley's work on characteristic X-rays. When the anode in an X-ray tube, against which the cathode rays or electrons are driven by the applied voltage, is made of different metals it is found that the resulting X-rays emitted from each metal have certain special wave lengths which are called characteristic wave lengths. Moseley found that the frequency of vibration of the characteristic X-rays of any element is proportional to the square of its atomic number. According to this arrangement the atomic number of the new element, Illinium, is 61, and was so designated prior to its discovery. The existence of element 61 was confirmed by a modification of the X-ray analysis method mentioned above.

In 1920 the Bureau of Standards mapped the arc spectrum of the elements, and in doing this work, data on some of the rare earth elements was taken from observations on samples which had been procured from the laboratory of the University of Illinois. These samples had been obtained by extensive fractional crystallization of salts obtained from monazite sand residues. In the course of the investigation it was found that the samples of neodymium and samarium, (elements 60 and 62) which were supposedly very pure, showed faint arc spectrum lines which were common to both samples and which could be attributed to no known element. These stray lines, which were about one hundred thirty in number, were recorded, and appeared in the Scientific Papers of the Bureau of Standards, Vol. 18, page 218. At that time the suggestion was made that these strange lines in the spectrum of neodymium and samarium might be indications of the undiscovered element, number 61.

Following this lead, fractionation of samples of neodymium and samarium was continued in the laboratory of the University of Illinois, under the direction of Professor B. S. Hopkins. Crystallizations were carried out on various salts of the rare earths over a period of several years. X-ray investigations made by Dr. L. F. Yntema in 1922 on some of the most advanced fractions, indicated that the concentration of the new element was, at that time, less than one-tenth of one percent. During the course of this work, five additional lines were found toward the violet end of the arc spectrum.

The problem of concentration was taken up by J. Allen Harris with Professor B. S. Hopkins in 1923 following the unsuccessful attempt to isolate element 61 in the material prepared by Dr. Yntema. The failures previous to this time suggested three possibilities of which the following seemed the most probable: the double magnesium nitrate of element 61 concentrates with one of the more plentiful elements on either side of it. In order to test out this theory, it was assumed that in the case of the double magnesium nitrates it was the neodymium with which the 61 salt was concentrating. Accordingly a series that had been worked over extensively by F. H. Driggs was taken and only those fractions rich in samarium were taken to continue as the double magnesium nitrate. Thus, even though the majority of the missing element might be left in the more strongly neodymium fractions, it was possible in this way to throw whatever amount there might happen to be of 61, into the insoluble end of the fractions. A concentration of the small amounts of neodymium in the least soluble fraction was obtained, but any absorption bands due to the existence of a new element if present were completely masked by the other spectra.

A second series taken from the above mentioned material was also taken, this being considerably more rich in neodymium than the one previously taken. In order to obtain a separation of the 61 from the neodymium it was necessary to find a salt which upon fractionation would force another element between 61 and 60, and if possible also between 61 and 62. An ideal case was found in the bromates, inasmuch as neodymium and samarium are forced apart leaving 61 with an element on either side of it giving little or no absorption in the visual spectrum.

On fractionation of this salt, Harris and Hopkins were soon able to pick up a very faint line in the absorption spectrum which did not correspond to any charted line for the two neighboring elements, but which had been assigned as a weak line of neodymium. Continued fractionation however brought this line in very strong and in a position in the series where it would be expected to find 61 concentrating most. At the same time, the wave length of this band corresponds very nicely to where one would expect that of 61. Further fractionation yielded two more bands both of which fit nicely into the curve of occurrence of absorption bands. Material showing this band most strongly was therefore taken for X-ray analysis, together with the head fraction of the first mentioned series, which although not showing any absorption would not be expected to do so inasmuch as the neodymium bands completely masked the wave length of the new bands.

In order to verify the presence of element 61 in this material, an X-ray spectrograph was designed by Dr. Yntema after the Uhler model with which he had done previous work along this line at Yale. Lack of funds prevented a most modern equipment being installed; hence it required some time to obtain results. After several alterations and mishaps particularly in having the tube break at inopportune moments, plates were obtained which showed definitely the line of L alpha of 61 as calculated from Siegbahns values. This line shows faintly but distinctly on two plates from each of two samples of material. The lines vary from the calculated value by plus thirty to minus forty ten thousandths of an angstrom unit. The claim for the presence of the new element is based on three separate points of evidence.

1. The presence in the arc spectrum of one hundred thirty-five lines whose wave lengths do not check with those shown by any known element.

2. The presence in the absorption spectrum, of the intermediate fractions between neodymium and samarium, of a band at 5810A, where the band of 61 should appear.

3. The presence of faint X-ray lines from two fractions in the position corresponding, within the limit of experimental error of the apparatus, to that calculated for the L alpha line.

The discovery of this new element was announced on March 8, and the name suggested for the new element is "Illinium," with the symbol "Il."

The author gratefully acknowledges his indebtedness to Prof. B .S. Hopkins and Mr. J. A. Harris for the scientific data and material presented in this article.

The Significance of Municipal and Sanitary Engineering

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fit the need where a single community could not afford to hire one. I lived in the town cited above, for about twenty years and I have never heard of any official action being taken for the removal of privies and other such eyesores, although the town is completely sewered. This is only an indication of some of the insanitary conditions prevailing but I believe it is also an indication why the increase in population for the past ten years was twenty-five.

As the size of a community increases and the population becomes more dense, the problems of sanitation become involved. Everything is on a larger scale; a larger water supply and a large quantity of waste matter to be disposed of. In small communities the collection and disposal of garbage, ashes and rubbish are seldom done systematically or by an authorized department. In cities this is a necessity to safeguard the health of the people. This is within the field of sanitary science. The collection and disposal of such matter is of economic importance to the city and any returns are clear profit. Today there are plants in operation for the utilization of these wastes, converting them into power, or obtaining grease and other valuable products. Some cities collect the wastes and sell them to the highest bidder and others maintain municipal piggeries. In Milwaukee, a return is brought from sewage by a plant which manufactures sludge cake which is rich in nitrogen and is a valuable fertilizer. Sanitary science has made this possible.

The water supply of a city is one of its most essential needs. Plenty of water is needed not only for drinking purposes but for the cleansing of the person, clothing, etc. To supply a large city with an adequate quantity of pure water is a fundamental part of the city's business. In some cases private companies supply the water but the same methods and devices are used. It is within the field of sanitary engineering to design and operate plants for the purification and softening of water and the removal of iron and manganese. A great amount of money has been invested in water purification plants and the protection of the health of the people served has warranted this expenditure. The value of this investment was first realized during the cholera epidemic in Hamburg and Altona in 1892. Both cities discharged their sewage into the Elbe River and both drew their water supply from this stream. Hamburg used the raw water unfiltered but Altona passed the water through a sand filter. Altona was downstream from Hamburg and its water supply contained sewage from both cities, but because of filtration the number of deaths was far less than in

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Present Investigation of Engineering Education

H. H. Jordan
Assistant Dean of the College of Engineering

At the annual meeting of the National Society for the Promotion of Engineering Education held at Urbana in June, 1922, it was proposed by Professor C. F. Scott of Yale University, then president of the society, that a thorough examination of the status of engineering education in the United States and Canada be undertaken. Professor Scott's proposal came as an answer to the ever challenging question, "What can the society do in a comprehensive way to develop, broaden and enrich engineering education?" Much of the talk and debate about the faults and shortcomings of engineering education at the annual meetings of the society had always been based on mere conjecture and opinion as to just what the facts really were in connection with some of the matters discussed. It was felt that as a matter of engineering procedure only it would be the better part of wisdom to get the facts before bringing the defendant before the bar.

It was proposed that the examination should be carried on under the direct supervision of the society with funds to be obtained from suggested sources. Since the Society for the Promotion of Engineering Education is composed of teachers of engineering, mathematics, English and allied subjects and of those in industrial and commercial life who have an interest in engineering education and its product, the engineering graduate, this inquiry was to be thoroughly introspective in character. In other words, it was to be "of, for and by the people" whose interests are most involved and through whom only can come changes for the better. Experience teaches that, except for the too often conventional purpose of "whitewashing" an activity or institution, this method of procedure promises most in the way of permanent results. It has enough of the impersonal in it to guarantee that it will be fair and enough of the personal to make it interesting to all concerned.

A Board of Investigation and Coordination, so-called, was formed by the Society to have full charge and direction of the investigation. Funds to the amount of $108,000 were provided by the Carnegie Foundation for the Advancement of Teaching for carrying on the enterprise over a period of three years. Mr. W. E. Wickenden, former professor of electrical engineering at the University of Wisconsin and later vice-president and coordinator of educational activities in the American Telephone and Telegraph Company, was chosen director of the investigation. An associate director and four special committees of the Society were appointed to assist in the work. Data concerning the engineering schools have been collected through the medium of a cooperating faculty committee in each college. Contacts with industry have been made through the National Industrial Conference Board. The professional engineers of the country have assisted in the investigation through their several national organizations.

In projecting this broad and well financed inquiry, the Society for the Promotion of Engineering Education was thoroughly aware of the fact that engineering education as a whole had been conducted in the past upon an essentially sound foundation. Emphasis has always been laid upon the principle of sound training in the fundamental subjects upon which professional engineering practice is based rather than upon the often overworked idea of turning out ready made professional engineers or highly skilled artisans. Unlike college of medicine and law, instruction in engineering has been from the beginning primarily undergraduate in character. Commercialized schools of engineering similar to many of the early schools of medicine, which were notoriously bad, have never found fertile fields in which to operate. The long rigorous path of practical experience which an engineering graduate must tread before he may come into responsible professional charge of engineering work, in marked contrast to the beginning of the professional life of the young M.D., effectually cuts off any chance of our technical schools being operated for private gain. No one is anticipating that the findings in the present investigation will result in anything like as revolutionary changes in engineering education as was the case in medical education following the celebrated Flexner report of 1900 in that field.

The investigation in its many ramifications has been grouped under several descriptive headings, a mere recital of which must serve to give the scope of the undertaking:

A. Relating to the past experiences and present practices of the colleges.

B. Dealing with the relationship of engineering education to industry.

C. Relations with professional organizations of engineers.

D. Studies and projects in educational psychology.

E. Investigation of engineering education in European countries.

Each of the main divisions enumerated above comprehends numerous sub-topics. For instance, there are ten distinct pieces of work to be done under the first title, included among which are the Study of Entering Students, the Study of Admissions and Eliminations, the Study of Graduates and Former Students, Teaching Personnel, Costs of Engineering Education, Engineering Curricula, etc.

Only a few of the more interesting things brought to light and emphasized thus far can be included in this brief description. Those particularly interested in the details of the investigation may read with profit the 1924 and 1925 numbers of the Journal of Engineering Education, the official monthly publication of the society.

It has been discovered, contrary to prevailing opinion, that students entering the engineering colleges come from the upper portions of the high school graduates, 60 percent of them being in the upper third of their class and only 2.6 percent in the lower third. These students are rated as doing well in the subjects of the high school curricula which are thought to be essential to success in studies of the engineering college.

Only three out of every ten students entering our engineering colleges survive and graduate from an engineering course in four years and not over four of the ten ever graduate from any college course. This heavy mortality seems on first thought, to indicate, an alarming condition of affairs. It has not yet been shown, however that any lessening of the rate would have occurred had the same students entered pre-engineering courses in Liberal Arts and Science colleges. The most serious aspect of the matter is that a third of the students who do not go on to graduation are recorded as scholastic failures while in college.

It appears from the figures available that a much larger percentage of engineering graduates remain in technical work than has been assumed by many. The civil engineers lead all other groups with a percentage of 85.8. Chemical engineers are lowest with a percentage of 61.2. The mechanicals are a bit higher at 62 percent while the mining and electrical groups show averages of 71.6 percent and 80.3 percent respectively. The figures must be regarded as tentative only since less than 50 percent of the graduates canvassed have furnished the desired information.

The initial salary received by engineering graduates varies but little for different institutions and is well typified by the class of 1924 whih reported median low salaries at $110 per month and median high salaries at $175 per month.

The part of the investigation which has attracted much attention and the interest of the teachers of engineering is that relating to "Teaching personnel." Under this heading much accurate information about the engineering teacher has been compiled and presented to the Society in the forms of salary and income curves, rates of turnover among the staffs of the various institutions, methods of preparation of the younger teachers, and other interesting facts too numerous to mention here. It does not appear from the data collected that teachers of engineering as a class are bothered with too much of the world's supply of wealth. The sources of information referred to earlier in this article will furnish those interested with first hand information concerning these matters. The salary charts are particularly interesting and informational.

One of the most worth while things of the investigation has developed from the study of engineering education abroad. In Mr. Wickenden's keen analysis of the situation in England and on the continent, there is presented a most illuminating picture of engineering education in those countries. Undoubtedly, the surprising increase in the number of technical schools in Germany as well as the concurrent increase in enrollment in these schools since the World War augurs well for the continued keen competition between engineers of that country and our own.

When the Society for the Promotion of Engineering Education meets in annual convention at Iowa City next June, there will be presented final reports of all the committees now engaged in the investigation. Engineering Education will have profited greatly from this introspective study. Many desirable changes will have been suggested but unless a definite trend toward professional education is started it is hard to see how anything revolutionary will result. Improvement in details are bound to take place once prevailing conditions are disclosed accurately and in their proper setting with attendant modern conditions of our whole social order.

Bronze Welding

C. E. Swift, m. e., '28

By the welding processes in use today nearly all of the metals, at least all of those in common use, such as steel, cast iron, malleable iron, copper and high copper alloys, and aluminum can be jointed quickly, economically, and with strengths approximating those of unbroken sections.

These processes may be identified as the hammer, the oxy-acetylene, the electric and the thermit.

The hammer process of welding is centuries old and is applicable only to wrought iron and steel. It consists in heating the ends of the parts to be welded to a white heat and forging them together on the anvil.

The second welding process, the oxy-acetylene, is the result of the accidental discovery some twenty years ago of the electric furnace method of producing calcium carbide, and the development of the blow-pipe for burning acetylene with oxygen. The temperature of the flame, 6300° F., is sufficient to quickly melt all commonly used metals, and it brought about developments in the autogenous welding of each metal that resulted in an amazingly rapid increase in the use of the process. A few years ago, before the present development of the automobile and oil industries, the manufacture of welding gases, apparatus and supplies was our third or fourth largest industry.

The third welding process, the electric, began in a small way prior to the discovery of the oxy-acetylene process and until recently its development has been slower than the oxy-acetylene, but now each process is advancing rapidly, the particular work that can be done best by each passing to it with a resulting increase in efficiency highly beneficial to the entire welding industry. Electric arc welding is done with either direct or alternating current, and on a large scale only in the welding of steel plate which with the direct current is made the positive and the welding wire the negative. The wire is brought into contact with the plate, then withdrawn about 1/8 in., producing an arc having a temperature of about 7,000° F. This fuses a spot on the plate and melts the end of the wire which builds up a deposit on the plate that solidifies as welding proceeds.

Electric welding of steel with steel rods has always produced hard brittle welds because as the steel vapor is projected through the air it is attacked by the oxygen and nitrogen and the oxides and nitrades formed seriously affect the quality of the weld metal. Recently an engineer of the General Electric Company tied a nozzle and hose from a hydrogen tank to his electrode and does the welding in an atmosphere of hydrogen. Under these conditions a faster and softer weld was made. As a practical proposition 100 lb. cylinders of ammonia are used. The amonia is run through a coil over a catalyzer which breaks up the ammonia into hydrogen and nitrogen and this is flowed around the weld, the nitrogen doing no harm.

If the oxy-acetylene process is analyzed it will be seen that that weld is made in an atmosphere of hydrogen. Acetylene when burned with oxygen frees pure hydrogen which envelopes the weld and is later consumed by oxygen from the air. That is why a good oxy-acetylene weld is always soft. The advantage of the electric welding is a greater concentration of the heat and now taken with this welding in a hydrogen bath it will make oxy-acetylene welding of steel with steel an obsolete process unless its backers are alert and in stride with these recent developments. So although this is now just a laboratory process it may in two or three years get to a practical stage of development which would then cut the oxy-acetylene welding of steel down to a minimum.

The fourth welding process, the thermit, was perhaps known before either the electric or the acetylene. The process is based on the heat resulting from the chemical reaction when iron oxide in intimate contact with aluminum is ignited. A mold is formed about the ends of the parts to be welded, an open bottom crucible is positioned above the mold and filled with iron oxide and aluminum. The intensely hot pure iron released by the reaction fills the mold and heats the ends of the steel parts to a welding temperature which solidify with the iron as one part. The process has been used only in welding of steel but some success has recently been announced in the welding of cast iron.

In welding by the oxy-acetylene, the electric arc and thermit processes, the weld areas of the base metal are completely melted. The expansion and contraction accompanying the making of these welds introduce in many cases very difficult problems. This is especially so in the welding of cast iron parts such as wheels, pipes, ribbed or webbed castings, parts of unequal thickness and very large and very heavy parts requiring considerable time to weld. The possibility that such parts would be out of alignment when the piece had cooled is so great that the common practice of nearly all large plants

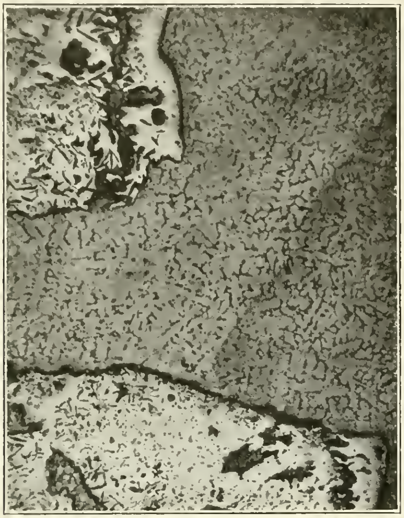


FIGURE 1.—MICROPHOTOGRAPH OF A BRONZE WELDED CAST IRON JOINT, SHOWING THE PENETRATION OF THE BRONZE INTO THE CAST IRON. MAGNIFICATION 35 DIAMETERS. *(By Courtesy of the Acetylene Journal.)*

is not to attempt to weld such parts in their own welding shop but to send them out to a shop that specializes on difficult welding jobs, and in many plants the common practice is to maintain duplicate parts of all machines or equipment liable to be broken. In the welding of steel many welders become proficient and could make welds approximating 100 per cent strength, but as a rule the intense heat required brought about such changes in structure of the metal adjacent the weld that the welded parts were liable to break near the welds.

During all these years, however, that the welding of metals has been developing by the oxy-acetylene and electric processes, it has never been possible to weld malleable iron, because once malleable iron is melted only a very poor quality of cast iron remains. Therefore, it has been necessary to repair broken malleable iron parts by brazing during which the weld areas are never brought above a dull red heat. This process has, however, owing to the use of Tobin bronze, proven remarkably successful, as the bronze melts and flows freely at a temperature under the annealing temperature for malleable iron and has a strength equalling that of malleable iron, approximating that of mild steel and from two to three times the strength of cast iron.

Tobin bronze has been one of the outstanding alloys of the past four decades, perhaps the most remarkable of all alloys. Composed of 59 percent copper, 1 to 1½ percent tin, and the remainder zinc, it melts at the remarkable low temperature of 1625° F. and has a tensile strength of 51,000 lbs. per sq. in. It is ductile and can be worked hot or cold. Today, as it has for the past forty years, it serves wherever great strains are likely to be imposed, as in shafting, on high speed bolts, and valve stems and seats, and it also resists corrosion to a remarkable degree.

Perhaps once in years in the advance of development of industry a worker stumbles on a physical fact of tremendous importance, such as the discovery that calcium carbide could be produced cheaply in the electric furnace which laid the foundation for the great welding industry of today, the economical production of acetone and fertilizers, and unnumbered by-products.

A discovery of almost equal importance to the welding industry was that molten Tobin bronze would surface alloy with clean steel, cast iron, mal-

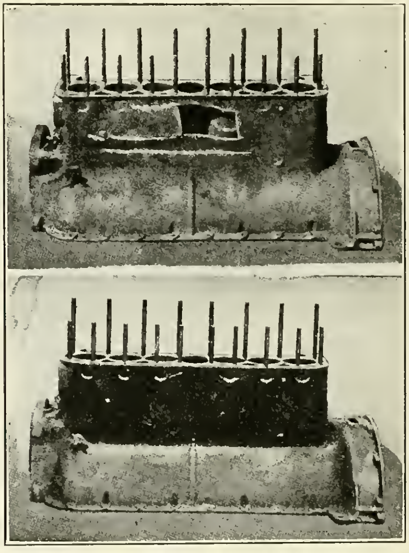


FIGURE 2.—THIS ILLUSTRATION SHOWS THE WATER JACKET WELDED AND PAINTED—AS GOOD AS NEW—AFTER BEING BRONZE WELDED.

leable iron, copper and high copper alloys at a dull red heat. No longer is it necessary to preheat the ribbed or webbed or large cast iron parts before welding, but in many cases now it is possible to make welds in place without dismantling, machining and reassembling. No longer need the unlucky automobilist turn his engine block with cracked water jacket over to the welder who blandly tells him that the job will require preheating and then regrinding and will probably cost from $10 to $60, but, unless he has a very bad break indeed, he can have it repaired in place in two or three hours instead of two or three days, and at a cost of $4 to $6.

A few months ago the transportation world was keenly interested in the account of a locomotive which had hauled a three million dollar trainload of silk from Seattle to St. Paul without change, and then turned around and hauled a trainload of valuable machinery from St. Paul to Seattle again without change. This locomotive made the round trip and arrived back at Seattle in perfect condition and then a hostler attempted to run this locomotive into the round house without draining the cylinders, thereby removing the front ends of the piston and valve cylinders almost as cleanly as if done with a great knife. New cylinders would have cost $1,700. The edges of the break were chipped off, the broken ends set back in place, and welded with bronze, and the locomotive today is in regular service and performing quite as well as before the accident. One welder effected this repair in 22 hours continuous work, using 200 lbs. of bronze.

Mr. Morehead of the Union Carbide and Carbon Corporation has set aside a fund in memory of his father who backed with all his energy and all his resources the development of the first manufacture of carbide in the electric furnace, the interest from this fund to go for the procuring each year of a gold medal to be awarded by the International Acetylene Association to the one who has done the most during the previous twelve months for the advancement of welding. At the close of the three day session of the annual meeting of the members of the International Acetylene Association held at the Congress Hotel, Chicago, in November, 1925, the secretary of the Association called upon Noah Wagner, Superintendent of the Prairie Pipe Lines, Tulsa, Oklahoma, who had been awarded the first of the medals, to state the most notable advancement in welding of the year. Mr. Wagner described the repair in place and without dismantling of two large oil pumping engines. The main bearing of one of these had been torn off, breaking eight 1½ in. bolts. Without removing this engine from the foundation and without preheating, this bearing was built up with Tobin bronze. The other engine had the air cushioning cylinder with a wall 1⅛ in. thick torn off and without dismantling or preheating it was set in place and welded with bronze. To have welded these engines with cast iron welding rods would have required their dismantling, preheating in a charcoal fire and reassembling, all of which would have taken days of time and would have cost possibly a thousand dollars or more, but with Tobin bronze, the repairs in each case were made in a few hours, saving one to two or three days of shut down.

In the great car building and repair shops of The Merchants' Dispatch Transportation Company at East Rochester, New York, is a large hydrulic press, a cylinder of which cracked a year or two ago. Instead of dismantling this press, placing the cylinder in a charcoal fire and welding with cast iron rods, the crack was cleaned and the weld made in place with bronze, saving approximately a thousand dollars.

Instances of repairs of large cast iron machine parts with Tobin bronze similar to these just noted can be found from the Atlantic to the Pacific, on steam ships, in mines, in large railroad shops, oil refineries, in fact wherever large machine tools and equipment are being subjected to severe daily use. The great advantage of the Tobin bronz welding of cast iron is that the bronze having two to three times the strength of the cast iron and being applied while the surfaces only of the weld areas of the cast iron are momentarily at a dull red heat, it is not necessary to bevel the broken edges their entire thickness but substantial portions of the thickness of the broken parts can be left in contact and the bronze flowed on, and when it cools the broken parts will be in all respects as formerly. The saving in the use of Tobin bronze rod over cast iron rod in such cases as where the use of the later would compel the dismantling, preheating, machining, and reassembling of the machine is in some cases as great as 90 to 95 percent.

The bronze welding of cast iron pipe is an art separate from all other welding process. Numerous pipe lines have been laid using bronze welding as the only method of jointing the pipes. This method of uniting the pipes has proven cheaper and more satisfactory than the old screw joint method. As in all other cases of bronze welding on cast iron the bronze is found to have penetrated the cast iron to a depth of 1/16 in. or more, as is shown in the photomicrograph, Figure I, which makes it impossible for the bronze to pull away from the cast iron. The effect of the heat on the cast iron due to the bronze welding has by numerous tests proven to be negligible.

Mr. H. Y. Carson, Research Engineer of the American Cast Iron Pipe Company, Birmingham, Alabama, has spent considerable time investigating the construction of welded pipe lines and from the compiled results suggested the following rules for welding a line of cast iron pipe:

1. The width W (Figure 3) of the Tobin bronze

weld on cast iron pipe should vary in direct proportion to the thickness of the cast iron pipe, and for a maximum strength the weld should not be less than $1\frac{1}{2}$ times nor more than $1\frac{3}{4}$ times the thickness of the pipe.

2. The thickness T (Figure 3) of the Tobin bronze weld on cast iron should vary in direct proportion to the thickness of the cast iron pipe and for a maximum strength weld should not be less than 3/16 times nor more than $\frac{1}{4}$ times the thickness of the pipe.

3. The size of the welding flame and the manner of applying the heat must be so regulated as to cause a brazing or "tinning" of the cast iron surfaces without showing excessive color of heat either in the pipe metal or welding metal. The most desirable and strongest welds have been produced on pipe where the average time of welding was limited in minutes to less than twice the outside diameter of the pipe. The average peripheral speed of applying the Tobin bronze should not approach a figure of less than approximately two linear inches per minute.

4. The bronze welded joint on cast iron pipe grows constantly stronger up to two or three hours from the time it is completed. Care should, therefore, be taken to prevent overstrains in the metal, especially during the first short interval of time directly succeeding the completed work of making the bronze weld. At this time the bronze is weak; after five hours the weld has maximum strength.

5. The length between flexible joints should be less than 100 ft. in most instances and in some instances should not be more than 30 ft., and where the soil is excessively weak and apt to settle greatly a 12 ft. or 16 ft. length should be the maximum distance between flexible joints. Installations where 75 or 80 percent of the total number of joints were bronze welded have been successful. Those lines where the bronze welded joints were from 95 to 100 percent of the total number of joints experienced trouble.

The use of Tobin bronze in the repair of cast iron pipe saves gas and water companies many thousands of dollars in the course of a year. In Figure 4 is shown such a repair at Washington, D. C.

Without question the effect on the welding of cast iron when the remarkable advantages of the use of Tobin bronze become generally known will be to make the use of the welding process desirable and economical where in thousands of cases rather than use cast iron rods with all their attendant costs of dismantling, preheating, machining and reassembling and risk of complete loss a new part of the machine is now procurred. Already in the great repair shops on the Pacific coast of the Sante Fe and Southern Pacific Railroads not only are the broken cast iron parts of the locomotive welded with Tobin bronze rods but also all other cast iron parts of machine tools and equipment. These shops have a world wide reputation for efficiency and use of latest methods and their use of Tobin bronze rods exclusively for welding any broken cast iron part makes certain that this practice will in time be universal in all shops doing welding according to the latest and most economical methods.

The use of Tobin bronze rods for the welding of steel while not having the great advantage of eliminating preheating, as in the case of cast iron, because preheating is seldom required in the case of steel, yet has the remarkable advantage of making it possible to weld steel at a low red heat only and thus avoid all possibility of contraction injuring or ruining the parts welded and of altering the quality of the steel being welded. It has been well known for some time that Tobin bronze surface-alloyed perfectly with clean steel at a red heat and that bronze has a strength approximating that of mild steel, which strength under proper treatment could be increased many thousand pounds per square inch, yet it has remained for but a comparatively few to exercise the courage and initiative required to make so radical a departure in the welding of locomotive frames as to change over from the oxy-acetylene welding with steel rods, electrically welding with steel rods, and thermit welding to welding these frames with Tobin bronze. This is not surprising as there is no weld known to the art which is subjected to greater stresses and strains of all kinds than the weld of a locomotive frame. Depending on their location in the frame these welds have to withstand the repeated thrusts of the pistons or the pull of fifty to one hundred loaded cars of fifty to one hun-

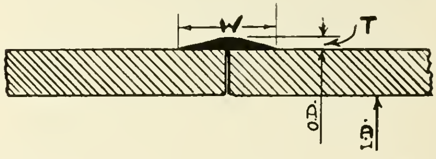


FIGURE 3.—A TYPICAL CROSS-SECTION OF BRONZE WELD AS APPLIED TO PIPE. *(By Courtesy of the Acetylene Journal.)*

dred and fifty tons each, yet the Union Pacific Railroad has at this time on one of its divisions some nine or ten locomotives with bronze welded frames, one of which, No. 3223, has three bronze welds, and none of these bronze welds have broken in a service which is now extended some nine to twelve months in some instances. The Great Northern has two locomotives with bronze welded frames one of which has been running nine months and the other two months since being welded.

Mr. J. H. Chaney, of the Georgia Railroad, reported to the spring meeting of the New York section of the American Welding Society that this railroad had several locomotives with bronze welded frames and that before proceeding with the bronze welding of their locomotive frames they had conducted a series of tests, welding 4"x4" steel sections with steel rods both by the oxy-acetylene and electric processes and with Tobin bronze by the oxy-acetylene process and in breaking these welds the Tobin bronze welds held in excess of 15 tons over either of the others. The results from the bronze welds in actual service bear out those of the tests, as the railroads report that none of these Tobin bronze locomotive frame welds have as yet broken.

An examination of the time cards covering this work show that including preparation each bronze weld was made in less than two hours, and the actual time of running in the bronze varied from fifty to fifty-five minutes. How very remarkable this is may be judged from the fact that it requires two skilled welders from four to six hours to make a locomotive frame weld with steel rods by the oxy-acetylene process. The average charge for the weld made with steel rods is for ten hours as against two hours for the weld made with Tobin bronze rods with a proportionate saving in oxygen and acetylene.

Figure 4.—Illustrations Show How Tobin Bronze Welding Rods Were Used to Seal a 13 Ft. Fracture in a Water Main at Washington, D. C. *(Photo by Courtesy of American Brass Company.)*

The procedure followed in welding with Tobin bronze is essentially the same as when welding with cast iron except that when using bronze the surface only of the weld areas of the base material need be heated momentarily to only a dull red. First, thoroughly clean the weld areas, grinding or filing off any scale. Second, make "V" opening about 25°, not 60° to 90° as when welding with iron or steel rods. Next, use a reliable prepared flux or a flux containing about seven parts boric acid to one part borax; mix a little flux with water and paint the

(Continued on Page 216)

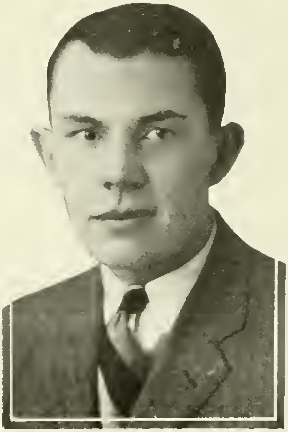
ILLINI ENGINEERS

DONALD HENDERSON BUSHNELL, c.e.,'26

Don is another outstanding man of this year's senior class and has taken an active interest in extra-curriculum activities. He has been a member of the Illini Board of Control for two years, worked on the Siren staff as a freshman and sophomore, and has been a member of the Junior Cap Committee, the Homecoming Accommodations Committee, Dad's Day Committee, the Senior Hat Committee, the Union Elections Committee, the Cap and Gown committee and Chairman of the Senior Informal Committee. He is also a member of Theta Tau and the A. S. C. E.

ARTHUR GERALD ROESKE, cer.e., '26

One of the best known engineers about the campus is "Jerry" Roeske. He is a member of Scabbard and Blade, Tu Mas, and Keramos. In his junior year he was a Lieutenant-Colonel in the Cavalry unit. He has been chairman of the Ceramics open house committee, the Ceramics Engineering banquet, and the Pan Hellenic Formal Committee. Roeske has also been a member of the Hobo Parade committee and the Senior Informal Dance committee.



ALLEN MARSHALL CAMERON, m.e., '26

"Al" is another of the very few engineers who has represented the College of Engineering in major activities. "Al" is well known because his activities cover a field on which engineers dare venture. He was a member of the Senior Informal Committee, the Senior Ball Committee, the Senior Cap Committee, the Junior Prom Committee, the Junior Cap Committee, the Sophomore Cotillion Committee, and the Gridgraph Committee. His excellent work on the Gridgraph committee won for him the position of Chairman of the same committee in his senior year. For the past two years he has been a member of the Illini Board of control.

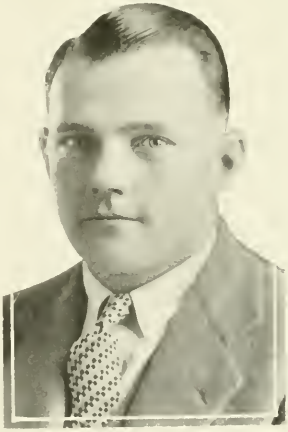
ILLINI ENGINEERS

AARON FRANK McCRORY, e.e., '26

One of the most outstanding men of this year's senior class is Frank McCrory. He has brought honor to the engineers by winning the post of Student Colonel for the R. O. T. C. Yes! An engineer can make a good soldier. Frank is a member of the Student Council and was chairman of the Military Ball Committee, the success of which was certainly a credit to his management. He was also on the Mi-Hila Committee and is a member of Scabbard and Blade.

INGRAM JONES, e.e., '26

Ingram Jones is the energetic young electrical engineer who is in a large way responsible for the great success of the Electrical Engineering show. He did a great deal for the 1924 electrical show and earned the position of manager of the 1926 show which he so successfully filled. It was a great deal of work but not too much for him. Jones is also a member of Theta Tau and the Electrical Engineering Society.



EUGENE CARTER BRAY, e.e., '26

"Gene" Bray is another active engineer and one who has not sacrificed scholarship for activities. In his senior year he was the chairman of the Engineering Student Council, and was one of the three students on the Student-Faculty Committee on the 1925 Engineering open house committee. "Gene" has also served as president of the student chapter of the American Society of Civil Engineers. He is also a member of Chi Epsilon, the honorary Civil Engineering fraternity.

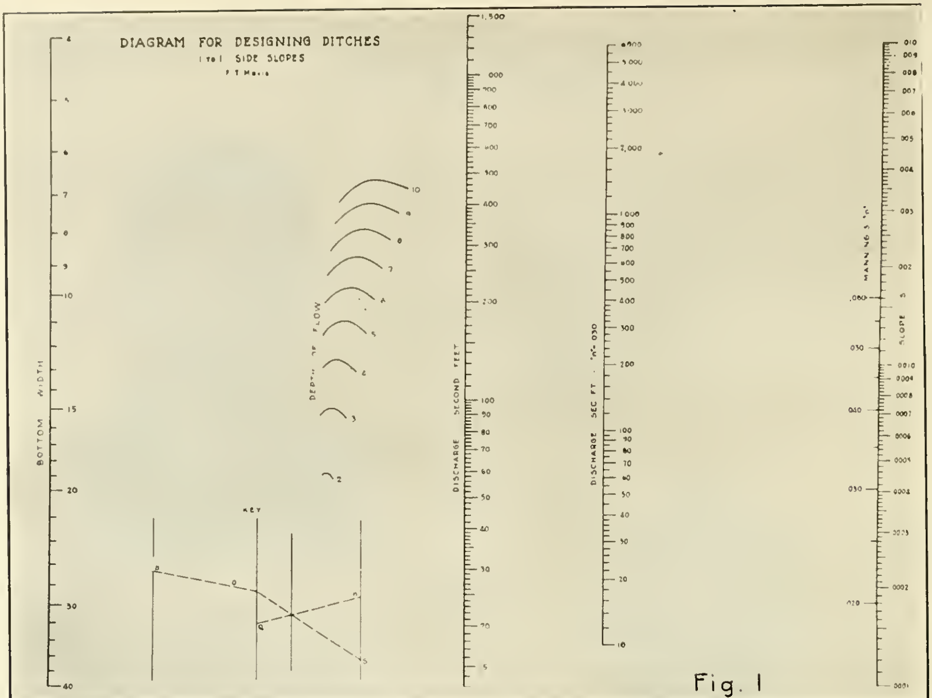


DIAGRAM FOR DESIGNING DITCHES
1 to 1 SIDE SLOPES
BOTTOM WIDTH
DEPTH OF FLOW
KEY
DISCHARGE SECOND FEET
DISCHARGE SEC FT. "N"=.030
SLOPE S
MANNING'S "N"

Fig. 1

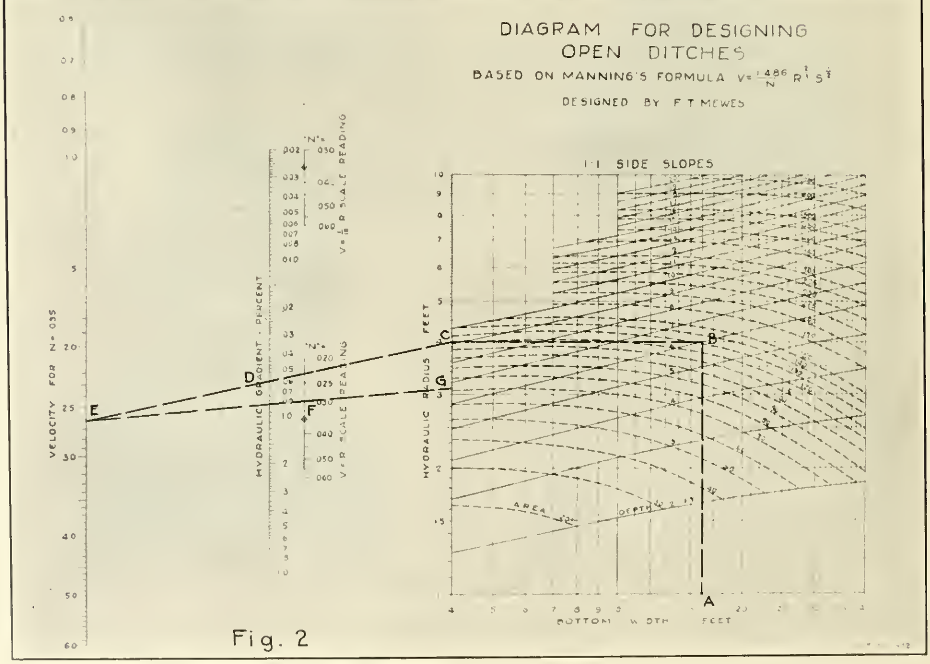


DIAGRAM FOR DESIGNING OPEN DITCHES
BASED ON MANNING'S FORMULA V= 1.486/N R^2/3 S^1/2
DESIGNED BY F. T. MEWES
1:1 SIDE SLOPES
VELOCITY FOR N=.035
HYDRAULIC GRADIENT - PERCENT
HYDRAULIC RADIUS FEET
BOTTOM WIDTH FEET
AREA
DEPTH
A
B
C
D
E
F
G

Fig. 2

Diagrams for Designing Open Ditches

F. T. Mavis (Formerly Mewes), *Graduate Student*

The complexities of many hydraulic calculations have led to the construction of numerous diagrams and tables to reduce the time and work involved. Computations of velocities by the Chezy-Kutter formula

$$V = \frac{41.67 + \frac{1.811}{n} + \frac{.00281}{S}}{1 + \left\{41.67 + \frac{.00281}{S}\right\}\frac{n}{\sqrt{R}}}\sqrt{RS}$$

would require a prohibitive amount of time were it not for tables which can be found in almost any book on hydraulics. Additional tables and diagrams have been calculated to simplify computations for open ditches with trapezoidal cross sections. Bellaisis "Hydraulics with Working Tables" (3rd Edition) and King's "Handbook of Hydraulics" are representative of the tables and Moritz "Working Data for Irrigation Engineers" of the diagrams for this purpose.

The Chezy-Kutter formula has gained a much stronger foothold among American engineers than among engineers in continental Europe. Engineers in this country think of the roughness or friction factor of an open channel in terms of Kutter's *n* and attempts to replace the Kutter formula by a simpler expression have met with only partial success.

It has been said that the Chezy-Kutter formula has two important advantages: (1) It is so involved, so elaborately entangled in its mathematical form, that many tables and diagrams have been prepared which make its use as easy and satisfactory as any man may desire. (2) It has a convincing moral effect on the engineer's client. The erudition and skill displayed by an engineer in bagging a little 8-inch pipe line by his facile handling of such a formidible mathematical siege-gun, in a report intended for the consumption of the green grocer, milk dealer or saloon keeper on a waterworks committee, must not be considered lightly; juggling with such things manifestly requires skill and training which everyone acknowledges should be paid for. This formula, properly printed, with ample leading in italics, affords an easy means of demonstrating one's skill[1].

The Manning formula has gone further than any other in replacing the Chezy-Kutter formula in this country. This formula is

$$v = \frac{1.49}{n} R^{2/3} S^{1/2}$$

in which, as in the Chezy-Kutter formula,

v = the mean velocity, in feet per second.

R = the hydraulic radius = $\frac{\text{Cross sectional area}}{\text{Wetted perimeter}}$

S = the hydraulic gradient, or slope of water surface

n = the roughness coefficient, approximately equal to Kutter's *n*.

A comparison of the two formulas is not within the scope of this paper. There can be little doubt, however, that for channels of ordinary proportions (excepting large rivers) Manning's formula is as good as Chezy-Kutter's. Results of gagings of a given channel at different stages very often show that Manning's *n* is subject to less variation than Kutter's *n*, while in about equally as many cases the reverse is true.

In the design of ditches the factors usually given are: (1) the quantity of water to be carried, (2) the slope of the bottom, (3) the depth of flow, (4) the shape of the channel i. e. the side slopes in channels with trapezoidal cross sections, and (5) the roughness factor or friction coefficient. The problem usually resolves itself into the selection of a suitable bottom width and depth of flow to carry the required quantity of water at a satisfactory velocity. The inter-relation of the factors affecting the design of ditches is fully covered in Pickels "Drainage and Flood Control Engineering" Chapter VII and will not be treated here.

The accompanying diagrams are based on Manning's formula and are arranged for calculating open ditches with one to one side slopes. Bottom widths range from 4 feet to 10 feet, and depths from 2 feet to 10 feet in Figure 1 and from 2 to 20 feet in Figure 2. Figure 1 is the more convenient for determining the proportions of the ditch section when the capacity, hydraulic gradient and roughness factor are known. It is probably the more convenient diagram in all cases except when velocities of flow are desired. The scales of bottom widths and depths in Figure 1 are complicated to the extent that a scale of areas or velocities was deemed unsatisfactory. Figure 2[2] earlier prepared by the writer is convenient for determining the velocity and discharge of a channel when the bottom width and

(Continued on Page 208)

EDITORIAL

Appreciate Your Technograph

This magazine is your magazine. Wherever it may be read, it is accepted as representative of the standards of the students of engineering at the University of Illinois. You cannot afford not to be actively interested in its quality, in the articles published, and in the policies of its Staff. Your friends in similar institutions have access to The Technograph on the exchange files of their own magazine, and their respect for Illinois and for the engineering ability you are developing will be influenced by the quality of your publication. We have the journals of the leading engineering schools in this country on our exchange files, and we invite you to compare them to The Technograph. We want you to know whether or not The Technograph is the best engineering students' publication in the country; for there is no reason why you should accept anything short of the best.

Part of the articles published in The Technograph are written by students. When an article, written by a member of the faculty, would be of great value to engineering students, the Staff considers it a mistake not to place the article before the student body. Also, we consider ourselves fortunate to be the first to secure articles upon engineering projects of national interest by professors of national authority when such articles will establish prestige for The Technograph among engineering journals. We believe it is a compliment to The Technograph to have been quoted on several occasions by the U. S. Bureau of Mines, and to find the leading, British, engineering publication, "The Engineer," desirous of maintaining exchange relations with The Technograph. Articles by faculty members should never discourage a student from submitting one; rather, the desire to place his article next to one by an older man of greater knowledge and experience should be an additional incentive to a prospective contributor. Articles written by students will always be in demand, and it is very unlikely that any good student article submitted will not be published.

Get in the Game

Don't be like the cow's tail which is always behind. Get in the game. If you are going to be an engineer, be one. You don't know of a really big engineer who isn't a member of every organization related to his work and almost without exception they are prolific contributors to the literature of their profession. These men are likewise widely known. They didn't get that way by letting the other fellow do the belonging and the writing, and they didn't get that way all in a day. They started modestly at the bottom and worked up. The time for you to begin is now. Join your student chapter and give it your hearty support. Go to the meetings and enter into the discussions. Look on your work this summer with the Technograph and the Schaefer prize in mind and write it up. You can't all make a publication, but you can all try. It is lots easier to get into a rut than it is to stay out. Don't follow the path of least resistance. Get in the game!

Summer Work

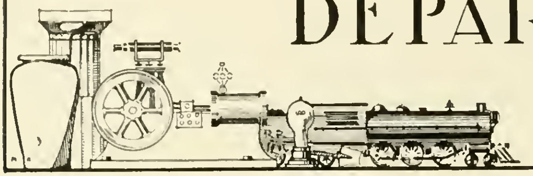
Since everyone at this time is interested in summer employment, it may be well to offer a suggestion as to the type of work for which we should look. With some of us the question of pay is the vital issue and we must take the job in which there is the most money whether it be in engineering work or not. But engineering experience is so necessary to one who plans to follow engineering as a profession that it would behoove those of us who are more fortunately situated to cast about carefully for our summer work and to make our selection more on the nature of the job than on the pay. An engineering graduate is generally sound in his theory, but he is, as a rule, weak in practical knowledge and experience. We must have both. We can't qualify as engineers in the true sense of the word until our theory has been tempered by practice, and the earlier in life that we begin to acquire our practical knowledge of the work, the better are our chances of arriving at the top.

A Suggestion for the Summer

Probably summer will find most of the engineers engaged in some kind of work relative to their particular branch of engineering, and many will find their work of sufficient interest to write about it and tell others of their experiences. Such interest is to be commended and it is hoped that more and more engineers will take such an attitude toward their work and write concerning it.

To add impetus to the movement, Mr. J. V. Shaefer, '89, has offered an annual prize for the best article on summer work. Next year the prizes will be $25 for the best article, and $15 for the next best article. The Technograph is anxious to support the movement also and is anxious to publish student articles of merit that come to its attention. We urge every engineer to write an article, for regardless of whether or not it wins a prize or is published, the writer will obtain considerable valuable training in expressing himself and in the use of English.

The Technograph wishes every engineer a happy summer, and hopes that all will come back in the fall with a complete knowledge of the work that they have been on all summer, and determined to write an article about it. The value of the experience will be well worth the effort.



DEPARTMENTAL NOTES

Mechanical

For the last seven years a careful investigation of warm-air furnaces has been conducted under the supervision of Prof. A. C. Willard. In fact, work is still going on in this field. Recently, however, the scope of heating investigation was materially widened. Now it includes also the study of direct team and hot water heating systems. Work on these systems is being supported by the National Boiler and Radiator Manufacturers and the Illinois Plumbers Association; and its condition is subect to the same general terms as were prescribed in the case of the warm-air furnaces.

Another addition has been made to the standard M. E. curriculum. It is M. E. 89, a course dealing with the heat treatment of metals. Seniors will be its victims. The department has long recognized the importance of the heat treatment of steel in modern industry, and it feels that it is making a much needed step in the right direction by introducing the new course.

Several bulletins of especial interest will be published by the Experiment Station in the near future. One of them, "A Thermodynamic Analysis of Internal Combustion Engines" by Prof. G. A. Goodenough and J. B. Baker will contain in addition an appendix on the "Analysis of the Complete-Expansion Engine Cycle" by A. E. Hershy. In his analysis, Mr. Hershy will explain the possible adaption of the Sargent complete expansion idea to the automobile engine. A second bulletin will be entitled "An Investigation of the Propagation of Flame in a Closed Vessel," and is being prepared by C. Z. Rosecrans. Also, the results of the drilling investigation being conducted in the Shop Laboratories under Prof. Benedict's direction, assisted by A. E. Hershey, will be ready in bulletin form sometime this summer.

Prof. Polson is directing three experiments in the Power Laboratory. One of them is the exact measurement of air flow through nozzles and orifices. Mr. B. J. Wilson is carrying on the work. He is using the air weighing tank as a fundamental basis for the measurement of the weight of air flowing.

Mr. H. E. Degler is doing graduate work on a Hvid oil engine. Special attention is being paid to the effect of changes in compression upon the efficiency and capacity of the engine. Timing of the fuel valve with respect to its influence on the fuel rate is also being studied.

Mr. N. J. Alleman, a senior M. E., is testing a Reo six automobile engine. He will incorporate the results of his work in the form of a Thesis. One of the items to be considered is the effect of heating the intake air before it reaches the carburetor.

For the third consecutive time the College of Engineering scholarship award has gone to an M. E. senior This time the honored one is R. W. Shields.

New Equipment

The following additions have been made to the equipment in the Power Laboratory:

(1) An 8½ in. by 11 in. Worthington air compressor driven by an electric motor. This compressor, as now installed, performs three ristinct services: First, it acts simply as an ordinary compressor; second, it operates as a vacuum machine; and third, it functions as a booster or second stage compressor. Finally, the machine supplies compressed air for starting oil and gas engines.

(2) A number of calorimeters for determining the heating value of solid, liquid, and gaseous fuels.

(3). Additional dynometer equipment. This equipment will be employed in furnishing power to a new sirocco fan donated by the American Blower Company. It will also be used to supply the necessary power for a proposed study of absorption brakes, automobile brakes, variable speed transmissions, clutches, and geared reducing units.

Mining

The University of Illinois Mining Society held a meeting at the Union Building on Tuesday, April 6, during which Mr. W. J. Putnam of the department of Theoretical and Applied Mechanics spoke on "Pumps". Mr. Putname traced the history of pumps in some detail from the old Egyptian mine pumps, up to the present day equipment. The pump at Joseph's Well was described and later pumping equipment in mining discussed. Mr. Putnam described and illustrated with lantern slides the European pumps of the seventeenth and eighteenth centuries and their use in mining operations.

After discussing the history and development of pumps, he proceeded to classify them under two main groups, the suction and centrifugal. These two groups were subdivided into plunger, piston, and turbine types Since pumps are of vital importance to mining operations, Mr. Putnam's illustrated talk was of more than usual interest.

Another meeting was held on Tuesday, April 20, at which two students of the mining department spoke. Mr. L. S. Voltz told the members of his experience as a practical mine surveyor. Mr. Young discussed "The Mining Situation."

The Mining Society presented a moving picture of mining and metallurgical operations in southeastern Missouri. The picture, "The Story of Lead," shown at 221 Engineering Hall on Friday, April 16, gave to the audience an idea of the underground mining methods used in the Flat River district of Missouri. Views of the slopes, drifts and tunnels were shown, while the mine was in operation. Methods of loading; hauling by electric locomotives; and mechanical means of dumping ore cars followed. The next scenes depicted the method of carrying the broken ore to the surface where it is charged into a large bin before being crushed. The broken ore which was crushed by large gyratory grinding machinery, is mechanically separated from gangue material and the lead and silver minerals are concentrated and refined. Other pictures of mining operations shown this year by the Mining Society were the "Story of Dynamite" and "When a Man's a Miner."

NEW APPARATUS

A Sink and Float Machine has been originated, devoloped, and constructed in the mining department laboratory for the purpose of investigation of coal cleanings. In this machine, zinc chloride solutions of various specific gravities are used ranging from 1.35-1.60. This machine is used for separating bone slate, and pyrite (high ash bearing materials) from the cleaned coal. It is used for small tests only, varying from five to ten pounds of coal.

The department has purchased an ore dressing microscope for the purpose of making qualitative and quantitative determinations of various minerals within ores and coals. It also aids in determining the physical structure of the various minerals which is so important in determining suitable cleaning and dressing operations.

An Auns coal cleaning table using air as the cleaning agent will be installed during the summer vacation. It will be used on Illinois coals in connection with experimental work on coal cleaning prior to using Prof. Parr's low temperature coking process.

The Pennsylvania Crusher Company has given the department the use of the small scale Bradford Coal pulverizer that was on exhibit at the Chicago power show in January. The department will have the use of it until the end of the year.

STOEK MEMORIAL EXERCISES

On Sunday afternoon, May 2, in the Engineering library, formal memorial exercises were held in connection with the presentation of the Stoek Memorial Tablet.

The tablet was presented to the university by Prof. A. C. Callen head of the department of Mining. The tablet was received by Prof. A. P. Carmen of the department of Physics, as the representative of President Kinley. The speakers were Elmer Allen Holbrook, dean of the school of Mines and Metallurgy of Pennsylvania State College, and Samuel Wilson Parr, professor of Applied Chemistry at the University of Illinois. Dean Holbrook was a member of the staff of our Mining department from 1913 to 1917.

Professor Talbot of the department of Theoretical and Applied Mechanics presided over the exercises. The memorial tablet was made by Lorado Taft.

Railway

Last month a test was made by a group of students and instructors from the Railway Engineering Department on the stationary plant of boiler and engine room equipment of the Peoria and Eastern Railroad Company shops at Urbana. The purposes of the test were to determine the performance of the boilers, first as expressed in pounds of water evaporated per pound of coal, second, as expressed in efficiency of the boiler, furnace and grate; and to make such determinations concerning the use of steam in the engine room that, first, rough estimates may be made regarding the distribution of the total steam used at the shops, second, rough estimates may be made regarding the performance of the engines and the air compressor.

The equipment tested consisted of two locomotive type boilers, two Buckeye engines, one Buffalo Forge engine operating a fan, and an air compressor which ran continuously during the test. The coal and water used was weighed on platform scales. The boilers were fed cold water. The exhaust steam from the engines and air compressor was collected, condensed and weighed. Indicator diagrams were taken from the two Buckeye engines and these diagrams were used as a basis for estimating the amount of steam used by the engines and by the air compressor. A stroke counter recorded the number of revolutions made by the air compressor.

The principal results from the boiler room showed 5.0 pounds of water were evaporated per pound of coal fired during the 24 hour run, the efficiency of the boiler, furnace and grate being 51 per cent. It was concluded that it should be possible to equip this plant with equipment, otherwise satisfactory, that would permit operation at an efficiency of 70 percent. The values expressing the performance of the boilers are low in comparison with good practice.

Screened lump coal from a strip mine west of Danville was used. An approximate analysis of the coal as fired was made by the Chemistry Department. A complete report, covering the operation and results of the test, has been sent to the Master Mechanic of the Big Four Railroad. The test was directed by Prof. Snodgrass, assisted by Mr. Schrader of the Railway Department. Student assistants were, Du Hing, '26; T. C. Stressor, '26; and J. H. Smith, '26.

New equipment has been purchased and is being installed in the brake shoe laboratory that will enable test motors and machinery to be run with current from the University Power plant. Until recently the power has been furnished by the Illinois Traction System from their lines adjacent to the Laboratory. A new underground lead will be run from the Power plant carrying 2300 volts, to a transformer in the Laboratory, where it will be stepped down to 220 volts to run a motor generator set, generating 600 volts direct current. This new system will enable more complete and efficient tests to be run by the personnel of the Railway Engineering Department.

Architectural

The faculty and the members of the architectural department were greatly pleased with the Beaux Arts Institute of Design judgments of April 26. G. S. Keith '27, received First Mention Placed on his design of "A Concert Hall," while W. C. Jones '27, and R. B. Mitchell '27, received first mention on the same design. Mr. Keith is the first student to receive an award of First Mention Placed in "Class B Project" since the department has been enrolled in the Beaux Arts Institute of Design. W. B. Parks '27, received a Second Medal on his archeology problem, "A Louis XV Pavilion." In the Class B. analatiques, P. K. Lehman '29, and C. V. Long '29, were awarded First Mentions. In this judgment the department made a wonderful showing, and the members are to be congratulated upon their excellent work.

In the recent senior Beaux Arts judgment of the problem, "A Carillion Tower," First Mentions were given to Roberson, Sobel, Berner, Hall, Helms, Gregg, Kramer, Chance, and Jacobson.

The Van Dort Prize in the senior class was won by F. B. Roberson, '26, and Second Prize by Herb Sobel, '26. In the junior class G. S. Keith won the First Prize. The First Prize in each class is twenty-five dollars in books, while the Second Prize is fifteen dollars in books. This is the first year that the juniors have been extended these prizes. The prizes are awarded on the basis of the Beaux Arts judgments.

On April 15th the Architectural Society was instructively entertained in the Ricker Library with a talk by Norman Brunkow, of the office of Graham, Anderson, Probst, and White, architects in Chicago. His subject was "The Design and Construction of the Chicago Union Depot." His talk was exceedingly interesting and very instructive.

The Plym Fellowship was won this year by A. R. Eastman, '23. The subject of the competition was "A Municipal Building." The fellowship consists of $1200 which is to be used by the holder to study in Europe for a year. Mr. Eastman is at present employed in the office of York and Sawyer, prominent New York architects, but he expects to leave for his European studies before long.

The American Institute of Architects medal, which is awarded each year to the senior having the best record during the four years, was won by Mary Thye Worthen, '26. Miss Worthen is the second woman in the department to receive this medal, the other one being Alberta Raffl, '23. During her four years, Miss Worthen maintained a scholarship average of over 4.5.

The Post Graduate Institute of Architecture and Landscape Architecture, which has its headquarters at Lake Forest, Illinois, has invited the department here to participate in its summer course. The Institute offers a three month course in collaborative work between architecture and landscape architecture. The students live and work together, and during the summer take an extended trip visiting, for the purpose of studying, the important cities of the middle west. Two students in each architecture and landscape architecture department from the University of Illinois, University of Michigan, University of Iowa, and Ohio State University are selected to take this work, the appointments being made on a basis of special ability and artistic endowments. The holders are provided with board, lodging and studios, and are given $100 in addition. At the conclusion of the course, a problem is taken, upon which the students work, one in architecture, the other in landscape architecture, the winners receiving a $1250 prize which is to be used in defraying the expenses of a European study.

Electrical

The E. E. Show of 1926 was held April 8, 9, 10 in the electrical engineering laboratory, the gym annex, and the woodshop. In keeping with the ideas set by its predecessors this show was bigger and better than ever.

An elaborate system of flood lighting turned the north campus into a great "White Way." One hundred and twenty exhibits were prepared by students, merchants, and manufacturing companies. These were educational, interesting, and amusing. Most spectacular of these was "man-made lightning" where the discharge of 1,000,000 volts across a nine-foot gap was shown.

The first talking movie ever exhibited, attracted a great deal of attention. The process and apparatus by means of which this was accomplished were developed here at the university by Professor Tykociner and Professor Kunz.

The show was well attended; there being a total of thirty-six hundred persons. Receipts from the show were about seventeen hundred dollars. After all expenses were paid, there remained seven hundred dollars to be placed in the student loan fund. This fund which has been accumulated by the proceeds from the E. E. Shows of the past, now totals twenty-six hundred dollars.

This show is known all over the United States and graduates of Illinois say that it seems to have attracted more attention to our Engineering school than anything else. Pathe and International news-reel producers sent cameramen to Illinois to take pictures of this show.

The splendid success of the show was due to the co-operation of students, faculty, merchants, and the manufacturers, who contributed whatever they could to the show. The board of managers under the direction of Ingram Jones did a wonderful piece of work.

Civil Engineering

Schaefer Prize

Mr. C. F. Hendricks '26, has been awarded the Schaefer prize for this year. This prize is offered annually by Mr. J. V. Schaefer '88 of Chicago, a graduate of the Engineering College. Each man competing for this award must submit an engineering essay on some work he has been connected with illustrated with photographs and sketches. The article which won the competition was on "The L. B. Jackson Building, Ashville, North Carolina". This building was a small structural steel sky-scraper with which Mr Hendricks was connected in a technical capacity.

A. S. C. E.

The Central Illinois Section of the A. S. C. E. have presented E. C. Bray and C. F. Hendricks, seniors in the department, with an award for scholarship and work in the student chapter. This award consists of the initiation fee and one years dues as a Junior member of the A. S. C. E. It has been through their efforts that the program of the student chapter has been so good this year. Nearly every meeting was well attended and the talks were always very interesting as well as instructive. Now is a good time for the freshmen, sophomores and juniors to get lined up with the student chapter and help make next year's program as successful as the meetings have been this year. Join now!

Notes

Professor Vawter recently attended a meeting of the American Railway Engineers Association in Chicago. Mr. Vawter is a member of the committee on "Roadways".

Professor T. D. Mylrea has recently presented an article on "Bond in Reinforced Concrete" before the Western Society of Engineers. This article was published in the January issue of the Western Society's Journal.

Professor Wilson made a trip to Madison, Wisconsin, to carry on some experiments in the laboratory of forestry.

J. D. Voorhees '26, and A. Masterson '26, were the winners of the I. O. Baker prize this year winning first and second respectively. The prize is awarded annually to the two best all around students of the department by the late I. O. Baker, Professor Emeritus of Civil Engineering.

General

The General Engineering Society held a meeting and election of officers in the Union Building on March 10. The following officers were chosen for the second semester: president C. M. Kreider, '27; vice president, I. R. Linnard, '28; secretary, H. O. Hale, '28; treasurer, H. J. Nebeck, '28.

H. C. Stearns, retiring president, spoke of the plans for the future and of the work which the General Engineering Society has before it. It was decided that the meetings should be

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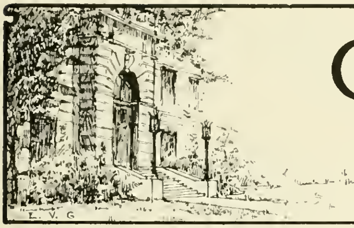

COLLEGE NOTES

A. I. E. E.

The first meeting of the school year was a joint meeting of A. I. E. E. and the E. E. Society. At this meeting Professor E. B. Paine, head of the department of electrical engineering, presented a paper entitled, "Recent Developments in the Public Utility Field." In this paper, Professor Paine discussed the conventional designs of cables used in the past for the transmission of electrical power through underground cables, the special problems which arise in the design of cables for high voltages, and gave explanations of some of the features of the cables for 133,000 volt three phase current which are soon to be installed in Chicago.

The second meeting of the years was also a joint meeting with the E. E. Society. The address at this meeting was by Mr. W. A. Durgin, the director of public relations for the Commonwealth Edison Company of Chicago, and was entitled, "A Message from Herbert Hoover." Mr. Durgin was formerly associated with Mr. Hoover in Washington, and in his paper he told of the important work done by Mr. Hoover's department in determining the factors tending to inefficiency and waste in important industries . Many diagrams and curves were shown to illustrate hte great savings have already been made in many of the cases which have been

The third meeting of the year, at which Mr. R. E. Doherty, consulting engineer of the General Electric Company at Schenectady, New York, spoke, was held jointly with the Physics Colloquium. At this meeting Mr. Doherty spoke on the subject, "Mechanical Force Between Electric Circuits." In his talk, he outlined the method of analysis by which it was possible to determine variations in mechanical forces existing between electrical circuits during the cyclic changes of current. The analysis was sufficiently general to include the circuits on rotating machinery as well as circuits that are not connected with moving machinery.

Notes

Several members of the College of Engineering faculty attended the meetings of the American Concrete Institute which were held in the Hotel Sherman, Chicago on the 24th, 25th and 26th of February.

A paper entitled "Formulas for the Design of Rectangular Floor Slabs and Supporting Girders," was read by Prof. H. M. Westergard of the department of theoretical and applied mechanics. The others who attended the meeting were: Prof. A. N. Talbot, head of the department of theoretical and applied mechanics; Prof. M. L. Enger, Prof. R. L. Brown, Prof. F. E. Richart, L. J. Larson, and A. Brandtzae of the department of theoretical and applied mechanics; and Prof T. D. Mylrea of the department of civil engineering.

Prof. H. F. Moore, research professor in the department of theoretical and applied mechanics, recently returned to the campus after making a speaking and business tour through the eastern states. While on his tour he spoke before the American Society for Steel Treating in Syracuse and Schenectady, New York, and attended a meeting of the committee of mechanical testing of the American Steel Treating Association in Philadelphia.

Prof. J. T. Tykociner, of the department of electrical engineering, read a paper entitled "Short Wave Transmitters and Antennae Models" at a recent meeting of the Chicago section of the Institute of Radio Engineers which was held in the hall of the Western Society of Engineers in the Monadnock Building, Chicago. Prof. Tykociner will be assisted by L. P. Garner of the department of electrical engineering in presenting another paper on a new wave-meter.

Prof. Hardy Cross of the department of structural engineering attended a conference on concrete and reenforced concrete specifications, which was held at the Bureau of standards in Washington, D.C. While Professor Cross was in the east, he also attended a meeting of a committee on Structural Engineering at Yale University.

Prof. A. N. Talbot, head of the department of theoretical and applied mechanics was recently honored by the Illinois Society of Engineers by election to honorary membership in that organization. Prof. Talbot, who is one of the three living charter members, was secretary of the society for several years. The other living charter members are C. G. Elliott '77, Washington, D. C., and A. H. Bell, Bloomington.

Prof. E. B. Paine, head of the department of electrical engineering, Prof. O. A. Leutwiler of the department of mechanical engineering, and Prof. Morgan Brooks of the department of electrical engineering attended the meeting of the Midwest Power Conference which was held in Chicago in January.

Prof. A. C. Callen, head of the department of mining engineering, has also recently returned to the campus after a visit in New York where he spoke at a meeting of the American Institute of Mining and Metallurgical Engineers.

Prof. G. A Goodenough of the department of mechanical engineering gave a series of four lectures at the Sheffield School of Science at Yale University during the third week of April.

Two of his lectures were on the subject of chemical equilibrium and the other two dealt with the effect of water particles on the flow of steam in turbine nozzles.

He also spent part of the week at the General Electric Company plant at Schenectady, New York. Prof. Goodenough is a consulting engineer for the company.

At a dinner meeting of the members of the Franklin Institute held in the Bellevue-Stratford Hotel, Philadelphia, Pa., Prof. H. F. Moore of the University gave a talk on the fatigue of metals.

Dean Milo S. Ketchum of the College of Engineering, Prof. C. C. Williams, head of the department of civil engineering and Prof. A. N. Talbot, head of the department of theoretical and applied mechanics represented the University at the annual spring meeting of the American Society of Civil Engineers which was held April 14-16 in Kansas City, Missouri.

Prof. Rexford Newcomb of the department of architecture and also controlling architect for the the Associated Tile Manufacturers was in Pittsburgh, Pa., the week end of March 27th where he held a consultation on the association's pavilion and exhibition at the Sesqui-Centennial Exposition which is to be held next summer in Peoria.

Prof. F. R. Watson of the depart ment of physics went to Chicago the first week in April to assist in the designing of the acousties for the new Stevens Hotel there.

Prof. C. T. Knipp of the department of physics has been appointed by the Illinois State Academy of Science as their representative in the Council of the American Association for the Advancement of Science. He has also been appointed as representative in the section committee of the association for section B for this year.

C. F. Hendrick '26 and E. C. Bray have been elected to student membership in the American Society of Civil Engineers.

Activity in the student chapter and high scholarship is the basis on which the society makes these yearly awards.

Hendrick is president of the student branch at the University this semester and is also associate editor of the Technograph. Bray was president of the student chapter last semester and has also served as president of the engineering student council.

Illinois Clay Manufacturers Association Convention

The forty-eighth convention of the Illinois Clay Manufacturers Association at the University opened April 13th with a luncheon at the University Club.

Prof. H. H. Jordan, assistant dean of the College of Engineering delivered the opening address. In his talk he told of the research work being done in the College of Engineering. Prof. C. W. Parmelee, head of the department of ceramics, and Prof. R. K. Hursh of the department of ceramics also spoke.

The convention, which included members from the Illinois Paving Brick Association, visited the Warm Air Heating Research Residence and the Fatigue of Metals Research Laboratories during the first afternoon it was in session.

On the second day of the convention, officers for the following year were elected. John M. Mamer, Chicago, was elected president; John M. Kleymeyer, Evansville, Indiana, vice president; and Prof. C. W. Parmelee, head of the department of ceramics, secretary-treasurer.

Experiment Station

Bulletin No. 154, "An Investigation of the Translucency of Porcelains," by Cullen W. Parmelee and Pierce W. Ketchum. This bulletin gives a report of the investigations made by the Engineering Experiment Station of the University of Illinois for the purpose of studying the causes of translucency and for the development of an accurate method for the determination of absolute translucencies in porcelain bodies.

Some of the conclusions reached as the result of measuring over four hundred specimens by means of various methods are as follows:

(1) Translucency is not inversely proportional to the thickness of the specimen.

(2) The relation between translucency and thickness is not a linear one as was formerly supposed, but an exponential one.

(3) In bodies composed of clay, feldspar, and flint, those with the highest feldspar content have the highest translucency and those with the highest clay content the least.

(4) Increase of burning temperature gives increase of translucency.

(5) Fine grinding of bodies gives a very striking increase in translucency at the temparatures used.

It was found, however that variation among individual specimens of the same composition is so large that it is necessary to take the mean results from several specimens in order to obtain trustworthy values of translucency.

E. E. Show

The Electrical Engineering Show closed April 10th after a highly successful three-day run. The show was held in the Electrical Engineering Laboratory, the University Wood Shop, and the Gym Annex. The exteriors of the buildings in which the show was held were illuminated by batteries of powerful flood lights, and Burrill Avenue, on which most of the buildings are located, was made as light as day by the temporary addition of many bright street lights.

Some of the features of the show which attracted considerable attention were, the talking movies, the man-made lightning, and the model radio station.

A large number of out-of-town utility companies and electrical concerns leased booths in the Gym Annex for the display of their products. The Illinois Traction System had an attractive exhibit on a spur of the short line tracks consisting of a train of special cars pulled by one of their new electric locomotives.

The money earned by the presentation of the E. E. Show is to be added to a fund, which is being saved by the Electrical Engineering Society, for the establishment of a student loan fund. When the savings reach $5,000 they will be turned over to the University for the beginning of the fund.

Synton

A new society bearing the name of "Synton" has been organized on the campus. Those eligible are radio amateurs or men with an equivalent knowledge of radio. The officers for the semester are: D. H. Vance '27, President; J. Franks '27, Secretary; R. C. Ballard '27, Vice-President; P. H Tartak '27, Treasurer. The charter members are F. Morf '26, P. H. Tartak '27, R. J. Solomon '27, T. Woodrich '27, J. Franks '27, D. H. Vance '27, R. C. Ballard '27, F. Tarborsky '27, G. R. Green '28, E. O. Krueger '27, H. E. Goldenberg '27, I. Ross '27.

The purpose of the society is to get the radio amateurs together in order to promote the interest of radio at Illinois. The plans for the future include several talks by some well known authorities on radio.

Fraternity Activities

Eta Kappa Nu

Soon after the nerve-racking finals became a thing of the past and the second semester had been started on its course, Eta Kappa Nu began looking for pledges. After a careful investigation of the senior and junior electrical engineering classes, the following men were picked to wear the blue and scarlet pledge ribbon: H. E. Keneipp, '27; G. W. Peterson, '27; J. F. Jirousek, '27; R. E. Morrison, '27; C. G. Ketel, '27, and A. H. Demmer, '26. An indoor informal was held April 22 and the outdoor informal on April 29. The formal initiation banquet was given May 6 at the Urbana-Lincoln hotel. Initiation activities had to be postponed to this late date because of the Electrical Engineering Show, to which both the members and pledges gave their whole hearted support.

Pi Tau Sigma

For the second semester Pi Tau Sigma has chosen two seniors and six juniors. The seniors chosen are R. A. Seepe and L. H. Clarkson. The juniors are B. Pruden, W. R. Irwin, H. V. Alexander, G. B. Supple, A. O. Janson, and F. W. Johnson

Prof. A. P. Kratz will be toastmaster at the formal initiation to be held Tuesday evening, May 4 at the Urbana-Lincoln. Professor G. A. Goodenough and A. O. Leutwiler will speak as will each initiate.

The fact that Pi Tau Sigma is fast becoming recognized is evidenced by the fact that chapters have been organized at three colleges during the past year. At present there are two more petitions for chapters under consideration.

Phi Alpha Lambda

Phi Alpha Lambda, honorary general engineering fraternity, resumed activities this semester by giving a banquet at the Phi Kappa house on March 14.

A large number of general engineers turned out and enjoyed an excellent dinner which was followed by several short speeches.

Five men were pledged in the second semester: G. E. Beverly, '26; E. P. Wells, '26; K. L. Mertz, '27; E. F. Todd, '28; and R. H. Landon, '28.

Mu San

Mu San, honorary Municipal and Sanitary Engineering fraternity has in the last semester added three new members to its organization. These are G. H. Turner '28, R. B. Plummer '28, and G. L. DeMent '27. An informal initiation was held at the Champaign-Urbana Sewage Treatment plant. This was later followed by the formal initiation at the Tau Delta Tau house and the banquet at the Urbana-Lincoln hotel. H. A. Vagtborg '26, President, was toastmaster and gave the address of welcome which was followed by interesting talks on "My Most Interesting Experience" by Dr. A. M. Buswell, Professor V. R. Fleming, and Professor M. L. Enger.

On April 8, 1926, an election of officers was held at which were elected, J. C. Sager '26, president, C. L. Hopper '27, vice-president and treasurer, R. B. Plummer '28, secretary and G. H. Turner '28, historian.

Theta Tau

Theta Tau, under a new regime of Officers, is holding its rank long established, the only strictly professional fraternity in the engineering world. The officers, who were elected in January, are H. M. Madsen, '27, Regent; C. B. Supple, '27, Vice Regent; H. W. McCoy, '27, Treasurer; H. R. Helvenston, '27, Scribe; and C. M. Kreider, '27, Corresponding Secretary.

Theta Tau holds its meetings the first and third Thursdays of each month. The first meeting of each month is set aside for the transaction of the chapter's business, while the second meeting is one of a strictly social nature. In recent social meetings, Theta Tau has been host to many interesting and entertaining guests.

Kappa chapter of Theta Tau recently received a visit from Prof. Holman, of the University of Minnesota, who came as an inspector from the Executive Council. Mr. Holman, reports the chapter to be in excellent condition, in all considerations.

In explanation of her policy, Theta Tau selects her men for what they are. Unlike other engineering fraternities, Theta Tau has no scholarship requirements, although a man's average is considered to some degree, an estimation of his worth. Theta Tau men are primarily selected for their prominence in activities and their sociability.

The regular semi-annual initiation banquet, for this semester was held May 2, at the Urbana-Lincoln Hotel. After an eight course dinner, H. W. McCoy '27 presided, as toastmaster. H. M. Madsen, '27 welcomed the newly initiated men, the response to which was given by L. S. Voltz, '27. Speeches were made by Professors Vawter, King, Leutwiler, and Marshall. Theta Tau is pleased to announce her new members:

L. S. Voltz, '27; H. V. Alexander, '27; E. B. Millner, '27; R. A. Williams, '27; R. E. Morrison, '27; G. F. Pauley, '27; G. H. Kenyon, '28; P. R. Bush, '28; R. H. Landon, '28; N. R. Miller, '28; R. B. Sawtell, '28; E. W. Gifford, '28; G. W. Hanney, '28.

Keramos

Keramos Fraternity was organized at the University of Illinois in 1915 by Ceramic Engineering students with a view to encouraging scholarship, practicability and sociability among the students of their department. Juniors meeting certain scholastic requirements as well as the two honor Sophomores are eligible for membership.

The fraternity was incorporated in 1925 under the laws of the state of Illinois. The same year a chapter was installed at Ohio University. It is the plan to expand further as soon as the Ceramics Department of other schools become sufficiently large to warrant the installation of chapters.

The following men were recently initiated:

HONORARY

T. N. McVay

ACTIVES

E. F. Creevy	Al Kleerup
R. G. Erman	Robert Lotz
V. F. Houser	W. N. Noble
O. L. Hammond	H. E. Primm
C. W. Planje	R. D. Rudd
E. T. Wheeler	

The present officers of the organization are:

L. D. Fetterolf, President
R. W. Morgan, Vice-President
R. G. Mills, Secretary-Treasurer.

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Contemporary Engineering News

Gas heating cheaper than coal for insulated homes.

This winter a seven room house, heated by gas, has attracted thousands of Chicago people, who have been interested by the saving in fuel bills which it makes possible. The house is insulated with a patented material which accounts for the conservation of the heat, making possible a saving of from 30 to 50 percent in the fuel bill even when gas is used, instead of coal. The insulating material comes in bags, like cement, and is mixed with water, poured down inside the walls, and allowed to set. It hardens into a sponge-like, porous mass, filled with millions of tiny air cells. The outside walls are covered with sheating and shingles, and the inside with a fire-proof gypsum wallboard. The space between the roof rafters is filled with the insulation the same as the side walls, and there is a two inch layer of the material beneath the lower floor to keep the floor warm and the basement cool.

The house is located in one of Chicago's forest preserves, where the temperatures are several degrees lower than in the crowded city districts. In a thorough test made this winter, automatic thermostatic control maintained a constant temperature of 70 degrees from 4:00 a.m. to 10.00 p.m. and 60 degrees during the night. With gas selling at 75 cents a thousand cubic feet, the fuel cost from October 1 to February 1 was $110, with an estimated cost for the whole winter of $160. Gas engineers claim that it would have cost $350 more to heat the house had it not been insulated.

The interesting part of the test was that the insulation made it possible to heat by gas at a lower cost than that of coal for the ordinary house. There was no furnace tending, ashes, dirt, or soot. Fuel bins were eliminated and the floor of the basement waxed and used for dancing. The gas boiler occupied only a small amount of space. The engineers estimated that to heat an uninsulated house of the same size, 29x40 ft., with five rooms downstairs and two upstairs, would require a boiler with a rating of 1150 feet and a direct radiating capacity of 575 feet. Figuring on the insulation, however, they guaranteed that a small garage or water heater, with a rating of 425 feet and a direct radiation capacity of 213 feet, would keep the house at a constant temperature of 70 degrees. The insulation proved so successful that snow remained on the roof for days, until melted off by the sun, while the roofs of nearby houses were cleared by the heat leakage.

An insulated house will more than pay the cost of the insulation through fuel saved in the first three years, according to a report of the United States Bureau of Industrial Research. Heat, the report states, leaks through lumber, brick, stone and plaster just as it does through glass, though not quite so fast, while the leakage through the special insulating material was almost zero. The cost of the insulation was $435, and approximately that same amount was saved at the start on the cost of the heating plant, since it was possible to install a smaller plant than would have been required to keep an uninsulated house warm.

Use of Gas in Industry Increasing

That gas fuel can be used extensively to take the place of steam for commercial and industrial drying is freely predicted by fuel engineers who are studying new heating methods.

Thanks to the use of city gas, paper manufacturers have finally caught up with the demand for finished paper caused by the enormous increase in advertising circulars and other printed matter of a similar nature. The installation of gas-fired dryers has resulted in a lower cost of finishing paper, as well as increased production, according to engineers who have reported their findings to the American Gas Association.

When paper is finished, in order to give it a lustrous surface, a thin coating of varnish is applied, which was formerly dried by steam. The new method dries the varnish by the radiation of gas heat reflected from the sides of a box into the dryer proper. It has also been found that a more uniform result is thus obtained.

Another example of the use of gas in industry is furnished by a gas furnace possessing all the control advantages of an electric motor, which has been developed by fuel engineers for a chair manufacturing concern in New England. The gas industry has been working to this end for some time and has developed similar furnaces for other industries on a scale which, it is predicted, will effect economies in practically every manufacturing process in which heat is used. In caning chairs, a continuous, uniform, but small amount of steam is required for softening the glue by which the strips of cane are attached to each other. As there was no equipment on the market which exactly filled the requirements, the gas company was appealed to for help.

Gas engineers worked out a scheme by which a gas-fired steam boiler equipped with automatic water feed and a low water cutoff was designed to do the work. It is reported that this installation works with even less trouble and attention than an electric motor, because there are no switches and no oiling is necessary.

WGY International Intercollegiate Night

Sessions of a collegiate League of Nations were broadcast recently by WGY when natives of twenty-one countries, representing seventy-five universities, a total of a thousand men, sang and cheered into the microphone of the Schenectady station. The second annual International Intercollegiate Night of the Edison Club was not all college cheers, however. The programs were produced and broadcast on two successive Saturday evenings. Perhaps in no other city could as many college men, representing as many colleges and countries, be assembled for a similar affair. With very few exceptions, the men are engineers or student engineers of the General Electric Company. All tote slide rules and most of them wear that emblem of scholarship, the Tau Beta Pi key.

WGY used its 50 kilowatt transmitter for the occasion and it is reasonable to assume that these programs of many nationalities were hurled beyond the border lines of the United States. Telegrams came from all parts of the country, usually from alumni who thrilled to the songs and cheers of their college days. Many of the college songs, as well as the cheers, were familiar to radio listeners but other songs, particularly those by the foreign-graduate bodies were new and of special interest.

One of the novelties of the second program was the offering of six Chinese engineers, graduates of four Chinese colleges and two American universities. They sang native college songs and cheered in six different Chinese dialects. A feature was a musical number on a Chinese instrument that looks like a cathedral, feels like a miniature organ, (being about twelve inches long,) and sounds like a flute. It is called a "sen". The British Empire group made up of men from England, Scotland, Ireland, Canada, and South Africa, Australia, India, and New Zealand, gave an exceptionally fine program of singing. The Indians' college song was a combination of song and yell. Twelve graduates of as many German Universities reproduced a night in a German fraternity. The leader announced each new song by rapping on the table with his sword. A toast followed each song and approximate beer was consumed in stein quantities. A feature was the Scandinavian program produced by graduates of Norwegian and Swedish technical schools. The songs of this group produced the heaviest volume of fan applause. The Edison Club quartet and the club orchestra took part in both programs but the heavy work, the accompaniment to eight hours of song, was admirably provided by "Doc" Fendley, University of Kentucky.

New Magneto Drive for Electric Locomotive Tachometer

A new form of magneto drive has been recently developed by the Electric Tachometer Company of Philadelphia in conjunction with the Westing house Electric and Manufacturing Company for the application of electric speed indicators to locomotives. This new drive permits the installation of an electric tachometer outfit in a few minutes time, and eliminates the use of special gears, pulleys or belts.

The outstanding feature of the new design is the method of driving the magneto from the locomotive wheel and the fact that this speed indicator operates independent of all other apparatus where as previous designs were essentially attachments for use with train control. It has formerly been necessary to use special gears or a belt for this type of drive. The new drive eliminates the use of special attachments and also eliminates the possibility of lost motion in a slipping belt. It can be attached to any locomotive by use of ordinary hand tools. No "extras" are required for the installation. The outfit is complete in itself.

The magneto is mounted (with shaft vertical) on the framework above or adjacent to one of the leading wheels on the locomotive. A small gear box is attached to the end of the locomotive axle, outside of the wheel. Only three small tapped holes in the axle are necessary for mounting. A short length of flexible shaft connects the gear box to the magneto. The gear box contains a pair of bevel gears. One of these is attached to the locomotivo axle. The other is mounted in a housing which is free to revolve around the first bevel gear as a center. The flexible shaft is attached to the second bevel gear and prevents actual rotation of the housing, although a small amount of motion is permissible. In action, the housing remains stationary and the gears revolve, transmitting motion through an angle of ninety degrees to the flexible shaft and magneto. This construction reduces the transmission problem to its simplest form and takes care of all movements of the locomotive wheels with respect to the locomotive frame. It allows the magneto to be rigidly mounted, as its heavy construction requires, and at the same time provides a positive drive which is independent of various wheel positions.

The development of this drive, is a decided forward step in the design of locomotive speed indicators. It solves at the same time the problems of easy installation, interchangeability, and independent operation. It eliminates the necessity of an engineer guessing as to whether or not he is going at the speed necessary to keep on schedule. In addition to this it also has been a means of saving fuel due to the fact that the enginemen can judge and regulate the speed of an engine when going up a grade and throw open the throttle soon enough so that it will be unnecessary for any extra effort to be extended to make the grade.

Future of the Oil-Electric Locomotive

Statement by E. H. Outerbridge, former Chairman of the Port Authority of New York.

"There is perhaps no other single factor in industrial life throughout the world today so much in men's minds, so important and potentially so beneficial in its results as economy in productive effort. This is true whether it be individual or collective effort. The Chief Executive of a nation must study and develop the most economic use of his faculties and his time to meet the complex duties that he is called upon to perform; governments, whether national, state or municipal, can only be beneficient if a constant increase in efficiency and economy in cost obtains; the Chief Executive in any great administrative capacity can only preserve his health, strength and efficiency by a scientific arrangement and economy of his effort; manufacturing industries can only be profitable and survive to the degree that true scientific economy permeates all their operations.

"It is a well-known axiom that capital is created only out of savings and it is increasingly true that profits and prosperity are dependent upon a continuous development of economy in productive effort, whether it be in the unit of man-power, of machine work or of administration.

"There is perhaps no other single field in which this principle is as vital as in the production of power. Superpower organization has become a topic of almost daily comment in the public press and great strides towards its accomplishment have already been made. The vision and courage of men bring these things to pass, but economic law and necessity is the underlying force which spurs men to invention and accomplishment and gives the owners of capital the confidence to employ it in such developments.

"There is perhaps no field in the use of power as important to the life and progress of humanity as the power employed in transportation, and of all forms of transportation the one of most vital importance in the United States, because of the extent of territory and its industrial development, is railroad transportation. There is, therefore, no field in the use of power where economy in its production is of such vital importance to the whole nation as economy in railroad power.

"There is no abler body of men in the United States than the trained railroad executives who in their several departments have specialized in every element of economy that enters into transportation operations and their accomplishments are witnessed by not only the most extensive railroad systems in the world, but by

(Continued on Page 200)

ALUMNI NOTES

D. C. Dunlap, c.e. '73 of New Orleans has acquired considerable fame as a civil engineer. He has done a great deal of work as a railroad engineer in connection with which he made several well known inventions including the continuous rail joint now used on all lines. He also invented the Dunlap combined manhole and catch-basin, a self-cleaning device for city sewer systems. During the World War he studied engineering problems and steel construction and designed various towers, switches, etc., for the monorail system of railways. He spent three years as chief engineer of the South Side Elevated Railroad of Chicago and three more in charge of building the Drainage Canal. He had charge of the work of reconstructing a line over the summit of the Rocky Mountains for the Union Pacific Company, made many railroad surveys and reports, and represented a number of Chicago contractors on deep foundations for steel buildings.

Just after his graduation, he began working on railroad surveys, his first one in in 1876 for the Chicago, Pekin, and Southwestern, then the Quincy and Mason City Railway.

In 1879 he was transit man and construction engineer for the Chicago and Northwestern Railway, his first work being 15 miles from Eyota to Plainview, Minnesota. Between 1879 and 1901 he was with the Chicago and Northwestern, the Chicago, Milwaukee and St. Paul, and the Union Pacific as locating and construction engineer.

D. Marsh, c.e., '09, is established as a civil engineer and licensed surveyor in Los Angeles. His activity is chiefly centered in the making of topographical maps for public utilities, architects, real estate operators, etc. He has done considerable work of this kind in the state of California.

H. A. Brown

Hugh Alexander Brown, e.e., '11 was recently married to Carrie Isabel Needham '12 of Urbana. He is well known in electrical engineering circles and is an assistant professor of electrical engineering at the University. In 1911, Professor Brown received his bachelor's degree from the University of Illinois and for the next two years was engaged in the service of the General Electric Company and the Illinois Traction System. He received the degree of master of science from the University and the professional degree of electrical engineer in 1920.

His activities as a teacher began with a teachers course with the Westinghouse Electric and Manufacturing Company which has been followed by a wide and varied teaching experience. During part of 1919 Professor Brown taught physics and electrical engineering at Ottawa College in Ottawa, Kansas. Since then he has spent two years with the University of Arkansas, one year with Penn State University, and five years with the University of Illinois. He is particularly well known for his research work in which he developed a new alkali vapor radio tube with Professor C. T. Knipp and a non-carrier wave system of radio telephone transmission with C. A. Keener.

Professor Brown is a member of Kappa Delta Rho, Sigma Xi, Epsilon Chi, and Eta Kappa Nu.

Mrs. Brown received the degree of bachelor of arts from the University of Illinois in 1912 and attended the School of Languages of Middlebury College in 1922. She was a teacher of French, Latin, and piano in the Urbana High School before her marriage.

A. N. Gonsior, c.e. '14, is manager of the Virginia and Rialto theaters in Champaign. For two and a half years after his graduation he was employed by the Illinois Bell Telephone Company. Following this he spent two years in the World War and then two and a half years with the Sinclair Refining Company after which he entered the show business.

E. E. Barrett

E. E. Barrett, c.e., '93, is a candidate for the board of trustees of the University. He has a long list of activities among which are president of the Alumni Association in 1922 and 1923, member of the Stadium Executive Committee, president of Adelphic

Literary Society, president of his class and business manager of the Technograph. He is president of the Roberts and Schaefer Company of Chicago, engineers in coal mining equipment, and holds several patents for improvements in coal handling devices.

M. J. Trees

M. J. Trees, c.e. '07, is president of the Board of Trustees of the University and has been a member of this board since 1923. In private life he is vice-president of the Chicago Bridge and Iron Works and a member of several professional and social organizations. Mr. Trees is one of the most outstanding alumni of the University of Illinois for the work he has done for the institution since his graduation. In 1911 he received the degree of C.E. for a thesis on the "Design of Elevated Steel Tanks."

S. Walker, c.e., '12, has recently been appointed head of the newly organized engineering and research division of the National Sand and Gravel Association. He has been doing concrete research for the last nine years under the direction of D. A. Abrams at the Lewis Institute at Chicago. In 1923 he conducted some field tests on concrete for a committee of several engineering societies and the Bureau of Standards. Several papers on concrete bear his name as author or co-author. During his student days, he was an assistant to Prof. A. N. Talbot.

C. L. Eddy, r.e., '00, professor of railway engineering at the Case School of Applied Science at Cleveland, has been appointed athletic manager of that institution. He has been active in the interest of Case athletics for the past few years during which time he has had charge of the freshman camp and the Case Club. He represented the school at the Ohio conference meetings and had charge of eligibility questions.

W. L. Abbott, e.e. '84, recently assumed the duties of his new office as president of the American Society of Mechanical Engineers. This is his second position of this nature as he was previously president of the American Institute of Electrical Engineers. Mr. Abbott has always been closely connected with electric lighting work, and is an authority on the subject of lighting. At present he is chief operating engineer of the Commonwealth Edison Company of Chicago.

Contemporary Engineering News

(Continued from Page 197)

transportation costs and charges per ton mile—the lowest in the world.

"For a number of years past much has been heard in the Marine field of a new form of power which has been rapidly growing and supplanting the former types of reciprocating and the later types of turbine steam engines. I refer to the well-known Diesel type of oil burning engine.

"In still more recent times, within only the past few years, invention has made it possible to build the oil-burning engine of much lighter weight per horse power and therefore of less cost than formerly, and through the skill, energy, invention and courage of three associated companies this principle has now been successfully applied in the development of what is known as the OIL-ELECTRIC LOCOMOTIVE.

"It is remarkable how quietly this development took place and that those concerned in and responsible for it said nothing about it and made no predictions for it until they were prepared to put upon the rails for practical demonstration the oil-electric locomotive.

"It is not my purpose and I am not qualified to enter into any technical description of this latest product of invention and science. Up to the limit of size and power so far produced demonstrations have already been given which have so convinced the best experts in railroad operation of its economy and usefulness for certain fields and character of employment that numbers of these engines have already been ordered. It is always ready to go, no time is required to be lost in getting up steam, no waste in blowing off or in banking fires. If its development in higher power units than as yet produced gives equally favorable results for long distance hauls, it will challenge the attention of railroad operating men wherever the steam locomotive is now the main dependence.

"If, as I believe, the draught efficiency of this engine per unit cost of fuel per ton moved greatly exceeds that of the steam locomotive, it would seem as if the oil-electric engine had the potential future of supplanting the present type of steam locomotive as fast as those wear out or as the railroads could afford to scrap them.

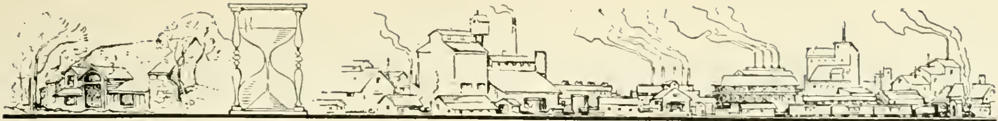
"There is, however, on the other side of this question an important consideration which may place some limitation upon the future of this invention. That question is the quantity and permanency of the supply of fuel oil if a vast and rapid increase in the use of the oil-electric engine should ensue, and the effect upon the price of oil of such increased demand. Judging from recent reports in the public press experts differ vastly in their estimates of the oil supply. Some insist that it is capable of great expansion and of supplying all possible needs for generations to come. Others state that in a few years the available quantities will begin to decline rapidly. With the enterprise of oil prospectors and operators it seems fair to assume that they will be discovering and developing new sources of supply as rapidly as it will be mechanically possible for the developers of the oil-electric engine to produce them in sufficient quantities to seriously affect the oil situation.

"The whole transportation world will watch the exploits of the oil-electric locomotive within the next few years. Without doubt it is a great contribution and has come to stay. Time only can tell whether it will become paramount."

James: "See that woman with the dirty face, daddy?"

Father: "Why, James her face is not dirty, she's that way all over."

James: "Gee Pa, you know everything."



(Continued from Page 192)

held at frequent intervals during the semester at which faculty members and practicing engineers will speak on topics of interest to all general engineering students.

Another short business meeting was held in the Union Building on March 23. F. M. Collins, '28, was selected to represent the General Engineering students as sophomore member of the Engineer's Co-operative Society Board of Control.

Chemical

We heartily welcome Dr. D. B. Keyes of the U. S. Industrial Alcohol Co., Baltimore, Md., to our University. Dr Keyes has accepted a professorship in industrial chemistry to become effective in September, and will succeed Prof. S. W. Parr, who is expected to be retired in September under the new plan of retiring professors. Dr. Keyes was graduated from New Hampshire College in 1913, and received his master's degree from Columbia University. He was given a doctor's degree from the University of California in 1917. He has worked with the U. S. Industrial Alcohol Co. since 1919.

Prof. S. W. Parr, head of the division of industrial chemistry has been awarded the eighth annual Chandler gold medal for achievement in chemistry. This award is in recognition of Prof. Parr's discovery of the method of coking Illinois coal, his invention of the Parr Peroxide Calorimeter, and his discovery of the alloy, Illium. He delivered the 1926 Chandler lecture on April 23 at Columbia University at which time the medal was presented. The Chandler medal and lectureship was secured through subscription by the alumni and students of the School of Mines at Columbia University in 1910 in honor of Charles F. Candler, head of the department of chemistry. The original medal was presented to Prof. Chandler at a banquet in his honor when he retired from the staff in 1910. The balance was to provide that a replica of the medal be given to each Chandler lecturer.

On April 6 Prof. B. S. Hopkins and J. Allen Harris presented their paper, "Element Number 61" before the first general session of the American Chemical Society at Tulsa, Oklahoma. With the aid of slides and charts the two chemists explained their work, and gave ample proof of the existence of element 61 in the samples with which they worked.

At the March meeting of the American Chemical Society, Prof. Taylor of Princeton University gave a very interesting talk on "The Theory and Mechanism of Catalysis." At the April meeting Prof. Willard of Michigan spoke on "Modern Analytical Chemistry." Slides were employed to show the latest and most efficient types of equipment for electrometric, colorimetric, and spectrometric analysis.

Ceramic Notes

Keramos Fraternity gave a smoker for the Junior ceramists in the Union Building on March 9, 1926. Prof. Parmelee gave a short talk on work in the ceramic industries. The Student Branch of the American Ceramic Society held a regular meeting in the Ceramics Building, March 11. Pres. Jack Baer presided. Dr. Andrews discussed research in a general way as to the methods and purpose and correlation of results.

The Ceramic Department has purchased special equipment in order to carry on the study of the coefficient of expansion of ceramic materials at high temperatures.

Chuck Abney, '25, who is now employed by the Columbia Brick and Tile Company, has been promoted to superintendent of the plant at Columbia, Ga.

A. V. Bleininger, former head of the Ceramic Department of this school and now chief ceramic engineer for the Homer-Laughlin China Company, gave a very interesting lecture recently on the production of the "Desirable Properties of Pottery Bodies."

The Sophomore class of Ceramic Engineers visited different ceramic plants located at Danville. They inspected the Western Brick Company's Plant No. 1, Danville Brick Plant, and the General Refractory Plant.

J. R. Greene, '22, gave a talk on Pyrometry, on April 8, at the regular meeting of the S. B. A. C. S. He explained the different temperature measuring instruments and the use best suited for each. Mr. Greene is employed by the Brown Instrument Company. Dr. Westman published an article on Thermoelectric Pyrometry in the April issue of the Canadian Chemical and Metallurgical Magazine.

Two very interesting talks on Enamels were given by H. F. Staley of the Metal and Thermite Corporation on April 20. The Illinois Clay Manufacturers' Association inspected the Ceramic Department on April 13. H. B. Gray, of the Vitreous Enamel Company of Cleveland, Ohio, was here interviewing the Seniors concerning jobs.

(Continued from Page 195)

Scarab

The annual Scarab Competition is now being held, the subject being "A Campanile for a Smoke Stack." The competitors on the final exercise are John R. Sweet, '27; C. C. Braun, '27; C. J. Pillow, '28; Arthur Wupper, '27; and M. R. Beckstrom, '28. The final drawings are due April 16, at which time they will be judged and the Scarab Bronze Medal awarded to the winner.

Scarab was founded at the University of Illinois in 1912. Since that time it has grown into a national architectural professional fraternity, having chapters now at Washington University, Massachusetts Institute of Technology, Pennsylvania State College, Armour Institute of Technology, and the University of Kansas.

The Scarab fraternity also sponsors a national competition for a silver medal every year, as well as an annual sketch problem.

Gargoyle

Gargoyle was founded in 1902 at Cornell University, Ithaca, New York. The local chapter was established here in January 1917. The society is strictly honorary and selects its membership from men of high scholastic ability in the architectural department. The activities of the organization consist chiefly in monthly meetings at which papers are read by the active members. Gargoyle proposes to award a certificate to the freshman in arch. and a.e. who makes the highest average, beginning this year. The members from the faculty are Prof. Palmer, Prof. Newcomb, Prof. Provine and R. E. Spangler.

Delta Mu Epsilon

The Honorary Mining fraternity, during its last meeting, held an election of officers. Mr. L. S. Voltz was elected president for this semester, L. R. Young, vice-president, B. H. Melvin, secretary, and R. Loger, treasurer. The pledges this semester are J. Seidel, H. Plumister, and M. Hartman.

Mr. H. Moses, general superintendent of the U. S. Steel Coal Mine at Bunsenville, Illinois, was pledged as an honorary member.

The formal initiation banquet was held May first at the Inman Hotel. On April 25 an informal initiation was held for the new members at the Bunsenville mine.

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We Call This a Dirty Dig

First Engineer: "Do you know anything drier than chewing on a new blotter?"

Second Ditto: "Sure thing—reading the TECHNOGRAPH joke section."

Before the Flood

"It will all come out in the wash," said the contractor as he looked at the bridge he had just built.

—Iowa Frivol.

Welcome

"So I told the freshman to indorse the check his family sent him."

"Did he do it?"

"Yes. He wrote on the back, 'I heartily indorse this check'."

—Princeton Tiger.

Calorics

Batty: "Betty, do you smoke?"

Betty: "Almost."

Hat Check Girl: "Aren't you going to give me a tip? Why, the champion tight-wad of the town gives me a dime.

Old Gent: "Well, gaze upon the new champion."—Iowa Transit Tremens.

A certain railway engineer who had made a complete study of the oil losses on his particular run, made it his first duty to instruct new firemen in the care of oil so as to eliminate these losses. On one occasion he was quizzing a new fireman on the duties of his post.

"What would be the most important thing to do in case of an unavoidable head-on collision?" he querried.

Without a moments thought he shouted, "I'd shut off the lubricator, grab the oil can, and jump."

Automotive Engineering

Axle—Swedish name, male.

Clutch—Term for affectionate posture taken by spooners and midnight joy riders. Known as "Half Nelson" in wrestling.

Flat Tires—People who get panicky when you do twenty-five and want to get out and walk when you hit thirty.

Bolt—Action taken when you hear a cop's whistle.

Nut—One-armed driver, speeder, etc.

Spark Plugs (obs.)—Term formerly applied by youthful Romeos to the old gray mare of the days of the buggy.

Brake—Faus Pas, such as calling your friend's car a "hunk of tin," etc.

—California Engineer.

Post Grad: "How are your brothers?"

Young Brother: "Just fine."

Post Grad: "What are they doing now?"

Young Brother: "Oh! One is an engineer, and the other one works."

Interviewer: "And so you made your gigantic fortune manufacturing just simple rubber bands. Surely you must have a business motto. What is it?"

Rubber Band King: "Make it snappy."

Applicant: "I am a graduate of the College of Engineering at the University of Illinois."

Employer: "Well, I guess I'll give you a chance anyway."

Critic: "What does this picture represent?"

Artist: "Satan's Daughters."

Critic: "Oh, Hell's Belles, eh?"

—Oregon State Tech Record.

We Hope No One Gets This One

She (after riding three hours): "Don't you ever stop to look at your engine?"

He: "Oh, no. This is a Packard, you know."

Vassar Grad: "Statistics show that the Harvard graduates who are married have an average of two children."

Harvard Grad: "That so?"

V.G.: "Yes, and statistics also show that the Vassar graduates who are married have an average of three children. What do you suppose that shows?"

H.G.: "Why that simply shows that women have more children than men."

—Transit Tremens.

"What does the professor of Chemistry get?"

"Oh, about $3,000 a year."

"And the football coach—"

"About $12,000 a year."

"Quite a discrepancy."

"Well, did you ever hear 40,000 people cheering a recitation in chemistry?"—Bison.

Cutting Comments

Any woman will look before she leaps—if there is a mirror handy.

In marriage, he who hesitates—is bossed.

The silk stocking was introduced in the 16th century, but it was only recently that all of it has been discovered.

Everything comes to him who tips.

—Canadian Magazine.

Examination question—Who chased who around the walls of what and why; if not why not? Answer yes or no.

A Handbook on the Generation and Use of SUPERHEATED STEAM and related subjects.

Just Published

THIS HANDBOOK is for steam power plant engineers and operators. It contains condensed data, well indexed for ready reference. Superheat Engineering Data is not intended to displace standard handbooks. But it is different. Much of the information it contains can be found in no other single publication. For instance, practically all types of stationary boilers commonly made in America are illustrated and brief comparative data is given as to sizes, tube sizes, arrangement of tubes, etc. In fact, much of the data has not hitherto been published and because of its character, one would have difficulty in securing it unaided.

Some of the Data Contained in the Book

- Superheated steam, its advantages over saturated steam and the proper design and performance of superheaters.
- Superheated Steam for Heating.
- Cylinder Lubrication with Superheated Steam.
- Superheater arrangements are illustrated for all types of boilers for stationary, marine and locomotive services, including waste heat, portable and separately fired superheaters.
- Data required to design stationary superheaters.
- Steam Tables covering pressures from below atmospheric to 600 lb., absolute, including properties of superheated steam from 50 to 300 deg. F., superheat.
- Specific heat of superheated steam.
- Reduction of superheat due to moisture.
- Complete information for figuring piping for handling water, saturated and superheated steam. Piping data includes proposed American Standard for high pressures. Also velocity and pressure drop of water and steam flowing through piping.
- Engineering data on coal and oil fired boilers, including tables giving heat value of gaseous, liquid and solid fuels.
- Data on bolts and screw threads, including recent work of American Engineering Standards Committee and National Screw Thread Commission.
- Conversion Tables.
- Many miscellaneous tables commonly used by steam engineers.

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lowest final cost per unit of production.

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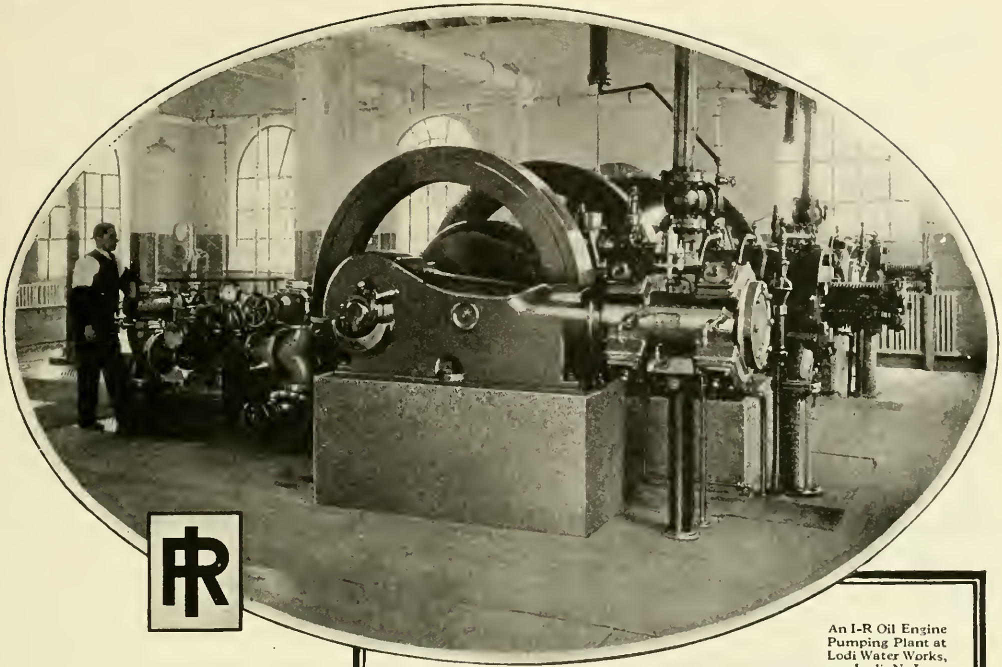


An I-R Oil Engine Pumping Plant at Lodi Water Works, Lodi, N. J.

Open Ditch Diagrams

(Continued from Page 187)

depth of flow are known factors.

The use of the diagrams can perhaps be explained to the best advantage of several examples:

EXAMPLE 1: Given Q=450 sec. ft., n=.030, s=.0003. Side slopes 1:1. To find the bottom width and depth of channel required.

Figure 1 is arranged with a special scale for discharge when n=.030 and one step in the general solution of this type of problem is eliminated. Project a straight line through the points s=.0003 and Q′=450 sec. ft. (Q′ is the scale of discharge when n=.030) to the scale Q at the center of the diagram. This line intersects the Q reference line at about 525 second feet. Through this last point, any straight line intersecting the scale of bottom widths, B, and tangent to one of the depth curves D gives values of bottom width and depth which satisfy the conditions. For example: B=8, D=10—; B=12, D=8.7; B=16, D=7.7; B=20, D=7.0—; and so on.

EXAMPLE 2: Given Q=450 sec. ft., n=.035, s=.00075, Side slopes 1:1. To find the bottom width and depth of channel required.

On Figure 1 draw a straight line through the points Q=450 second feet (on the scale in the center of the diagram) and n=.035. On the scale of discharge for n=.030 read Q′=520 second feet. Draw a straight line through this point (Q′=520) and s=.00075 to an intersection with the Q scale in the center of the diagram at 383 second feet. Through this last point, any straight line intersecting the scale of bottom widths, B, and tangent to one of the depth curves, D, gives values of bottom width and depth which satisfy the conditions. For example B=10, D=7.9+; B=16, D=6.5; B=20, D=5.8; and so on.

EXAMPLE 3: Given bottom width 16 ft., depth of flow 6.0 ft., s=.0006=.06 percent, n=.035. To find the velocity and discharge.

Figure 2 is arranged with a special scale of velocities when n=.035 so that one step in the general problem is unnecessary in this case. Enter the diagram at the point A corresponding to a bottom width of 16 ft. Proceed vertically to the solid line corresponding to a depth of 6.0 ft. at the point B. At the point B, interpolate between the dotted curves and read the cross-sectional area equal to 132 sq. ft. Draw a line horizontally from the point B to the scale of hydraulic radii at the point C. From the point C draw a line through the hydraulic radii at the point C. From the point C draw a line through the hydraulic gradient scale for s=.06 per cent and read the velocity for n=.035 at E equal to 2.61 ft. per sec. The discharge is then equal to 2.61×132=344 sec. ft.

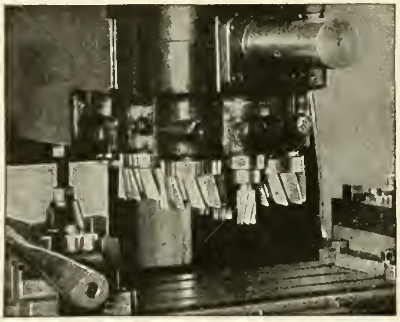
Open Ditch Diagrams

EXAMPLE 4: Given the same data as in Example 3, except that n=.030. To find the velocity and discharge.

Proceed as in example 3, finding the area=132 sq. ft. and the velocity for n=.035 equal to 2.61 ft. per sec. Draw a line through the point E (velocity for n=.035) and n=.030 on the n scale and read the velocity for n=.030 on the scale of hydraulic radii at G, equal to 3.05 ft. per sec. The discharge in this case is 3.05×132=402 sec. ft.

Diagrams of the kind herein presented offer a sufficiently accurate and exceedingly rapid method of determining proportions of ditches when capacities, slopes and roughness factors are known. They are equally convenient when applied to unsteady flow calculations where backwater or drop down curves are to be determined. With regard to their accuracy in these problems the writer has come to the conclusion, after checking a number of analytical calculations against calculations with the diagrams, that the differences in the results are within limits of accuracy imposed by uncertainties in roughness coefficient values.

[1] *Engineering Record*, June 8, 1901.
[2] *Engineering News-Record*, January 25, 1923.



More cuts per minute by adding more good cutters

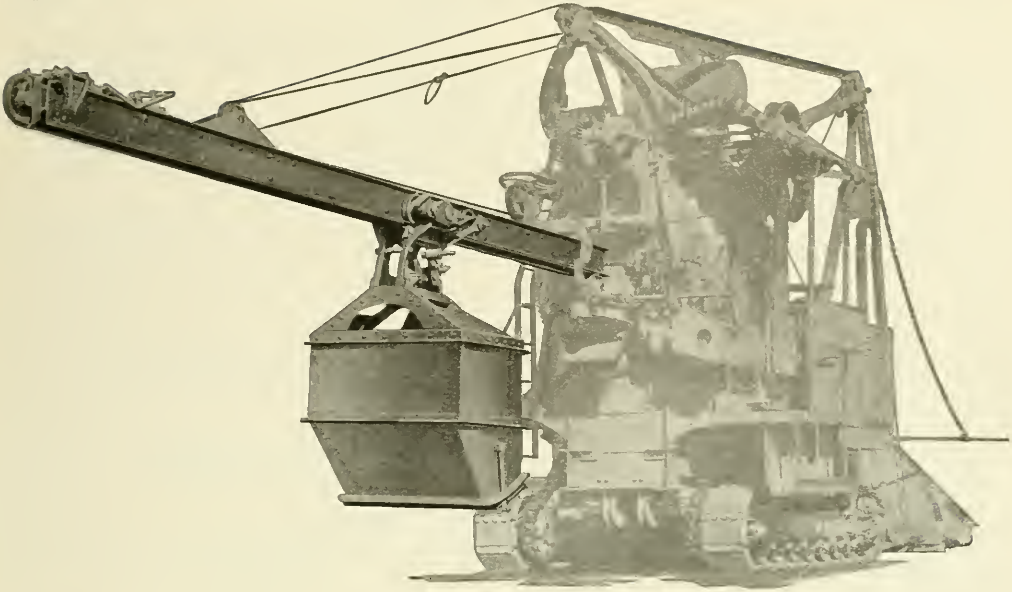
IN the endeavor to achieve quicker and more economical methods in milling, the number of cutters used in a single set-up has tended to increase. This is particularly true of automotive shops where high production is the watchword.

Two automotive jobs are shown. Above is a Brown & Sharpe Automatic Milling Machine which fairly bristles with cutters. Eight Brown & Sharpe cutters—four Coarse Tooth End Mills and four Spiral Shell End Mills—are used. Below is a view of an operation on a Brown & Sharpe No. 13B Plain Milling Machine in which six Brown & Sharpe Coarse Tooth Side Milling Cutters and three Spiral Shell End Mills (in back) are used.

The advantage of such operations depends largely on the durability of the cutters. Too frequent stops for sharpening or changing cutters are disastrous to the production schedule. As the best insurance of durability, long life, and long service between sharpenings Brown & Sharpe Cutters were chosen for these and many similar jobs.

BROWN & SHARPE MFG. CO.

PROVIDENCE, R. I., U. S. A.



Construction Engineering

(Continued from Page 173)

dom lingers." Wisdom is classified and analyzed knowledge applied to the case in point and comes more largely from experience than from learning or intuition.

It has been quite customary in contract work up to within the last decade to designate the engineer as the final court of jurisdiction in all questions which may arise as to the performance of the contract. This system has given rise to many disputes, many of them resulting in suits at law. It is coming to be quite generally believed that the interests of society will be better served by providing in all construction contracts for some reasonable method of arbitration. Contract form A. I. A. No. 1, which contains an arbitration clause, has been adopted by the American Institute of Architects, and is recommended by its members to their clients for use.

Finally, let me say that your success in any line of endeavor will be predicated largely on intelligent work. Set up your mark and keep shooting at that mark, and no other, until you score a bull's eye. Don't forget that material gain is only an incident of success, not the end. No agency, institution, structure or effort can permanently succeed that is not founded in righteousness. The highest type of building is character building. You are the architect of your fate. Edgar Guest well expresses it in this short poem:—

"All that stands between your goal
And the deeds you hope to do,
And the dreams which stir your restless soul—
Is you!

The way is rough and the way is long
And the end is hid from view,
But the one to say if you shall be strong—
Is you!

Oh, the world may smile or the world may frown
And the skies be gray or blue,
But the one who shall travel up or down—
Is you!

Though far it seems to the gleaming top
And the day brings dangers new,
The only one who can bid you stop
Is you!

For whether you work or whether you play,
Are false to your best or true,
Rests not with your friends or foes to say—
But you!"

He—"What would you say if I should kiss you?"
She—"At last!"

Municipal and Sanitary Engineering

(Continued from Page 176)

Hamburg. During the epidemic, the deaths per 10,000 in Hamburg numbered 134 whereas in Altona 23 per 10,000 died of the disease. Filtration not only reduces the death rate of water borne diseases but a noticeable reduction in deaths from other diseases, especially infant diseases is apparent from a study of morbidity tables.

The field of Municipal and Sanitary engineering has broadened out enormously in the past fifteen years. Communities are more educated in the need of sanitation; agitation for the protection of fish and animal life in the streams has brought cities to build sewage treatment plants; state and national legislation has compelled cities to rebuild complete sewerage systems for better sanitation and protection of health. A few years ago, boards of health consisted of medical men only but today engineers fill many of these positions.

This article has been limited by space and has not intended to in any way cover the field of sanitary science. It is intended to convey a few facts and ideas which will give the reader the significance of Municipal and Sanitary engineering. The real significance lies in the benefits to mankind in the protection of its health.

Bronze Welding

(Continued from Page 183)

weld areas before heating. Then heat the surfaces of the weld areas of the base material to a low red only, keeping the flames neutral and applying it so the entire surface will be brought to an even heat. Keep the inner cone of the flame from coming in contact with the bronze, as it will burn the bronze and weaken the joint. Apply flux as usual while welding; that is, after heating the surfaces of the weld areas to a dull red, sprinkle on a little flux and occasionally dip the hot end of the rod in the flux. When sealing a long crack with Tobin bronze, spot at the extreme ends and in the center, filling in between the spots until the weld is complete, starting at the center of the casting and working toward the edge. Avoid overheating by not applying the flame continuously to the same place and try to completely fill each section of the "V" opening with one application of the Tobin bronze.

The advantages of using Tobin bronze welding rods can be summed up briefly as follows: 1. Tobin bronze welds have the strength of mild steel and from two to three times the strength of cast iron. 2. Welds are made with bronze in about one-quarter the time and proportionally less gas than is required when welding with steel or iron. 3. Welding with the mild heat required for Tobin bronze does not expand the base material sufficiently to cause warping or cracking. Consequently extensive preheating is unnecessary and the weld can usually be made without the expense of dismantling and reassembling. 4. With ordinary care the base material need not be burned. 5. Tobin bronze welds will not rust and provide unusual resistance to corrosion.

The Jackson Building

(Continued from Page 171)

this job had to be driven in the field because of clearance limitations. Two good examples of the sort of connection that requires field riveting may be seen in Fig. 4. The stiffening angles on the slope of the bracket that is seen beneath the main floorbeam had to be field driven because the bracket could not be connected to the beam with the stiffening angles in place. Then, in the extreme lower left, the shelf angle on the little spandrel beam had to be shipped bolted so that it could be taken off while the wind bracket was being riveted.

The structural frame in this particular case represented about ninety percent of the job in so far as trial and tribulation were concerned.

"My sister's like a radio program."

"How's that?"

"Anybody can pick her up."—*Western Weekly.*

"My girl called me down for kissing her."

"Well, I wouldn't take any of her lip."

"Don't flatter yourself. She wouldn't give you the opportunity."—*N. Y. Medley.*

"Ye remind me of the wild sea waves."

"Oh-h-h, because I'm so restless and unconquered?"

No. Because you are all wet and you make me sick."

SAFETY FIRST

"What 'ya mean goin' fifty miles an hour?"

"My brakes don't hold and I was hustling to get home before I had an accident."

SIDE-STEPPER

Father—"My son, I'm afraid that I will never see you in heaven."

Son—"Whatcha been doing now, Pop?"

—*California Engineer.*

A SHORT CIRCUS

Wife—"Wire you insulate? Watts the matter?"

Husband—"Fuse where I was you'd be late too."

Wife—"This is positively shocking. If it happens again I'll get a switch and socket to you, and I conduit too."—*The Tech Owl.*

Buckets of Brawn for Bearings

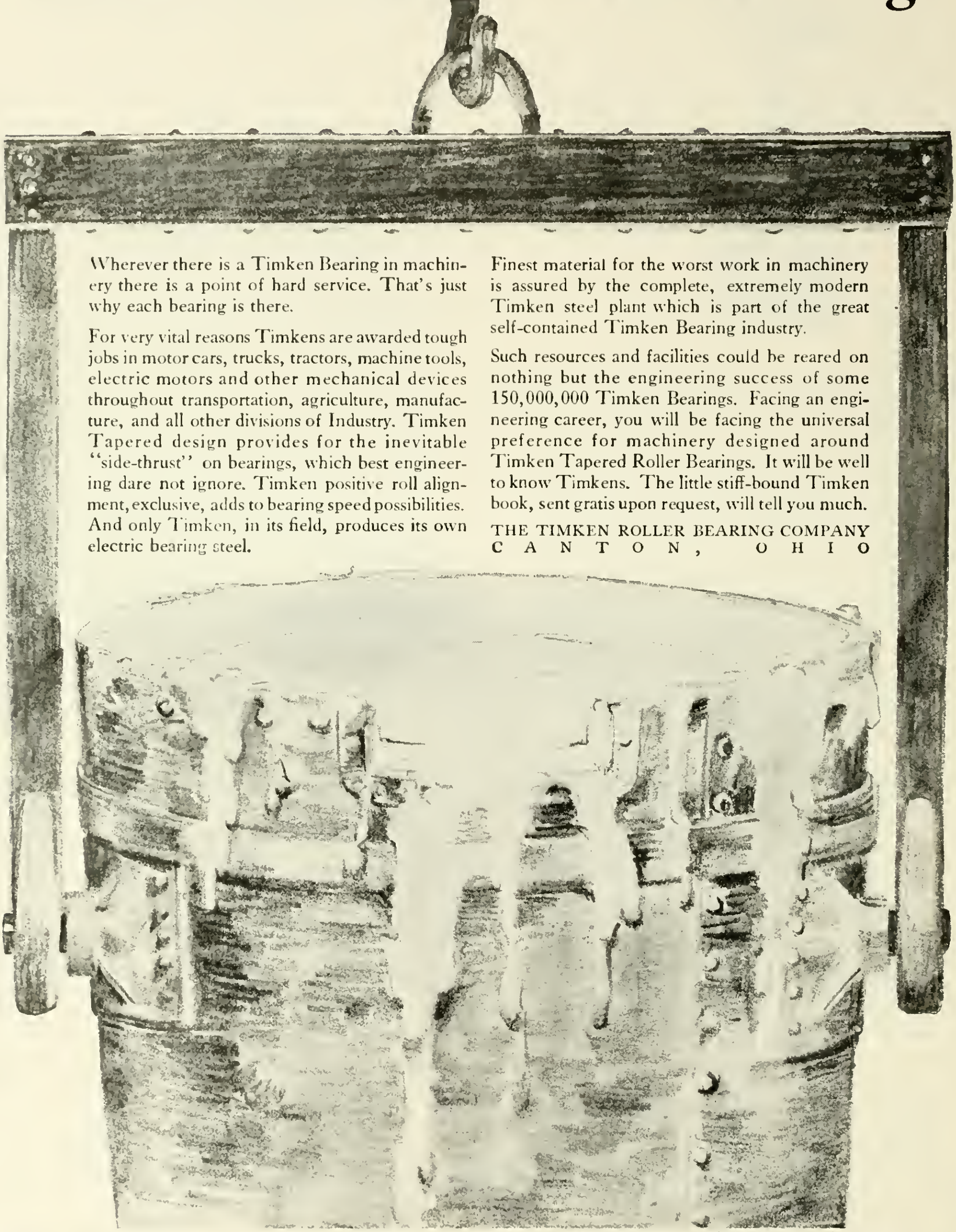
Wherever there is a Timken Bearing in machinery there is a point of hard service. That's just why each bearing is there.

For very vital reasons Timkens are awarded tough jobs in motor cars, trucks, tractors, machine tools, electric motors and other mechanical devices throughout transportation, agriculture, manufacture, and all other divisions of Industry. Timken Tapered design provides for the inevitable "side-thrust" on bearings, which best engineering dare not ignore. Timken positive roll alignment, exclusive, adds to bearing speed possibilities. And only Timken, in its field, produces its own electric bearing steel.

Finest material for the worst work in machinery is assured by the complete, extremely modern Timken steel plant which is part of the great self-contained Timken Bearing industry.

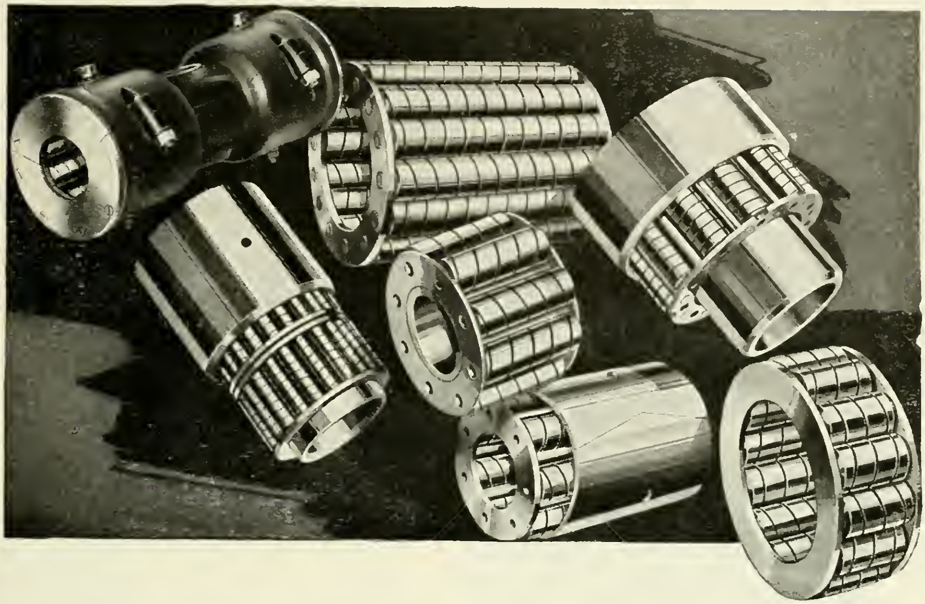
Such resources and facilities could be reared on nothing but the engineering success of some 150,000,000 Timken Bearings. Facing an engineering career, you will be facing the universal preference for machinery designed around Timken Tapered Roller Bearings. It will be well to know Timkens. The little stiff-bound Timken book, sent gratis upon request, will tell you much.

THE TIMKEN ROLLER BEARING COMPANY
CANTON, OHIO



The world's largest producer of electric furnace steel is Timken. In these giant buckets or "ladles," the liquid Timken steel leaves the furnaces to go through all the processes of manufacture, entirely within the Timken plants

TIMKEN Tapered Roller BEARINGS



There's a Hyatt Answer to Your Bearing Question

Hyatt Roller Bearings are used the world over. They are installed in numerous types of equipment—manufacturers representing over forty different industries include them as standard in their products.

A large majority of all American made gasoline tractors and power farm implements depend upon Hyatts for efficient bearing performance. Nearly all the better grade of passenger cars and trucks are equipped with them.

Their application in lift trucks, trailers, etc., has increased the load pulling capacity of workmen.

In steel mills where bearings are subjected to terrific thumping service, Hyatts guard against breakdowns and delays.

Textile machinery, line shafts, contractor's equipment, conveyors, etc., operate at maximum capacity for longer periods and at less expense when easy turning Hyatts are substituted for the rubbing friction of ordinary bearings.

In nearly every country on the globe, Hyatt equipment is selected when constant dependable service must be assured. For thirty years and more, the use of Hyatt Roller Bearings has been expanding. You, perhaps, will some day assist in extending their use. When that time comes, the resources of Hyatt are at your disposal. *Hyatt Roller Bearing Company, Newark, N. J.*

HYATT

ROLLER BEARINGS

They call it the "Pierce Type"

R. T. PIERCE

When the class of '15 at Maine was being graduated, the name "Pierce" meant no more in the field of metering than Sweeney or Jones. Today, however, if you'll talk to such companies as the Detroit Edison Company, The Southern California Edison Company, the Duquesne Light Company, or the United Verde Copper Company, you'll learn that "Pierce" means a type of remote metering, which enables a man in a central dispatcher's office to read the condition of a sub-station several miles away.

Superpower brought in the need for an improved method of remote metering, and R. T. Pierce, Maine '15, in the employ of Westinghouse, devised it. He designed a system that operates on a new and different principle, and that has met with general acceptance in the Central Station field. He also was active in the recent re-designing of the entire Westinghouse instrument line.

The question is sometimes asked: Where do young men get when they enter a large industrial organization? Have they opportunity to exercise creative talents? Or are they forced into narrow grooves?

This series of advertisements throws light on these questions. Each advertisement takes up the record of a college man who came with the Westinghouse Company within the last ten years or so, after graduation.

It was only a few months after Pierce had completed the graduate student course at Westinghouse that he was given an assignment in the instrument section of the engineering department. He took it merely as a "fill-in" job. Soon he saw that instruments play a vital part in every electrical operation. As an instrument engineer, Pierce spent several weeks on the U. S. S. Tennessee and the Colorado during their trial runs. He has ridden in the cabs of electric locomotives. He is in closer touch with radio than anyone not a radio engineer.

A design engineer comes continuously in contact with sales negotiations, and Pierce's contact with them proved so beneficial that he was lately made head of the Instrument Section of the Sales Department, which means that he really has charge of the sale of all instruments to Westinghouse customers.

Westinghouse

Photograph by courtesy of Captain R. R. Belknap, U. S. N.

Fighting Submarines with Elevators

When the American people answered "War" in 1917, no matter was of more importance than the readjustment of the great industries to the conditions of war, and no contribution to national defense was more exacting than that of the Otis Elevator Company.

It was a long way from the ordinary operations of business buildings throughout the country to the North Sea in war time, yet strangely enough Otis automatic leveling or micro-drive elevators proved one of the most valuable innovations in connection with naval warfare.

Up to the time the American Navy became a factor in the World War, it had been impossible to lay, in the North Sea, the contemplated mine barrage, which it was hoped could be used to prevent submarines from skirting the north end of the British Isles. This had been impossible, because the time required to get the mines overboard prevented successful results. The Otis Elevator Company cooperated with the American Navy and provided automatic leveling elevators for the delivery of the mines from the hold of the mine layers to the main deck, where they could be put overboard at such frequent intervals as to make the laying of the barrage a success.

In an article published several years ago, Captain Belknap, U.S.N., who was in command of the mine laying squadron at the time, stated that in the nine months or more of operation, in which sixty thousand mines were handled in and out, as well as many more in the course of drills, there was only one occasion in which any one of the thirty-two elevators was shut down. This was the fault of the operator, not the elevator, in that it was run too far up and jammed there for a few hours, but without causing any delay in the mine laying operation.

In war as in peace, the Otis Elevator has become one of the indispensable parts of our civilization.

Otis Micro-Drive Elevators, as developed for the mine laying ships and for the great Army and Navy Bases at New York and Boston, are now in constant use throughout all parts of the country in office buildings, hotels, department stores, warehouses, terminals and factories. The automatic leveling feature eliminates "inching" at the floors, obviates the stumbling hazard in passenger elevators, as well as saving time in operation, and increasing the life of the apparatus. On freight elevators it also provides an exactly level landing to facilitate the handling of freight.

OTIS ELEVATOR COMPANY

Offices in all Principal Cities of the World

Crows

In a field in sunny Spain stands a stone mortar. Crows hover around it, picking up bits of grain and chaff—cawing.

Here Marcheta, in the fresh beauty of her youth, will come to pound maize. For years she will pound maize. The stone will stand up under the blows; not a dent has the muscle of three generations of women made upon it. But the crows will hurl their black gibes upon a woman aging early and bent with toil. *Old Marcheta*—still in her thirties.

The American woman does not pound maize. But she still beats carpet; she still pounds clothes; she still pumps water. She exhausts her strength in tasks which electricity can do better, and in half the time.

The high ideals of a community mean little where woman is still doomed to drudgery. But the miracles which electricity already has performed indicate but a fraction of the vast possibilities for better living and the tremendous opportunities which the future developments in electricity will hold for the college man and woman.

Electricity, which can release woman from her burdens, has already created a revolution in American industry. Wherever mankind labors, General Electric motors can be found carrying loads, driving machinery and saving time and labor. And there is no branch of electrical development today to which General Electric has not made important contributions.

A series of G-E advertisements showing what electricity is doing in many fields will be sent on request. Ask for booklet GEK-1.

7-72DH

GENERAL ELECTRIC

GENERAL ELECTRIC COMPANY, SCHENECTADY, NEW YORK